SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY

CONTRACT SPECIFICATIONS
FOR
TRACTION POWER SUBSTATION REHABILITATION

CONTRACT 5 – BROAD, LOUDON, PARK, AND CASTOR SUBSTATIONS

Volume 1

APRIL 1, 2026

50% SUBMISSION

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TABLE OF CONTENTS

DIVISION 01 — GENERAL REQUIREMENTS
01010 - Summary of Work
01025 - Measurement and Payment
01045 - Cutting and Patching
01050 - Field Engineering
01060 - Regulatory Requirements and Safety
01061 - Safety and Security Certification Requirements
01100 - Special Project Procedures
01200 - Project Progress Meetings
01300 - Submittals
01305 - Requests for Information
01380 - Construction Photographs
01400 - Quality Requirements
01410 - Inspection and Test Plans
01420 - Testing and Inspection Services
01452 - Contractor Quality Control - Traction Power Equipment
01500 - Construction Facilities and Temporary Controls
01505 - Mobilization and Demobilization
01510 - Maintenance, Support and Restoration of Existing Utility Facilities
01570 - Maintenance and Protection of Vehicles, Pedestrians and Passengers
01580 - Project Identification Signs
01590 - SEPTA Field Office
01600 - Materials and Equipment
01612 - Delivery, Storage and Handling - Traction Power Equipment
01700 - Contract Closeout
01710 - Final Cleaning
01720 - Project As-Built Documents
01752 - Spare Parts and Maintenance Materials - Traction Power Equipment
01810 - Commissioning of Systems
01820 - Demonstration and Training
01822 - Demonstration and Training - Traction Power Equipment
01830 - Operations and Maintenance Data
01832 - Operations and Maintenance Manuals - Traction Power Equipment

DIVISION 02 — SITE CONSTRUCTION
02070 - Selective Demolition
02080 - Hazardous Material Abatement
02081 - Asbestos Abatement
02082 - PCB Abatement
02083 - Heavy Metals Abatement
02084 - Petroleum Contaminated Material Abatement
02085 - Lead Paint Abatement
02205 - Impacted Soil Management
02209 - Geotextile Fabric
02220 - Excavation, Backfill and Compaction
02230 - Subbase
02270 - Erosion and Sedimentation Control
02520 - Bituminous Concrete Paving
02533 - Cement Concrete Sidewalk and Driveway Apron

02724 - Manholes
02821 - Chain Link Fences and Gates
02822 - High Security Ornamental Fences and Gates

DIVISION 03 — CONCRETE
03100 - Concrete Forms
03200 - Concrete Reinforcement
03300 - Cast-In-Place Concrete
03600 - Grout
03710 - Remove Efflorescence From Concrete
03930 - Concrete Repair
03932 - Concrete Wall Repair

DIVISION 04 — MASONRY
04011 - Masonry Cleaning
04012 - Brick Masonry Repair
04014 - Stone Restoration
04200 - Unit Masonry
04212 - Terra Cotta Masonry
04270 - Glass Unit Masonry Assemblies
04720 - Cast Stone

DIVISION 05 — METALS
05090 - Metal Fasteners, Joining and Welding
05120 - Structural Steel
05310 - Steel Decking
05500 - Metal Fabrications
05511 - Metal Grating Stairs
05520 - Handrails and Railings
05610 - Miscellaneous Metals
05900 - Metal Restoration and Cleaning

DIVISION 06 — WOOD, PLASTICS, AND COMPOSITES
06105 - Miscellaneous Carpentry
06610 - Glass Fiber Fabrications

DIVISION 07 — THERMAL AND MOISTURE PROTECTION
07190 - Water Repellents
07210 - Building Insulation
07500 - Membrane Roofing
07590 - Preparation for Re-Roofing
07620 - Sheet Metal Flashing and Trim
07720 - Roof Accessories
07841 - Penetration Fire Stopping
07842 - Joint Fire Stopping
07900 - Joint Sealers

DIVISION 08 — DOORS AND WINDOWS
08110 - Metal Doors and Frames
08331 - Overhead Coiling Doors
08710 - Door Hardware
08800 - Glazing

DIVISION 09 — FINISHES
09662 - Electrically Insulated Floor Covering
09705 - Epoxy Resin Flooring

09910 - Paints and Coatings
09960 - Painting of Steel
09965 - Graffiti Resistant Coatings

DIVISION 10 — SPECIALTIES
10140 - Identifying Devices
10200 - Louvers and Vents
10520 - Fire Protection Specialties
10800 - Toilet and Bath Accessories

DIVISION 13 — SPECIAL CONSTRUCTION
13700 - Intrusion Alarm System
13850 - Fire Alarm and Detection System

DIVISION 15 — MECHANICAL
15010 - Basic Mechanical Requirements
15050 - Basic Mechanical Materials and Methods
15060 - Hangers and Supports
15062 - Hangers and Supports for Plumbing Piping and Equipment
15075 - Mechanical Identification
15080 - Mechanical Insulation
15120 - Sleeves and Sleeve Seals
15130 - Pumps
15140 - Domestic Water Piping
15150 - Sanitary Waste and Vent Piping
15160 - Storm Drainage Piping
15165 - Storm Drainage Piping Specialties
15183 - Duct Insulation
15184 - Refrigerant Piping
15400 - Plumbing Fixtures and Equipment
15412 - Emergency Plumbing Fixtures
15700 - Heating, Ventilating and Air Conditioning Equipment
15794 - Electric Unit Heaters
15841 - Indoor Custom Air-Handling Units
15850 - Diffusers, Registers and Grilles
15857 - HVAC Gravity Ventilators
15890 - HVAC Ductwork
15935 - Building System Controls
15940 - Sequence of Operation
15950 - Testing, Adjusting and Balancing

DIVISION 16 — ELECTRICAL
16010 - Basic Electrical Requirements
16050 - Basic Electrical Materials and Methods
16060 - Grounding and Bonding
16070 - Hangers, Anchors and Supports
16075 - Electrical Identification
16120 - Conductors and Cables
16121 - Medium Voltage Cable
16122 - DC Traction Power Cable
16123 - Building Wire and Cable
16129 - Fiber Optic Cable
16130 - Raceways and Boxes
16131 - Bus Duct
16138 - Ductwork and Electrical Manholes and Handholes

16140 - Wiring Devices
16210 - Electric Utility Services
16230 - Generator Assemblies
16240 - Battery Equipment
16260 - Traction Power Rectifier
16271 - Auxiliary Power Transformers
16273 - Traction Power Rectifier Transformers
16274 - Transformer and Rectifier Unit
16290 - Protective Devices and Instrument Transformers
16300 - DC Remote Control Board
16315 - Dead Break Junction Equipment
16335 - Surge Protection
16340 - Medium Voltage Switchgear Assemblies (60 Hz)
16344 - DC Traction Power Switchgear Assemblies
16348 - Negative and Drainage Switchboard
16411 - Enclosed Switches
16412 - DC Enclosed Switch Cabinets
16413 - Enclosed Transfer Switches
16421 - Enclosed Motor Controllers
16440 - Panelboards
16460 - Low-Voltage Transformers
16500 - Lighting
16700 - Communications
16760 - Fiber Optic Network
16772 - CCTV System
16910 - Electrical Systems Control SCADA, Remote Terminal Unit - Including HMI
16920 - Stray Current Monitoring
16950 - Testing

SECTION 01010

SUMMARY OF WORK

PART 1 - GENERAL

1.01 Description

A. The Design and Build Contract No. 5 consists of final design, rehabilitating and upgrading existing Traction Power Substations (TPSSs) located at Broad, Park and Loudon on the SEPTA Broad Street Subway line and Castor on the Route 59 Trackless Trolley of the City Transit Division (CTD). The Design-Build Contractor (Contractor) shall complete the final design and rehabilitate all equipment and installations at the facility, unless specifically noted otherwise.

1. At Broad, Park and Loudon field survey and provide final design for the replacement of DC remote control panels (cabinets).

B. Contractor should note that a new Safety & Security Certification requirement has been added. The Contractor shall complete all SSC requirements. This specification defines the requirements for implementing SEPTA's Safety and Security Certification (SSC) Program to ensure that all safety and security critical project elements are properly identified, designed, constructed, tested, and verified prior to acceptance and operational use. The SSC process applies throughout design, construction, testing, and pre revenue phases and requires coordinated participation by the Design Consultant, Design Build Contractor, and SEPTA's SSC Consultant through hazard and threat analyses, conformance checklists, verification activities, and formal certification. Completion of this process is mandatory to demonstrate compliance with applicable Federal, Commonwealth, and SEPTA requirements and to confirm project readiness for occupancy and revenue service.

C. The Contractor shall have proven experience in the traction power systems of railroads. The Contractor shall have design capability or subcontractor capabilities on the team to advance the design from 50% level to 100 % level and sign/seal the drawings, besides subcontractors of other disciplines such as civil/structural, mechanical, and other required trades to complete the rehabilitation of the TPSSs.

D. Initiate the rehabilitation work in the following order, unless approved by SEPTA otherwise:

1. Broad, first (only one station can be rehabilitated at a time)
2. Loudon, second
3. Park, third
4. Castor, fourth (independent of the three (3) TPSSs above)

E. The work shall be performed in close coordination with SEPTA and the utility and other trades working at the site.

F. The Contractor shall be responsible for the following administrative activities:

1. Creating and maintaining the Project schedule for all work.
2. Provision of Project identification signs (Refer to Section 01580).

3. Furnishing and maintaining SEPTA field office (Refer to Section 01590), including associated utilities.

4. All snow removal, regular trash removal and cleaning from the Project sites.

G. Brief Description of SEPTA's Traction Electrification System:

1. SEPTA operates a comprehensive transportation system in the Philadelphia metropolitan area and suburbs. The CTD network of subway, light rail and electric trolleybus routes is an important part of SEPTA's service in the Philadelphia metropolitan area. The network includes the Broad Street Subway (BSS), the Market Frankford Subway elevated (MFSE), five (5) Subway Surface Trolley Lines, the Route 15 Historic Trolley (Girard Avenue and Richmond Streets), and the Routes 59, 66 and 75 Trackless Trolleys (electric trolleybuses).

2. Each TPSS has a unique electrical and physical layout.

3. The three (3) subway TPSSs to be rehabilitated as part of this Contract predominately provide power to the Broad Street Subway (BSS) and are located along this line at or near Mount Vernon Street, Loudon Street, and Cumberland Street. The BSS is third rail powered and was commissioned in 1928. The other TPSS to be rehabilitated as part of this Contract provides power to the Route 59 Trackless Trolley. The present Trackless Trolley routes were originally streetcar lines that were converted to electric trolleybus operation during the 1960's. The nominal system voltage of the CTD network is 700 V DC. The TPSS components vary in vintage from 1928 to present day technology. A Wayside Energy Storage System (WESS) allows for vehicle regenerative voltages up to 800 V DC.

4. Rehabilitation requires removal and replacement of essentially all existing equipment in a manner staged to prevent total outage, except at Castor TPSS. The Contractor shall field verify quantities of existing equipment to be removed. Remove abandoned equipment in quantities as field verified by the Contractor. Reflect the intent of having a full replacement of traction power equipment in the Contractor’s prepared final design for each site. Provide (furnish and install) quantities of equipment necessary for maintaining the current full operational functionality of the traction power system. WESS equipment is not to be removed and replaced, but new positive and negative cables and connections to the new DC equipment shall be provided as part of this work, subject to approval by SEPTA.

5. Broad TPSS has dual 13.2 kV utility services and contains two (2) 3250 kVA rectifier transformers, rectifier anode AC buses, two (2) 3000 kW rectifiers, two (2) 8000 A DC cathode breakers, positive and negative DC buses, ten (10) 3000 A DC feeder circuit breakers and one (1) 3000 A DC transfer circuit breaker. The TPSS also houses one (1) 2000 kVA 13.2/4.8 kV transformer and five (5) 4.8 kV cable feeder circuit breakers. There is also one (1) 400 kW diesel generator, one (1) 400 kW rectifier for the generator and five (5) 2000 A DC emergency cable feeder circuit breakers at this location. One (1) remote DC breaker room control panel and one (1) DC emergency cabinet shall also be removed and replaced. This TPSS is supervisory controlled and monitored, and supplies traction power for the BSS from stations Cecil B. Moore to City Hall, and also feeds the Broad-Ridge spur. This TPSS was originally commissioned in 1928 and is located at 1327 Mt. Vernon Street. In 1972, the diesel generator and its associated emergency equipment were added. Additionally, in 1979, the TPSS was partially modernized, at

which time the medium voltage AC switchgear (for 13.2 kV circuits) and rectifier/transformers were upgraded. The DC circuit breakers, however, remain as original. There is also a collection of "abandoned" (out-of-service) equipment (switchgear, transformer, etc.) in the TPSS room that will need to be dismantled and removed as part of this Contract.

6. Park TPSS has dual 13.2 kV utility services and includes two (2) 3250 kVA rectifier transformers, rectifier anode AC buses, two (2) 3000 kW rectifiers, two (2) 8000 A DC cathode breakers, positive and negative DC buses, eight (8) 3000 A DC feeder circuit breakers, one (1) 3000A DC transfer circuit breaker, six (6) 2000A DC circuit breakers and two (2) 1600 A DC emergency cable feeder circuit breakers. This TPSS also houses one (1) 2000 kVA, 13.2/4.8 kV transformer and six (6) 4.8 kV cable feeder circuit breakers. One (1) remote DC breaker room control panel and one (1) DC emergency cabinet shall also be removed and replaced. This TPSS is supervisory controlled and monitored and provides traction power for the BSS from stations Cecil B. Moore to Allegheny. The TPSS, originally commissioned in 1928, is located at 2440 N. Park Street. In 1980 the TPSS was partially modernized, at which time the medium voltage AC switchgear (for 13.2 kV and 4.8 kV circuits) and rectifier/transformers were upgraded. In 1992, the 13.2/4.8 kV transformer was replaced. The DC circuit breakers at this location are the originally installed equipment. Recently, between 2017 and 2018 SEPTA installed WESS equipment in this TPSS.
7. Loudon TPSS has dual 13.2 kV utility services and includes two (2) 3250 kVA rectifier transformers, rectifier anode AC buses, two (2) 3000 kW rectifiers, two (2) 8000 A DC cathode breakers, positive and negative DC buses, four (4) 4000 A DC feeder circuit breakers, four (4) 3000A DC circuit breakers, one (1) 3000A DC transfer circuit breaker, five (5) 2000 A DC feeder circuit breakers, and two (2) 1600 A DC emergency cable feeder circuit breakers. This TPSS also houses one (1) 2000 kVA, 13.2/4.8 kV transformer and six (6) 4800 V cable feeder circuit breakers. One (1) remote DC breaker room control panel and one (1) DC emergency cabinet shall also be removed and replaced. This TPSS is supervisory controlled and monitored, and supplies traction power for the BSS from Hunting Park to Olney Station, and also feeds a significant portion of Trackless Trolley Route 75. The TPSS was originally commissioned in 1928 and is located at 1410 W. Loudon Street. In 1979 the TPSS was partially modernized at which time the medium voltage AC switchgear (for 13.2 kV and 4.8 kV circuits) and rectifier/transformers were upgraded. In 1990, four (4) of the eight (8) DC feeder circuit breakers were replaced, and in 2007 the 13.2/4.8 kV transformer was replaced. Recently, in 2012, the rectifier transformers were also replaced. The DC circuit breakers, however, remain as original. Recently between 2017 and 2018, SEPTA installed WESS equipment in this TPSS.
8. Castor TPSS has one (1) 13.2 kV incoming utility service, one (1) 1130 kVA rectifier transformer, rectifier anode AC bus, one (1) 1000 kW rectifier, a 4000 A DC cathode breaker, positive and negative DC buses, and three (3) 2000 A DC feeder circuit breakers (one (1) is a transfer bus circuit breaker). This TPSS is supervisory controlled and monitored and provides power to the northern end of the Route 59 Trackless Trolley (electric trolleybus). The TPSS was commissioned in 1950, and included a PCB oil-filled rectifier transformer, live frame mercury-arc rectifier, and open style DC circuit breakers in a single floor brick building that is located on the Route 59 terminus loop. In 1995, the

transformer was retro-filled and reclassified as non-PCB. The obsolete mercury-arc rectifier was also replaced with an open frame solid-state rectifier.

9. Rehabilitation of the Castor TPSS will allow SEPTA to provide a reliable Route 59 Trackless Trolley system power supply for many years to come.
10. SEPTA engaged with another contractor to replace the roof at Broad TPSS, which was completed in April 2019. Refer to Article 1.02/L for details of the relevant reference drawings for the roof replacement project.

H. The Contract is intended to rehabilitate the TPSSs to a like new state. All equipment, components, installations, Supervisory Control and Data Acquisition (SCADA), lighting, auxiliary power systems, conductors, and cables, unless expressly stated otherwise, shall be replaced with new equipment and components where indicated on the Contract Documents.

I. The work generally consists of, but is not necessarily limited to, the following:

1. Completion of the 50% design to 100% level:
   a. Completing the 50% design supplied with the Contract Drawings and Specifications to a 100% level.
   b. Signing and sealing the drawings, reports and specifications.
   c. Perform a Lead/Asbestos/PCB survey prior to commencement of work. All testing is to be coordinated through SEPTA System Safety Department.
2. Site Demolition and Clearing for each TPSS in Construction Contract No. 5:
   a. Clearing and grubbing including removal and disposal of debris and abandoned equipment.
   b. Selective demolition of pipes, conduits, duct banks, manholes, fuel tanks and metal cases.
   c. Recycle scrap metal.
   d. Test, then dispose of as hazardous waste scrap material, storage tank and contaminated soil.
   e. Asbestos abatement.
3. Site Fencing for Castor TPSS in Construction Contract No. 5:
   a. Construct new chain link fencing around building and equipment yard including swinging gate.
   b. Replace the existing chain linked security gate at Park TPSS.
   c. Replace the iron fence in the alley at Park and Loudon TPSSs.
4. Site Utilities for each TPSS in Construction Contract No. 5:
   a. Protect in place site utilities as indicated on the Contract Drawings.
5. Grading, Storm Water System and Sedimentation Control for each TPSS in Construction Contract No. 5:
   a. Grade at site in accordance with the Contract Drawings.
   b. Provide sedimentation control to include filter fabric, filter bags for inlet protection, storm protection.
6. Equipment Yard Pads for Castor TPSS in Construction Contract No. 5:
   a. Construct new electrical and non-electrical equipment pads as indicated on the Contract Drawings.

7. Cast-In-Place Concrete Foundations for Castor TPSS in Construction Contract No. 5:
    a. Construct foundations for outdoor electrical equipment as indicated on the Contract Drawings.
8. Control Systems for each TPSS in Construction Contract No. 5:
    a. Demolish existing concrete equipment pads and refinish floor.
    b. Relocate existing batteries and other auxiliary power supply equipment to facilitate the work.
    c. New Protection and Control Panels:
        1) Installation of new protection and control panels.
        2) Decommission and remove existing control panels after commissioning of all new equipment.
        3) Installation of cable trays and cable ladder.
9. Structural Repairs to Existing Masonry Walls for each TPSS in Construction Contract No. 5:
    a. Remove vegetation from wall joints.
    b. Remove efflorescence from wall face.
    c. Repair spalled areas.
    d. Seal concrete.
    e. Refinish/repair masonry walls and brick fence posts.
    f. Repair roof system.
10. Work that will bring each TPSS in Construction Contract No. 5 into compliance with all relevant codes, regulations, standards, etc.:
    a. Caging of access ladders.
    b. Signage.
    c. Add doors and stairs.
11. Mechanical and HVAC System for each TPSS in Construction Contract No. 5:
    a. Energy recovery ventilator units.
    b. Electric unit heater.
    c. Heat Pump.
    d. Exhaust fan in battery room.
    e. Air conditioning split system for battery room.
    f. Louvers with dampers.
    g. Emergency eye wash in battery room.
    h. HVAC unit.
    i. Electrical controls and sensors.
    j. Power connections, conductors in raceways and supports.
12. Architectural System for each TPSS in Construction Contract No. 5:
    a. Seal openings.
    b. Replace windows and doors.
    c. Replace roll-up doors as indicated on the Contract Drawings.
13. Auxiliary power system, to include all cabling and AC power panel to receive power from existing PECO supply for each TPSS in Construction Contract No. 5.

a. TPSS Battery System (136 V DC System):
   1) Install new batteries. Relocate, temporarily if required, existing batteries to facilitate the work in the control room.
   2) Install new battery chargers.
   3) Install new battery transfer panel.
   4) Install new dropping resistors.
   5) Remove existing battery system and dispose per SEPTA instructions.
b. New 136 V DC power panel.
c. AC power panel to provide power for lighting and new equipment.
d. Auxiliary power conduits, boxes, and conductors.
e. Disconnect switches.
f. Receptacles.
g. Auxiliary transformer(s).
h. Bonding and grounding.
i. New outdoor cable raceway systems as required.

14. Lighting for each TPSS in Construction Contract No. 5:
    a. Site lighting to suit new equipment arrangement.
    b. Indoor lighting.
15. Fire Alarm and Intrusion Detection for each TPSS in Construction Contract No. 5:
    a. Fire alarm system.
    b. Intrusion detection system, including CCTV system.
    c. Controls in interface with HVAC for shut down.
16. Communication and SCADA System for each TPSS in Construction Contract No. 5:
    a. Provide Remote Terminal Unit (RTU) with integrated TPSS gateway computer.
    b. SCADA conduits or cable trays and cables for indication and control circuits.
    c. TPSS controls and sensors.
    d. Existing servers A, B and C located at 1234 Market Street to be replaced prior to any new RTU installation for this Contract. Provide labor required for testing.
    e. Replacing the communication cable from the TPSS termination cabinet to the nearest outdoor junction box/manhole.
17. Traction Power and SEPTA emergency AC and DC power systems equipment, for each TPSS in Construction Contract No. 5, to include incoming medium voltage supply, 15 kV AC switchgear (for 13.2 kV circuits), traction transformer rectifiers sets, auxiliary and signal power transformers, 15 kV AC switchgear (for 4.8 kV circuits), 1000 V DC switchgear, traction return system, auxiliary power supply network, traction power and return cables, rail return bus, return cables including, but not limited to, the following (as indicated on the Contract Drawings):
    a. 15 kV AC Incoming/Feeder Circuit Breakers:
       1) Seven (7) at Broad TPSS.
       2) Seven (7) at Park TPSS.
       3) Eight (8) at Loudon TPSS.
       4) Three (3) at Castor TPSS.

b. One (1) 15 kV AC tie circuit breaker at Broad, Park and Loudon TPSSs.
c. 4.8 KV AC Circuit Breakers (15 kV Rated):
    5) Nine (9) at Broad TPSS.
    6) Six (6) at Park TPSS.
    7) Five (5) at Loudon TPSS.
d. 1000 V DC Circuit Breakers with a Withdrawable Direct Acting Trip Element:
    1) Two (2) cathode breakers at each of Broad, Park, and Loudon TPSSs. One (1) cathode breaker at Castor TPSS.
    2) Ten (10) feeder breakers at Broad, Nine (9) feeder breakers At Park, eleven (11) feeder breakers at Loudon, and two (2) feeder breakers at Castor TPSS.
    3) Three station service breakers each at Park and Loudon TPSS and five (5) station service breakers at Broad TPSS.
e. Two (2) 4 MVA transformer rectifier sets at Broad, Park and Loudon TPSSs.
f. One (1) 1 MVA transformer rectifier set at Castor TPSS.
g. One (1) 2 MVA lighting power transformers (13.2 kV/4.8 kV) at Broad, Park and Loudon TPSSs.
h. Two (2) 150 kVA auxiliary transformers (13.2 kV/120-208 V) at Broad, Park and Loudon TPSSs.
i. One (1) 45 kVA auxiliary transformer (13.2 kV/120-208 V) at Castor TPSS.
j. Potential and current transformers (PTs, CTs).
k. 500 kW diesel generator set at Broad TPSS.
l. 500 kW rectifier at Broad TPSS.
m. 1000 V DC Withdrawable Circuit Breakers:
    1) Five (5) in Broad TPSS.
    2) Six (6) in Park TPSS.
    3) Four (4) in Loudon TPSS.
n. Manual disconnect switches.
o. DC current shunts.
p. Surge arresters.
q. AC and DC circuit breaker test cabinets.
r. Renewal of all high voltage buses, wires, connections, insulators, conduit, etc.
s. Replace existing return rail/ground busses, install new return rail/ground busses, and return rail cables from the TPSSs to the nearest manhole. Coordinate replacement with SEPTA.
t. Ground grid with ground buses and connections to the equipment and perimeter fencing. Install new ground grid and associated conductors to supplement and/or replace the existing ground grid and all equipment connections. This shall include return circuit connections in the areas affected by the new and existing equipment.

18. Recover redundant assets and return to SEPTA (spares/asset value) for each TPSS in Construction Contract No. 5.

19. Demolition, Removal and Disposal of Equipment:
    a. SEPTA will remove parts from existing circuit breakers before removal of existing circuit breakers from the Project site. Coordinate with SEPTA for the details and schedule. The Contractor is responsible for removal and disposal of all asbestos containing materials (arc chutes, transite panels, wiring, etc.).

b. All transformer-rectifier sets.
c. All 13.2 kV and 4.8 kV switchgear.
d. All auxiliary transformers and lighting and power transformers.
e. All DC circuit breakers.
f. Generator set at Broad TPSS and all its attachments including active and abandoned fuel tanks.
g. 400 kW rectifier at Broad TPSS.
h. All DC emergency cabinets.
i. All DC remote control boards.
j. All local supervisory, SCADA termination and SCADA cabinets.
k. All rectifier isolation switches.
l. All normal and emergency circuit breakers and control cabinets.
m. All emergency DC lineups.
n. All DC circuit breaker control boards.
o. All PTs, CTs, disconnect switches.
p. 125 V DC batteries, battery charger rectifiers.
q. All 600 V DC lighting and heating equipment.
r. All abandoned 4800 V AC signal power equipment.

20. Testing, commissioning, training, and placing into revenue service of all components and equipment to make a complete operating system; followed by post commissioning testing.
21. Final Design, procurement of materials, manufacture, factory testing, delivery and storage of components and materials, installation, all field testing, commissioning and bringing into revenue service all components necessary for implementation of full and correct operation of the TPSSs.
22. Perform all work based on the Contract Documents. The Contractor shall develop the final design drawings and specifications for review and approval by SEPTA. Construction work shall not be commenced until SEPTA has approved the final design drawings and specifications.
23. Verify and update all design requirements prior to commencement of detailed/final design.
24. The TPSS functionality will remain as exists today, except for the changes as specified in the Contract Drawings.
25. Test all hazardous material prior to starting any work.
26. Abatement or remediation of contaminated or hazardous materials.
27. Verification of existing conditions including utilities.
28. Final construction plans for all TPSS work including temporary structures, signed and sealed by an Engineer licensed in the Commonwealth of Pennsylvania.
29. Final construction specifications for all TPSS work including temporary structures, signed and sealed by an Engineer licensed in the Commonwealth of Pennsylvania.

30. All permits required to perform Contract work from municipal Authority Having Jurisdiction of the work site.
31. Work plans that are fully coordinated with the SEPTA Project Manager.
32. Support SEPTA public involvement initiative with technical information and presentation graphics.
33. Provide temporary power.
34. As-built drawings in AutoCAD and PDF format.

J. Complexity of the Contract:

1. The traction power work included in this Contract is complex and requires a high degree of coordination between the Contractor, suppliers, subcontractors, and SEPTA. Therefore, the Contractor shall schedule the work to minimize the requirement for outages. Also, the Contractor shall coordinate the repair and rehabilitation work between all subcontractors to ensure minimal requirement of outages.
2. It is expected that the traction power equipment will be procured from multiple manufacturers. The Contractor is required to ensure that all components and equipment meet the requirements of the Contract and are compatible with each other for integration of the equipment into a single operable system. Services of a full time experienced and licensed Electrical Engineer in the Commonwealth of Pennsylvania are essential to accomplish this.
3. The current control of each TPSS is by a supervisory and remote control system using interposing relays and hardwired and/or fiber optic cable connection to SEPTA's SCADA system. The proposed control of each TPSS shall be by a supervisory and remote control system using microprocessor-based control relays and hard wired and/or fiber optic cable connection to SEPTA's SCADA system. The microprocessor relays shall be connected to a SCADA RTU which shall communicate with the SCADA system. However, the TPSS shall remain functional via local control in the event of failure of any component or components of the supervisory and remote control system. The relays shall be able to be interrogated via an integral Human Machine Interface (HMI).
4. Multiple levels of testing shall be required, including design and production tests at the manufacturer's plants, and commissioning and post-energization testing at the site.

K. Traction Power Limit of Work:

1. The limit of the work shall be all the traction power electrical equipment within the boundary of the traction power compound. It also includes replacement of positive feeder and rail return cables and communications cables from the TPSS to the nearest manhole.
2. PECO feeder cables within the TPSS and out to the property line or point of common coupling.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Provisions and other Division 1 Specification Sections, apply to this Section.

B. Agreement.

C. Section 01025 – Measurement and Payment

D. Section 01060 – Regulatory Requirements and Safety

E. Section 01300 – Submittals

F. Section 01400 – Quality Requirements

G. Section 01500 – Construction Facilities and Temporary Controls

H. Section 01580 – Project Identification Signs

I. Section 01590 – SEPTA Field Office

J. Section 16010 – Basic Electrical Requirements

K. Section 16060 – Grounding and Bonding

L. Preliminary Drawings:

1. Preliminary drawings demonstrate viability of proposed design solutions and are provided to convey the scope of the SEPTA Substation Project. The Contractor shall adopt the scope and solutions defined by the preliminary drawings as a basis for final design and construction.

M. Performance Specifications:

1. Project performance specifications identify the general requirements, products, execution, and quality control measures that shall be adopted while constructing or procuring materials. These performance specifications must be integral to the final design plans, and adhered to as the Contractor acquires manufactured products, materials, or construction services. The Contractor is encouraged to use and refine the project performance specifications to develop final technical specifications for construction, provided the final technical specifications preserve the fundamental framework and work result of each performance specification as approved by SEPTA.

N. Reference Documents:

1. Reference documents that were obtained or developed in conjunction with these Contract Documents are provided as general background information. The reference documents have no contractual basis for design and construction. The Contractor must validate the accuracy of applicable reference documents before using this information to develop designs or construction plans. Table 01010-1 is a list of the reference documents.

Table 01010-1 Reference Documents

Reference File Name	Brief Description
Broad Substation Roof Replacement Plans	Plans for Broad TPSS roof replacement project
SEPTA 630VDC Emergency Lighting and Power Cable – Single Line Diagram	Orange, Blue, and Green Line Subways, City Transit Division - 630V DC Emergency Lighting & Power Cable, Emergency Power Generation, Electrical Single Line Diagram – 600 V DC Emergency Distribution Existing Conditions

DWG 7E-16563	M.F.S.E./B.S.S./Ridge Ave. Spur - 4800V.A.C. Power & Lighting Cable Loading - Single Line Diagram - Electrical
Environmental Investigation Report	Environmental Assessment of 17 TPSS/SWS sites
Loudon WESS Details-Rev3_signed 171108	WESS equipment and cable layout Rev 3 by Constellation / SEPTA
Management of Lead Paint in SEPTA Construction Projects Document #3001	SEPTA standard method report
3004 Asbestos Control and Handling Program 2023	SEPTA standard method report
PECO fault duty letters - dc TPSS	2016 PECO letters - Contracts 4 & 5 locations
SEPTA Station 20 Sansom Points List	SEPTA standard template for master station
Tentative layout of WESS Equipment in Park TPSS_22-Jan-2018	Tentative layout, final as built plans to be available only after April 2018
Park PECO Info	PECO Conduit Map near Park TPSS
Broad PECO Info	PECO Conduit Map near Broad TPSS

O. Permit Matrix (attached to this Section):

1. The Permit Matrix summarizes the various permits that may be required for the Substation Rehabilitation project. This matrix identifies the type of permit, reviewing agency, municipality or city, and the entity responsible for obtaining each permit.

1.03 Quality Assurance and Quality Control

A. The Contractor will assume responsibility for executing a Quality Assurance/Quality Control (QA/QC) program. The QA/QC program's basic form will be specified in the Contractor's Quality Control Plan (QCP) as submitted under Section 01400 and will include the tests and inspections called for in the technical sections of the Specifications. The Contractor shall be responsible for requiring all subcontractors and suppliers to adhere to the Contractor's QA/QC program and participate in quality assurance activities.

B. If a Project is governed by 'Buy America' requirements, SEPTA will require documentation to confirm the country of origin of all applicable products and materials. The Contractor is responsible for communicating 'Buy America' requirements to subcontractors and suppliers. The lack of sufficient documentation may be grounds for rejecting a product or material.

C. Quality activities will be documented by the Contractor. SEPTA may audit the Contractor's QA/QC activities. The Contractor will make the subcontractor's applicable documentation available to SEPTA.

D. The Contractor and subcontractors are required to cooperate fully with testing and inspection activities carried out by SEPTA and its agents. The Contractor will provide the SEPTA Project Manager with adequate (as determined by the SEPTA Project Manager) notification for all activities which require testing and/or inspection. For all inspections and testing required by code, work may not proceed until this testing and inspection has been completed.

E. Once a product or material has been accepted through the submittal process, no substitution of this material or product will be allowed without resubmitting it following the

provisions of Section 01300. SEPTA reserves the right to require removal of any non-reviewed material and product.

1.04 Contractor Responsibilities

A. The Contractor shall furnish all materials, tools, equipment, supervision, administration, and transportation, and perform all labor and services necessary to furnish, deliver, construct, install, connect and/or interconnect and test as required to complete all work described in the Specifications and indicated in the Contract Drawings.

B. The Contractor is solely responsible for ensuring the methods and equipment required to transport the new and existing equipment into and out of the working site location will cause the least amount of impact to SEPTA Operations and/or local residences and/or businesses. The Contractor shall develop and submit the delivery/transportation plans and procedures for SEPTA approval.

C. The Contractor is responsible for securing and paying for all necessary permits and approvals required to complete the work. No work may commence on site without securing and paying for the necessary approvals including but not limited to:

1. Permits and utility connection fees.
2. Temporary power.
3. Governmental fees.
4. Licenses.
5. Inspections.
6. Any local taxes.

D. SEPTA PMIS (Project Management Information System):

1. SEPTA has a PMIS in place used for tracking Key Performance Indicators (KPI) through integrated reporting and dashboards populating capital projects with ‘real time’ information essential for performance tracking and benchmarking which are essential to achieving SEPTA’s project management goals.
2. SEPTA shall make access available, to the Contractor, to SEPTA’s PMIS for the Contractor’s use to exchange Project information as required throughout the life of the Project at no additional cost to the Contractor. User access licenses are not required for the Contractor’s use of SEPTA’s PMIS. The SEPTA Project Manager shall create user accounts with appropriate permissions for the Contractor’s use throughout the life of the Project.
3. The Contractor is required to coordinate with the SEPTA Project Manager regarding hands-on training for Contractor Project employees on the SEPTA PMIS program (i.e., e-Builder). SEPTA will not compensate the Contractor or their personnel for any formal and/or informal training of the Contractor’s staff on the SEPTA PMIS.
4. The Contractor shall submit all Project information/communications through SEPTA’s current PMIS. Document distribution to Project members shall be accomplished both within the PMIS system and via email as appropriate. Project document distribution to parties outside of the Project communication system shall be accomplished by secure email of outgoing documents and attachments, readable by a standard email client.

E. SEPTA Notification:

1. Give written notices necessary for, and incidental to, the due and lawful prosecution of the work.
2. Provide fourteen (14) day notification to SEPTA for all construction work which requires observation, testing and/or inspection.
3. Notify the SEPTA Project Manager at least fourteen (14) days in advance of the date the individual construction stages or elements will be fully complete and ready for inspection.
4. Notify the SEPTA Project Manager at least fourteen (14) days in advance of the date the entire work will be substantially complete and ready for inspection.
5. Notify the SEPTA Project Manager at least fourteen (14) days in advance of the date the entire work will be substantially complete and ready for inspection.

F. Utility Notification:

1. Known existing utilities may be indicated on the Contract Drawings but the Contractor may not interpret this information as either complete or accurate. Regardless of the existing utilities shown on the Contract Drawings, the Contractor must identify and verify the location of all existing utilities; prior to working; by following applicable regulations and procedures such as contacting the PA One Call system and asking SEPTA personnel to identify utilities at the site.
2. The Contractor shall determine ownership of all utilities and notify utility owners prior to intended work start date. Deliver a copy of this notice to the SEPTA Project Manager within eight (8) hours of the submittal of the notification.
3. Verify location of existing utilities prior to working in or adjacent to areas containing existing utilities.
    a. Notify SEPTA as specified on the Contract Drawings prior to intended start work date in an area in which other SEPTA infrastructure may be located.

G. Protection and Repair of the Work and Adjacent Property:

1. Prior to commencement of work, the Contractor and the SEPTA Project Manager shall examine the site and document the condition of all areas not intended to be changed by the Project. Depending on the scope of work, this may include features such as sidewalks, driveways, roadways, and adjacent facilities.
2. The Contractor must repair any damage to property caused, directly or indirectly, by the actions of the Contractor to the satisfaction of the SEPTA Project Manager (and property Owner if the damage is to property not owned by SEPTA) at no cost to SEPTA.
3. Until final acceptance of the work by SEPTA, the Contractor shall be responsible for maintaining the executed work in its finished condition as determined by the SEPTA Project Manager. All work shall be restored to its finished condition prior to final acceptance at no expense to SEPTA.

H. Support of Existing Structures and Right of Way:

1. Existing structures, adjacent to the Project work area, must be supported adequately utilizing underpinning, shoring and other temporary stabilization measures. A plan to

execute this temporary support and stabilization must be approved by the SEPTA Project Manager prior to any excavation commencing. At the discretion of the SEPTA Project Manager, the Contractor may be required to have this plan prepared and sealed by the Professional Engineer licensed in the Commonwealth of Pennsylvania.

2. Under no circumstances shall excavation in the vicinity of track and right of way occur without the prior approval of the SEPTA Project Manager.

I. Until final acceptance of the work by SEPTA, the Contractor shall have the charge and care thereof and shall take every reasonable precaution against injury or damage to any part thereof by the action of the elements, theft, vandalism, or from any other cause, whether arising from the execution or from the non-execution of the work. The Contractor shall rebuild, repair, restore, and make good, to the satisfaction of the SEPTA Project Manager, all damages to any portion of the work occasioned by any of the above causes before final acceptance and shall bear the expense thereof at no cost to SEPTA. The Contractor shall coordinate with the utility regarding outages required.

J. Contractor's Field Staff:

1. The Contractor shall have a full-fledged design firm on its team to advance the 50% level design to 100% and sign/seal the drawings. The design team shall have architects and design engineers, licensed in Commonwealth of Pennsylvania, of all disciplines. The Design team shall also have specialty designers for the studies specified in the Contract Documents. The key personnel are described hereunder:
    a. Project Manager:
        1) The Contractor shall designate a Project Manager. The work of the Project Manager includes oversight and coordination of the entire Contract, including mobilization, final design, procurement, construction, testing & commissioning, quality assurance, and safety.
        2) The Project Manager shall serve as SEPTA's single point of contact for all contractual issues.
        3) The Project Manager shall coordinate prosecution of the work with each sub-contractor, public utilities, government bodies, PECO, PADOT, SEPTA Operations and other contractors. The Project Manager shall implement means and methods to eliminate or minimize possible delays in the work caused by conflicts with utilities or other outside agencies or jurisdictions.
    b. Design Manager:
        1) The Contractor shall designate a Design Manager. The Design Manager shall be responsible for completing all facets of final design including document research, surveys, field verification, final design, quality assurance, shop drawings, and as-builts.
        2) The Design Manager shall facilitate coordination between designers, subconsultants, utility companies, agencies having jurisdiction, suppliers, constructors, SEPTA, and any other entity that impacts the work.
        3) The Design Manager shall enforce quality standards and safety procedures.
        4) The Design Manager should have a direct line of communication with the Project Manager and the Superintendent.
        5) The Design Manager shall be a licensed Engineer in the Commonwealth of Pennsylvania.
    c. Environmental Engineer:
        1) The Contractor shall designate an Environmental Engineer. The work of the Environmental Engineer shall include site investigations, sampling, and administration of

laboratory analyses, data interpretation, and developing remediation recommendations for construction.

2) The Environmental Engineer shall coordinate with designers, agencies having jurisdiction, SEPTA, and any other entities that have authority over environmental practice.
3) The Environmental Engineer shall monitor construction activities for compliance with specified remediation plans.
4) The Environmental Engineer shall be licensed Engineer in the Commonwealth of Pennsylvania.

d. Traction Power Lead Engineer:
1) The Contractor shall designate a Traction Power Lead Engineer. The Traction Power Lead Engineer shall be responsible for completing final design of all TPSS power equipment and supply systems. Duties include comprehensive design coordination with interfacing disciplines.
2) The Traction Power Lead Engineer will coordinate with Contractor vendors, PECO, SEPTA, and providers of SEPTA supplied equipment.
3) The Traction Power Lead Engineer shall perform or supervise checking of shop drawings and prepare of as-built drawings.
4) The Traction Power Lead Engineer shall inspect delivered equipment for conformance to procurement specifications.
5) The Traction Power Lead Engineer shall monitor construction for conformance to final construction plans.
6) The Traction Power Lead Engineer shall monitor and coordinate testing & commissioning activities.
7) The Traction Power Lead Engineer shall be a licensed Engineer in the Commonwealth of Pennsylvania.

e. Superintendent:
1) The Contractor shall designate a Superintendent. The Superintendent shall have demonstrated competency in the work of this Project. The Superintendent shall be responsible for all aspects of construction including coordination with the final designer, suppliers, permitting agencies, agencies having jurisdiction, SEPTA, and any other entity that has legitimate activity within the limits of work.
2) The Superintendent shall be a full-time employee and shall be assigned exclusively to this Contract. Contract employees are not permitted.
3) The Superintendent shall coordinate the TPSS outages with sub- contractors and SEPTA.
4) The Superintendent shall maintain a detailed critical path method construction schedule, and a comprehensive activity log. The Superintendent shall attend recurring progress meetings with SEPTA and SEPTA's representatives.
5) The Superintendent should have a direct line of communication with the Project Manager and the Design Manager.
6) The Superintendent shall enforce construction quality standards and safety procedures.

f. Traction Power Integrator/Designer:
1) The Contractor shall provide the services of a Traction Power Integrator (TPI) who shall be responsible for complete traction power system integration. He shall coordinate the shop drawings and supplies from the suppliers of transformers, 15 kV AC circuit breakers, transformer rectifiers, DC circuit breakers, disconnect switches, cables, control circuits, and surge arresters to ensure full compatibility with each other, proper location of the conduits to suit the equipment, relay selection and setting of the relays.

2) The TPI shall be a Professional Engineer licensed in the Commonwealth of Pennsylvania.
3) The TPI shall be responsible for:
   a) Coordinating and integrating the design of all disciplines into a single system.
   b) Ensuring that there are no conflicts between the various equipment and subsystems especially in regard to functionality and layout.
   c) Coordination of various studies, selection of protective relays and their settings.
   d) Review and signing of the shop drawings before submitting to SEPTA for review.
   e) Coordinating the construction activities in each stage of construction to minimize the requirement of power outage.
   f) Coordinating matching of equipment various suppliers for working on the medium voltage and low voltage supply.
   g) Coordinate and work with PECO for work related to the utility supply and make service applications and submittals.
   h) Coordinating the testing of various subsystems and complete system.
   i) The TPI shall be a registered Engineer in the Commonwealth of Pennsylvania.

g. Quality Control Manager:
   1) The Contractor shall assign a Quality Control Manager for the duration of the work.
   2) The Quality Control Manager shall be responsible for developing, implementing, and enforcing project-wide quality control procedures for all design and construction activities.
   3) Refer to Section 01400 for a definition of the responsibilities of this position.

h. Safety Officer:
   1) The Contractor shall assign a designated on-site Safety Officer.
   2) The presence of the Safety Officer at the site is mandatory while work is being performed.

i. Communications Specialist:
   1) The Contractor shall provide the services of a Registered Communication Distribution Designer (RCDD). Proof of RCDD certification shall be provided to SEPTA's Project Manager for approval. SEPTA reserves the right to reject the qualifications of the proposed RCDD based upon their lack of certification.
   2) The RCDD shall oversee the entire fiber optic cable equipment selection, procurement, installation, testing, and training of SEPTA maintenance and operating personnel.

K. Staff Qualifications:

1. The work on this Contract requires specified experience as described in the description of the specialized work of the Contract. The positions referenced in Article 1.04/J in this Section are considered key personnel and the review of their resumes and experience is a responsibility requirement under paragraph 4d (6) of the Instructions to Bidders. The lowest bidder shall furnish SEPTA with the resumes of the staff proposed to hold the above positions within five (5) days of receipt of SEPTA’s written request.

2. If, in the course of the work, these individuals are proposed to be replaced by the Contractor and/or SEPTA deems that their work is no longer satisfactory, the terms of the Paragraph VIII K of the Agreement will be invoked. SEPTA have the right to require any or all of these individuals be replaced upon notifying the Contractor in writing.

3. The Contractor shall provide a Project Team organizational chart and resumes of all identified key staff.

L. SEPTA Construction Sustainability Policies:

1. SEPTA has adopted a series of sustainability policies which SEPTA expects the Contractor to follow. These include but are not limited to the following:

a. Building Site Waste Management Plan:

1) Within ten (10) days of Notice to Proceed, and before any site work begins, the Contractor shall submit a Building Site Waste Management Plan. The plan shall specify which site debris shall be recycled, reused, or otherwise diverted. The goal of this plan shall be to reuse or salvage 75% of the land clearing debris including rocks, trees, stumps, and associated vegetation and 100% of excavated soils. Any materials which are disposed of off-site must meet all applicable regulations and be specifically approved by the SEPTA Project Manager. For material, which is disposed of off-site, the Contractor will be responsible for chain of custody documentation.

b. Construction Material and Waste Management Plan:

1) Within ten (10) days of Notice to Proceed, and before any site work begins, the Contractor shall submit a Construction Material and Waste Management Plan. The plan shall specify which construction and demolition materials shall be recycled, reused, or otherwise diverted. The goal of this plan shall be to divert 50% of nonhazardous materials and waste (measured by weight or volume) from landfills unless the local municipality has designated a greater amount.

c. Sustainability Documentation:

1) All sustainability strategies which are fulfilled by the Contractor's actions must be documented to the satisfaction of the SEPTA Project Manager.

M. Notification

1. Provide advance notification to SEPTA's Project Manager prior to important design, manufacture, and testing and construction events, as shown in Table 01010-2.

2. Notify the SEPTA Project Manager of any delays, field activity or factory test cancellations both verbally and with written confirmation.

TABLE 01010-2 NOTIFICATION SCHEDULE

Event	Activity	Minimum Advance Notification Requirement (Days)
Design Review Meetings	-	Fifteen (15)
Field Inspections	-	Seven (7)
Testing	Factory	Thirty-Five (35)
	Field	Fifteen (15)
Ground Gird Construction	Construction Commencement	Fifteen (15)
	Backfilling	Seven (7)
Equipment Delivery	-	Fifteen (15)

N. Project Milestones

1. The Contractor shall prepare a critical path method project schedule that meets or accelerates the milestone durations specified by SEPTA.

2. Allow one (1) month for each SEPTA review cycle.

1.05 SEPTA Responsibilities

A. SEPTA shall furnish free of charge to the Contractor three (3) complete half size sets of the Contract Documents including one (1) set of full-size Contract Drawings, Specifications, Addenda and/or conformed Contract Documents. The Contract Documents will also be available electronically in the PMIS (e-Builder), to which the Contractor will have access.

B. SEPTA Force Account:

1. Because these are operating TPSSs, SEPTA's Substation Operations personnel must be on site at all times any Contractor work is being done for protection of the Contractor's personnel and for continuity and reliability of revenue service.

2. Substation Operations personnel also will be used for the protection of the Contractor's personnel when equipment or personnel must work near energized circuits.

3. Communications and Signal (C&S) employees providing interface support, cutting of active circuits, and final connections on the SEPTA end for the new installation and termination of copper and fiber optic signal and communication lines, including fiber optic cables outside of the TPSS.

4. Substation Operations and SEPTA Underground Power personnel to identify and tag cables uncovered or pointed out by the Contractor.

5. Construction Inspector to oversee the construction activities.

6. SEPTA Project Manager to manage the design and construction of the TPSSs and also witness complete testing, commissioning, and acceptance of full TPSSs.

1.06 Contractor's Use of Worksite

A. Site Availability and Access to Worksite:

1. The Contractor shall confine operations at the site to areas permitted by law, ordinances, and permits, according to the schedule and the Contract Documents and shall not unreasonably encumber the site with any materials or equipment.

2. Keep existing driveways and entrances serving the site clear and available at all times, except as otherwise specified in Section 01500.

3. The Contractor shall not interfere with SEPTA or public circulation by the storage or staging of equipment or material. SEPTA reserves the right to require the Contractor to relocate equipment or material immediately and at any time even if the current location has been previously approved.

4. Keep the predefined portions of the worksite available for SEPTA's operations during the construction period as noted in the construction staging plan and other submittals. SEPTA reserves the right to take control of any part of the work at any time without prior notice.

B. Storage of Materials and Equipment and Deterring Vandalism:

1. Consider the safety of the work, and that of people and property on and adjacent to worksite, when determining amount, location, movement, installation, and use of

materials and equipment on worksite. All storage and staging areas must be approved by the SEPTA Project Manager.

2. Do not load finished work with equipment and products that would endanger the integrity of the finished work.

3. Move stored products as often as necessary if the products interfere with foreseeable operations of SEPTA, public and private utilities, and other contractors at no additional expense to SEPTA. Security of stored materials shall be the Contractor's sole responsibility. Secure additional storage and work areas if needed for construction operations at no additional expense to SEPTA.

4. The Contractor shall take precautions to prevent vandals from placing loose construction debris, supplies and equipment into positions that might foul the track or otherwise interfere with the operation of SEPTA vehicles. These steps shall include, but not be limited to, securing movable items, like construction fencing and scaffolding, and storing debris and material in fenced and locked enclosures.

5. Failure to take adequate steps may result in the Contractor having to go to the job site and secure these materials during non-construction hours, at no cost to SEPTA. SEPTA will hold the Contractor responsible for any damage or injury caused, or contributed to, by failure to take these precautions effectively.

C. Protection of the Public and SEPTA:

1. Protect the general public and SEPTA operations from construction related activities shall always have the highest priority. Any work on streets or access ways which could affect traffic or pedestrian access must receive prior approval by SEPTA and other agencies as required by law. Conduct work on streets and access ways on SEPTA property in a manner, which will ensure that pedestrian and vehicular traffic will either not be obstructed or obstructed to the least possible degree. Employ appropriately trained and authorized flagmen where required by ordinance or to create a safe job site.

D. Construction Operations Requiring SEPTA Service Interruptions and/or Utility Interruptions Must Meet the Following Requirements:

1. Should any temporary disruption of SEPTA's operations and/or use of the electric, water or telephone utilities at such site be necessary, it will be undertaken only pursuant to reasonable notices (not less than seven (7) days) given to the SEPTA Project Manager and shall not continue beyond the previously agreed upon period, without further written concurrence from SEPTA.

1.07 Work Sequence or Construction Staging

A. Each of the three (3) TPSSs on the Broad Street Subway (Broad, Park and Loudon) must remain in operation during construction during normal revenue service. A full outage may be allowed for brief periods for critical activities. A full outage can be allowed only at one (1) TPSS at a time. A full outage can be allowed only in the night at one (1) TPSS at a time. The proposed sequence of construction replaces limited amounts of equipment at a time and requires multiple cutovers as the new equipment is placed into service. The Contractor can work at all the TPSSs simultaneously, provided that the Contractor is working independent of affected systems at each of the other TPSSs and no activity shall have a negative effect on the continued operation of the traction power and lighting systems. The Contractor shall

develop a staging plan for approval by SEPTA's Project Manager. The Castor TPSS will need a complete shutdown at the time of replacement. The Contractor shall suitably plan the staging to ensure that the SCADA remote control interface replacement work is integrated with the traction power system upgrade and modernization work. Refer to Article 1.13 in this Section for details of the outages that can be permitted.

B. Do not remove any existing structures or remove any equipment from service which would affect the on-going operation until such temporary provisions have been made, or permanent construction work has been completed and equipment is operable. The SEPTA Project Manager shall be the sole judge of when the Contractor's operations are causing interference with operations, and his orders and instructions shall be carried out without delay.

C. Ensure that all workers are on site and that all necessary material and equipment have been delivered prior to commencing work.

D. For the narrative in Article 1.07/E in this Section, note that descriptions of 13.2 kV AC switchgear are referring to 15 kV class medium-voltage AC switchgear with 13.2 kV circuits, while descriptions of 4.8 kV AC switchgear are referring to 15 kV class medium-voltage AC switchgear with 4.8 kV circuits.

E. The work at each of the three (3) TPSSs on the Broad Street Subway (Broad, Park and Loudon) will be performed by the Contractor in three (3) stages, stages 1, 2 and 3. The work at Castor TPSS will be done in one (1) stage only. The following staging plan describes one (1) possible way to stage the work. The Contractor shall develop the final staging plan, as a part of the final design, to introduce appropriate work modifications and changes, to perform the work more efficiently and to minimize the duration of any outage. The suggested construction sequence is shown in the Contract Drawings and as follows:

1. Broad TPSS:
    a. Stage 1:
        1) Remove out of service equipment.
        2) Install temporary protective barriers around existing DC switchgear.
        3) Remove concrete encased fuel oil tank in pieces using the existing access points.
        4) Cut and reinforce wall to accommodate new rectifier transformer layout.
        5) Remove existing rectifier transformer set #1.
        6) Install new battery equipment on first floor.
        7) Install new rectifier transformer set #1 and temporarily feed from existing 13.2 kV AC switchgear.
        8) Remove existing 8000A rectifier #1 isolation switch.
        9) Install new DC switchgear, insulated floor covering and bus work in basement level.
        10) Remove existing 2000 kVA lighting and power transformer, existing 4.8 kV switchgear and existing 112.5 kVA, 4.8 kV/120-208 V auxiliary transformer.
        11) Remove existing negative equalizer bus and install and test the new negative and drainage switchboard.
        12) Remove existing emergency switch cabinet, existing DC emergency cabinet, existing 400 kW rectifier and existing 400 kW generator set. Install new emergency switch cabinet, new DC emergency cabinet, new 500 kW rectifier and new 500 kW generator set.

13) Remove existing enclosure with 2000A circuit breakers and existing emergency DC lineup.
14) Install new feeders to DC switchgear. Existing feeders need to be demolished first to make room in the existing duct bank to install new feeders.
15) Install new RTU/HMI cabinet. Install control power and RTU/HMI interconnections. Reconnect existing traction power equipment; not replaced or installed in stage 1; to the new RTU/HMI cabinet and test operation.
16) Remove existing RTU and SCADA cabinets.
17) Install new DC circuit breaker test cabinet.
18) Field survey and provide final design for the replacement of the DC remote control panel (cabinet).

b. Stage 2:
1) Remove existing 13.2 kV AC switchgear.
2) Install new 13.2 kV AC switchgear.
3) Remove existing battery equipment from first floor.
4) Commission the system before removing existing rectifier transformer set #3.
5) Remove existing rectifier transformer set #3.
6) Remove existing 8000A rectifier #3 isolation switch.
7) Install new rectifier transformer set #2.
8) Remove existing generator fuel oil tank.
9) Install new generator fuel oil tank.
10) Remove existing 112.5 kVA, 13.2 kV/120-208 V auxiliary transformer.
11) Install two (2) new 150 kVA, 13.2 kV/120-208 V auxiliary transformers.
12) Install new AC circuit breaker test cabinet.

c. Stage 3:
1) Install new 2000 kVA lighting and power transformer.
2) Install new 4.8 kV AC switchgear.
3) De-energize existing DC circuit breakers, open hatch in first floor slab where there is a former cut to remove the existing DC circuit breakers.
4) Level the floor.

2. Loudon TPSS:

a. Stage 1:
1) Remove out of service equipment.
2) Install temporary protective barriers around existing DC switchgear.
3) Close the two (2) floor openings on the first floor and install and test the new 13.2 kV AC switchgear where the previous floor openings were located.
4) Disconnect and transfer the two (3) PECO feeders from the existing 13.2 kV AC switchgear to the new 13.2 kV AC switchgear.
5) Remove existing rectifier transformer set #2.
6) Install new rectifier transformer set #2.
7) Remove existing 112.5 kVA, 13.2 kV/120-208 V auxiliary transformer.
8) Install new 150 kVA, 13.2 kV/120/208 V auxiliary transformer.

9) Install new section of DC switchgear to be fed from new rectifier transformer set #2. This bus section shall include DC feeders 2641, 2642T, WESS equipment and DC station service feeds.
10) Remove existing negative equalizer bus and install and test the new negative and drainage switchboard.
11) Remove existing 8000A rectifier #2 isolation switch.
12) Remove existing emergency switch cabinet and existing DC emergency cabinet. Install new emergency switch cabinet and new DC emergency cabinet.
13) Remove existing emergency DC lineup.
14) Remove existing battery equipment from first floor.
15) Install new battery equipment on first floor.
16) Install new RTU/HMI cabinet. Install control power and RTU/HMI interconnections. Do not disturb existing RTU connections to existing switchgear that remains operational.
17) Field survey and provide final design for the replacement of the DC remote control panel (cabinet).

b. Stage 2:
1) Remove existing DC circuit breakers from basement and first floor.
2) Remove existing transfer bus switches from basement.
3) Remove existing rectifier transformer set #1.
4) Install new rectifier transformer set #1.
5) Remove existing DC circuit breaker control boards.
6) Remove existing 8000A rectifier #1 isolation switch.
7) Install new section of DC switchgear to be fed from rectifier transformer set #1. This bus section shall include DC feeders 2601, 2602, 2603, 2604, 2605, 2606, 2607, 2608, 2614 and 2615.
8) Install new AC and DC circuit breaker test cabinets.

c. Stage 3:
1) Remove existing 4.8 kV AC switchgear and install new 4.8 kV AC switchgear.
2) Install new 2000 kVA lighting and power transformer and remove existing 2000 kVA lighting and power transformer.
3) Remove existing 112.5 kVA, 4.8 kV/120-208V auxiliary transformer.
4) Install new 150 kVA, 13.2 kV/120-208V auxiliary transformer.
5) Remove existing 15 kV vacuum switches from basement after cutover of the new 4.8 kV circuit cables to the SEPTA power network.
6) Remove existing RTU and SCADA cabinets.

3. Park TPSS:

a. Stage 1:
1) Remove out of service equipment.
2) Install temporary protective barriers around existing DC switchgear.
3) Remove existing rectifier transformer set #3.
4) Remove existing 8000A rectifier #3 isolation switch.
5) Remove existing section of 13.2 kV AC switchgear including PECO feeder 1071, rectifier transformer set #3 feeder, auxiliary transformer feeder and bus tie.
6) Remove existing battery equipment from first floor.

7) Remove existing 112.5 kVA, 13.2 kV/120-208 V auxiliary transformer.
8) Install new section of 13.2 kV AC switchgear to feed new rectifier transformer set #2 on first floor.
9) Install new 150 kVA, 13.2 kV/120-208 V auxiliary transformer.
10) Install new rectifier transformer set #2.
11) Install new section of DC switchgear to be fed from new rectifier transformer set #2. This bus section shall include DC feeders 2707, 2703 and DC station service feeds and cathode breaker.
12) Remove existing negative equalizer bus and install and test the new negative and drainage switchboard.
13) Install new battery equipment on first floor.
14) Remove existing emergency switch cabinet and existing DC emergency cabinet. Install new emergency switch cabinet and new DC emergency cabinet.
15) Remove existing emergency DC lineup.
16) Install new RTU/HMI cabinet. Install control power and RTU/HMI interconnections. Do not disturb the existing RTU connections to existing switchgear that remains operational.
17) Field survey and provide final design for the replacement of the DC remote control panel (cabinet).

b. Stage 2:
1) Remove existing DC circuit breakers from basement.
2) Remove existing transfer bus switches from basement.
3) Remove existing DC circuit breaker control boards.
4) Remove existing rectifier transformer set #1.
5) Remove existing 8000A rectifier #1 isolation switch.
6) Remove remaining section of existing 13.2 kV AC switchgear.
7) Install new 2000 kVA lighting and power transformer and remove existing 2000 kVA lighting and power transformer.
8) Disconnect existing section of 4.8 kV AC switchgear including Main #2 feeder, 2651A feeder and 2651B feeder.
9) Disconnect WESS equipment from the positive and negative buses. Connect WESS equipment to new DC switchgear. Do not remove WESS equipment or cables.
10) Install new section of 13.2 kV AC switchgear to feed new rectifier transformer set #1, second 150KVA 13.2kV/120-208V auxiliary transformer and 2000 kVA lighting and power transformer.
11) Install new section of 4.8 kV AC switchgear including Main #2 circuit breaker, 2651A circuit breaker and 2651B circuit breaker.
12) Install new rectifier transformer set #1.
13) Install new section of DC switchgear fed from new rectifier transformer unit #1. This bus section shall include DC feeders 2706, 2702, 2708, 2704, 2705, 2701, cathode breaker and WESS equipment.
14) Install new AC and DC circuit breaker test cabinets.

c. Stage 3:
1) Install remaining section of new 4.8 kV AC switchgear.
2) Remove existing 112.5 kVA, 4.8 kV/120-208 V auxiliary transformer.

3) Remove existing RTU and SCADA cabinets.

4. Castor TPSS:
   a. Stage 1:
      1) Without Power Shutdown:
         a) Install new fence and door for new rectifier transformer outside of the TPSS.
         b) Install new oil-filled rectifier transformer outside of the TPSS.
         c) Lay the new underground 13.2 kV feeders from PECO stub-up.
      2) With Complete Power Shutdown:
         a) Remove existing rectifier transformer, rectifier unit, auxiliary transformer, 13.2 kV AC switchgear, DC circuit breakers, transfer bus switches, batteries, and DC circuit breaker control board.
         b) Make the structural modifications and other building repairs.
         c) Install new rectifier unit, auxiliary transformer, 13.2 kV AC switchgear, 700V DC switchgear, batteries, and RTU/HMI cabinet.
         d) Make connections of new 13.2 kV AC incoming line with the rectifier transformer, and from rectifier transformer secondary to rectifier unit.
         e) Make connections to the DC network; replacing DC positive and negative feeder termination points in existing manhole that is in Castor Avenue.
         f) Install new AC and DC circuit breaker test cabinets.
         g) Commission the system.

1.08 SEPTA Operational Constraints

A. Holiday Service:

1. SEPTA will prohibit service shutdowns and diversions on certain Holidays and Holiday weekends. Holidays include Memorial Day weekend, the Welcome America Celebration one (1) week before the Fourth of July weekend, the Fourth of July (and the Fourth of July weekend, if applicable) and Labor Day weekend.

2. Outages, shutdowns, and diversions shall not be permitted during the "Holiday Season" which is defined as the period starting 5:01 am on the Wednesday before Thanksgiving Day until January 2, inclusive.

3. Outages requiring bussing of the passengers require a minimum of four (4) weeks' notice. This applies also to operating trolley buses without electric traction power.

B. Operational Constraints:

1. All track and power outages, as requested by the Contractor, are restricted to the window between 1:30 am and 4:30 am Monday thru Friday, (including switching and grounding).

2. With the exception of Castor TPSS, SEPTA will not take a TPSS out of service outside of the 1:30 am to 4:30 am Monday thru Friday outage window.

3. Meet the requirements in Section 01065.

4. SEPTA will conduct an annual Green Line 'Trolley Tunnel Blitz' each year for the duration of the Contract. Expect this intensive effort by SEPTA to draw CTD field and SEPTA engineering resources away from the Contract effort. Plan to use minimal SEPTA

support during this annual nine (9) day tunnel restoration event, often held mid-July. See the SEPTA.org web site for more information.

C. Construction Constraints:

1. Any actual construction activities with the potential to interfere with SEPTA operations and passenger service shall not begin until:
   a. The Contractor provides a written plan to SEPTA indicating impact to passenger service and SEPTA operations. Such plan shall include remedial solutions acceptable to SEPTA.
   b. The plan is approved in writing by SEPTA. The Contractor shall be responsible for revision and resubmittal of the plan until it is approved by SEPTA.
   c. Before starting work on a construction stage, the Contractor may submit a written request to SEPTA to amend or adjust the staging plan.
2. For the purposes of bidding, the approximate work hours on the Contract shall be as follows:
   a. Work that does not have the potential to interrupt service will be allowed from 7:30 am to 4:00 pm.
   b. Work that requires a service interruption or full station outages will be allowed from 1:30 am to 4:30 am Monday thru Friday, with proper advance notice.
3. The Contractor shall, at no additional cost to the Contract, make allowances for SEPTA published holidays, special events, weather related events, availability of SEPTA support personnel, operational needs, safety factors, other adjacent work activities and other minor changes in the hours of work.

D. SEPTA reserves the right to return any track to service without prior notification at any time and make other adjustments as needed to facilitate operations.

1.09 SEPTA Occupancy and Use

A. Portions of the work will be placed in operation by SEPTA in advance of the completion of all work, following an inspection to determine completion of these portions of the work and completion of appropriate field tests. Occupancy and/or utilization of these portions of work by SEPTA will not relieve the Contractor of responsibility for proper integrated completion of all parts of the work, nor shall it act to relieve the Contractor of any responsibilities under the Contract Documents for warranty of the work.

B. SEPTA reserves the right to use, or cause to be used, any portion of the work as soon as it is made ready for use. Such use shall not be construed as acceptance of the work by SEPTA. The Contractor shall be responsible for maintenance and up-keep of all newly installed work and the site until final acceptance of the work.

1.10 Existing Conditions

A. The existing conditions represented in the Contract Drawings are based on the best available information obtained from one (1) or any combination of the following sources:

1. Field survey.
2. As-built documents (from SEPTA archives).
3. Reference drawings.

4. Visual investigation.

B. The Contractor is responsible for verifying the conditions presented. If verified conditions are close to those represented on the Contract Drawings, the Contractor shall, in addition to reporting the verification to the SEPTA Project Manager, proceed with the work at no additional cost to SEPTA. If conditions are significantly different to those presented on the Contract Drawings, the Contractor shall, in addition to reporting the verification to the SEPTA Project Manager, submit a detailed scheme and associated cost for completing the required work for review and comment. The Contractor shall allow twenty-one (21) days for review and comment.

C. The Contract Documents establish specific criteria and standards of performance. The Contractor shall use its discretion to determine means of compliance and is responsible for coordinating with other subcontractors at the site in order to achieve compliance.

1.11 License and Permits

A. The Contractor is responsible for applying for, paying for, and obtaining licenses and permits for the Contract per the Permit Matrix attached to this Section.

1.12 Final Design

A. The Contract Drawings are approximately 50 percent complete and identify the scope of work that must be performed while meeting the objectives listed in this Section. The Contractor shall complete the final design of the TPSS rehabilitation and utilize a design capable entity on their Project Team who will carry the present 50% design through to 100% completion.

B. Final design documentation shall include, but not be limited to, confirming the preliminary design as necessary, and developing all necessary final details related to equipment layouts, staging, functional schematics, sectionalizing, site layouts, equipment detail and arrangements, relay and protection diagrams, equipment interconnection, cable and conduit routing and schedules, specifications and construction schedule.

C. The Contractor may propose alternative construction staging as necessary for review and acceptance by SEPTA. In such cases the Contractor shall provide all design aspects as deemed necessary by SEPTA. It is required that the Contractor develop a CPM sequence of work for submission to SEPTA.

D. Final design shall also include all required studies and calculations, including but not limited to short circuit study, ground grid design field tests and calculation of allowable step and touch potentials, relay and protection setting coordination study, arc flash & shock protection boundaries calculations and listing of requirements of accessories (cones, tape, etc.), lighting calculations, and mechanical systems calculations.

E. The Contractor shall provide, at a minimum, 60 percent, 90 percent, and 100 percent design submittals, for SEPTA review, in completion of the design.

1.13 TPSS Rehabilitation

A. The Contractor shall review the staging approach presented in the Contract Drawings and Specifications to develop detailed staging plans for final design and associated work. Detailed staging plans shall be submitted to SEPTA for approval, clearly identifying the

number and duration of half TPSS and full TPSS outages. Note that outage can be allowed only at one (1) TPSS at a time, subject to SEPTA's acceptance of Constructability Review memorandum. The Contractor shall request each outage one (1) week, minimum, in advance for review and approval by SEPTA. The Contractor shall indicate the details of the outage required, duration, start time, finish time and the details of work proposed to be performed in the request. The Contractor shall develop the format of the request with SEPTA soon after NTP.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

THIS PAGE NOT USED

ATTACHMENT – PERMIT MATRIX

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SEPTA SUBSTATIONS REHABILITATION PROJECT

Permits Matrix

S	*SEPTA to obtain*	C	*Contractor to obtain*

					Contract 1			Contract 2						Contract 3	Contract 4			Contract 5				Contract 6
					Bethayres	Neshaminy	Yardley	Lansdale	Hatboro	Portal	12th	18th	Woodbourne	Market	Ranstead	Ellen	Broad	Park	Loudon	Castor	Chest. Hill East
				Duration	Lower Moreland Twp.	Bensalem Twp.	Yardley Borough	Lansdale Borough	Borough of Hatboro	Phila.	Phila.	Phila.	Middletown Twp.	Phila.	Phila.	Phila.	Phila.	Phila.	Phila.	Phila.	Phila.
Discipline	**Permit**	**Description**	**Reviewing Agency**																		
Site Civil	Land Development Approval	Municipal approval of proposed site improvements	Township/Borough	120 days prelim approval 120 days final approval					**S**				**S**								
	Building (See Architectural)																				
	Zoning (See Architectural)																				
	E&S Control Plan Adequacy	Project review for >5000 sf earth disturbance	County Conserv. District	45 days initial submission 20 days final approval									**S**								
	Stormwater Plan Review	Project review assumed for >5000 sf and <15000 sf earth disturbance	Phila. Water Department	20 days initial submission 20 days final approval										**S**		**S**					**S**
	Sewer Connection Approval	Permit for Drainage Connection	PWD-Water Transport Records	20 days												**S**					
	PennDOT Highway Occupancy Permit	Construction activities in PennDOT ROW	PennDOT District 6-0	60 days initial submission 60 days final approval										**S**							**S**
	Street Closure for Equipment Placement	Temporary occupation of city-owned ROW	Phila. Streets Dept.	10 days minimum										**C**	**C**	**C**	**C**	**C**	**C**	**C**	
	Street Closure for Utility Work	Excavation in city-owned ROW	Phila. Streets Dept.	10 days minimum										**C**	**C**	**C**	**C**	**C**	**C**	**C**	
	Project Review	Required for state or federally funded project	PA Hist. and Mus. Commission	30 days									**S**								**S**
Architectural	**Philadelphia**																				
	Building	Permit for construction activity	Phila. Licenses & Insp.	20 days						**C**	**C**	**C**		**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
	Zoning	Approval of design for modified or new buildings	Phila. Licenses & Insp.	20 days initial submission 20 days final approval						**S**				**S**	**S**	**S**				**S**	**S**
	Historic Commission Approval	Review of structure in historic district	Phila. Historic Commission	60 days																	**S**
	Township/Borough																				
	Building	Permit for construction activity	Township/Borough	60 days assumed	**C**	**C**	**C**	**C**	**C**				**C**								
	Fence/Decorative Wall	May be included with building permit	Township/Borough	60 days assumed	**C**	**C**	**C**	**C**	**C**				**C**								
MEP	Electrical	Permits assigned to contractor performing construction work	Ph. L&I / Twp. / Borough	Licensed Contractors only, assumed to be a contractor defined duration	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
	Plumbing		Ph. L&I / Twp. / Borough		**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
	Mechanical		Ph. L&I / Twp. / Borough		**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**	**C**
Environmental	Soil Remediation	Federal, State, or local **process and fee** required for the management and disposal of contaminated soil.	To be determined	120 days assumed																	
	DEP Registered Tank Removal	**Process and fee** for the Removal of fuel tank registered with PA Dept. of Environmental protection	PA Dept. of Environmental Protection	120 days assumed													**C**				
General	CSX Right of Entry Permit	Access for contractor to shared ROW	CSX	90 days assumed		**C**	**C**						**S**								

SECTION 01025

MEASUREMENT AND PAYMENT

PART 1 - GENERAL

1.01 Description

A. This Section covers general requirements for measurement of quantities and schedule of values required to process payment applications according to the provisions set forth in the Agreement.

B. Provide a detailed breakdown of the Contract sum showing values allocated to each of the various parts of the work, as specified herein, and as required by other provisions of the Contract Documents.

C. Provide the baseline schedule of value and all subsequent schedule of value updates in MS Excel format.

D. None of the instructions/directions listed in this Section are to supersede, eliminate or circumvent document submission procedures or requirements listed or implied in SEPTA's Standard Form Construction Contract - Exhibit III (federally funded) Planning, Scheduling and Progress Monitoring Specifications.

1.02 Related Sections

A. Documents affecting work of this Section include, but are not necessarily limited to the Agreement, pertinent sections in Division 1 and technical Divisions 2 through 16.

B. Exhibit III of the Agreement.

1.03 Measurement of Quantities

A. The work performed under the Contract will not be measured, except to establish percentage of completion for each value line payment item.

B. Contract Specifications require factory (design and production) tests to be performed on the following traction power equipment, traction power rectifier transformers, auxiliary power transformers, traction power rectifiers, disconnect switches, circuit breakers, switchgear, generator assemblies, battery equipment, Supervisory Control and Data Acquisition/Remote Terminal Unit (SCADA/RTU) and instrument transformers. Include in the bid the amount of credit to be given to SEPTA for each individual factory test if it is waived by SEPTA upon review of the reports of the tests performed on similar or essentially similar equipment in the past (Sections 16230, 16240, 16260, 16271, 16273, 16274, 16290, 16344, 16910).

1.04 Scope of Payment

A. Payment for work performed under the Contract will be paid in accordance with the Agreement, for the:

1. Traction Power Substation Rehabilitation Project.

2. Complete in place and in conformance with the Contract Documents.

1.05 Quality Assurance

A. Prior to applying for first application of payment, secure SEPTA's approval of the Schedule of Values.

B. During progress of the work, including any change order work, modify the Schedule of Values, as required, and as approved by SEPTA.

C. Provide data, including detailed bid preparation documents to substantiate each value line.

1.06 Schedule of Payments

A. Submit a schedule of values in accordance with the requirements specified in the Agreement.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01045

CUTTING AND PATCHING

PART 1 - GENERAL

1.01 Description

A. This Section covers general requirements pertaining to cutting (including excavating), fitting, and patching of the work required to:

1. Make the installation fit properly in an existing and new structure.
2. Uncover work to inspect hidden conditions and then patch.
3. Remove and replace non-conforming or otherwise defective work.
4. Repair holes and cracks caused by removal of existing or new but misplaced accessories and equipment.
5. Coordinate the work of all trades.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01060 – Regulatory Requirements and Safety

C. Section 01300 – Submittals

D. Section 01305 – Requests for Information

E. Section 01400 – Quality Requirements

F. Section 01600 – Materials and Equipment

G. Section 02070 – Selective Demolition

H. Section 02220 - Excavation, Backfill and Compaction

1.03 Submittals

A. Request for Approval:

1. Prior to cutting any element, submit written request to the SEPTA Project Manager for permission to proceed with any demolition, cutting or patching. Request should include structural design calculations that have been sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania for temporary structural supports.
2. Should conditions of the work, or schedule, indicate a required change of materials or methods for cutting and patching, so notify the SEPTA Project Manager and secure his written permission prior to proceeding.

B. The SEPTA Project Manager may require the Contractor to submit a detailed plan, at least ten (10) business days in advance of the desired date of the work, with any or all of the following information:

1. Explanation of why this work is needed.

2. Extent of work and how adjacent work will be protected and blended in at the work's conclusion.
3. Modifications to existing structural components including signed and sealed calculations and drawings by a Professional Engineer licensed in the Commonwealth of Pennsylvania.
4. Products and methods to be used in the work.
5. Schedule of when the work is to be done.
6. Utilities (both SEPTA and non-SEPTA) affected by the work.
7. At historical locations, specific procedures which will mitigate the impact of the cutting and patching on the historical integrity of the structure.

1.04 Quality Assurance

A. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. Provide a plan for the inspecting/testing of all modified structural components to ensure structural integrity is maintained. This plan shall be signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

C. The SEPTA Project Manager reserves the right to require an approved mock-up for any cutting and patching work prior to execution of the entire work.

1.05 Restrictions

A. Structural elements shall not be cut or patched in a manner that would reduce the load carrying capacity of load deflection ratio. All processes which affect structural members must be signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania and submitted to SEPTA for review before work begins.

B. Operating elements or safety related components shall not be cut or patched in a manner that would result in reducing their capacity to perform as intended or result in increased maintenance or decreased operational life or safety.

C. Construction exposed on the exterior or in occupied spaces shall not be cut or patched in a manner that would, in the opinion of the SEPTA Project Manager, reduce the building elements' aesthetic qualities, or result in visual evidence of cutting and patching. The responsible Contractor shall remove and replace work cut and patched in a manner deemed to be visually unsatisfactory by the SEPTA Project Manager.

D. Dispose of all waste in a legal manner following all local codes and regulations.

PART 2 - PRODUCTS

2.01 Materials

A. Except as otherwise indicated in the Contract Documents or approved by the SEPTA Project Manager, provide materials for cutting and patching which will result in equal or better

work than work being cut and patched, in terms of performance characteristics and including visual effect where applicable.

B. Use materials identical with original materials where feasible and satisfactory results can be produced subject to review by the SEPTA Project Manager. If original materials are unavailable, use materials which match appearance and match or exceed performance of the original material as interpreted by the SEPTA Project Manager.

PART 3 - EXECUTION

3.01 Inspections

A. Inspect existing conditions, including elements subject to movement or damage during cutting, excavating, patching, and backfilling.

B. Provide temporary support before uncovering any hidden conditions per Article 3.02 in this Section.

C. After uncovering existing conditions, inspect conditions affecting installation of new work, including the suitably of all substrates to receive new material.

3.02 Hazardous and Dangerous Conditions

A. If, during the preliminary inspection and/or the cutting and patching procedure, material of a suspicious nature is discovered, the Contractor shall stop work in the vicinity immediately, abandon, isolate and mark the area, erect signs saying, 'DO NOT ENTER' and alert the SEPTA Project Manager immediately.

B. If, during the preliminary inspection and/or the cutting and patching procedure, the safety of the structure appears to be endangered, or there appears to be movement in structural elements, the Contractor shall stop work immediately, install bracing, and mark the area, erect signs saying, 'DO NOT ENTER' and alert the SEPTA Project Manager immediately.

3.03 Discrepancies

A. If uncovered conditions are inconsistent with the Contract Documents, immediately notify the SEPTA Project Manager and secure needed direction.

B. Do not proceed until undocumented conditions are resolved, and the SEPTA Project Manager gives direction.

3.04 Temporary Support and Protection

A. Provide adequate temporary support to prevent instability of work to be cut. Do not endanger adjacent work.

B. Provide adequate protection of the work, including adjacent areas, during cutting and patching, to prevent damage; and to protect from adverse weather exposure.

C. Where services and utilities are to be affected by cutting and patching work, attempt to bypass to avoid interruption or obtain prior approval for this work.

3.05 Performance

A. Perform required excavation and backfilling in accordance with Section 02220 and in conformance with all safety regulations and requirements.

B. Cut work in a manner which avoids damage to work to be retained and adjoining work. Where physical cutting is required, cut work with sawing, and grinding tools maintaining a neat straight finished edge. Core drill openings through concrete and masonry work. Cut exposed finishes through to unexposed finishes.

C. Obtain prior approval for all equipment to be used and all demolition procedures. Do not cut with hammer and chipping tools. Use water and adequate ventilation to control dust.

D. Do not cut mechanical or electrical equipment or conduit without determining the status of equipment with certainty and consulting with the appropriate contractor. Never assume equipment or conduit is abandoned without establishing its status. Cap or seal piping, ductwork, and conduit to prevent moisture from entering.

E. Patch seams to be durable and invisible to the satisfaction of the SEPTA Project Manager. Restore exposed finished or patched areas in a manner to eliminate evidence of patching.

F. Do not cut and patch operational elements or safety related components in a manner that would result in a reduction of their capacity to perform in the manner intended, or that would result in increased maintenance, or decreased operational life or decreased safety.

G. Where new or enlarged doorways or openings as shown in existing construction, take the necessary precaution to support the walls above the openings and install new steel lintels above the openings. Where the wall finish is plaster or CMU, reinforced precast block lintels may be used where approved by the SEPTA Project Manager. New wall materials shall be toothed into existing wall materials. New metal frames shall be anchored and grouted identically to what is required for all new work.

H. If existing utilities, pipes, and/or conduits must be relocated by any contractor, the affected contractor shall install by-pass services of quality equal to the existing system prior to beginning the work subject to the approval of the SEPTA Project Manager.

I. When painting patched areas, continue painted area to a visual barrier such as an expansion joint, edge of material, corner or other joint. Obtain approval for paint color matches on a mock-up which, if approved by the SEPTA Project Manager, may become part of the work.

J. At exterior locations, test all patches to determine if they create a watertight condition.

3.06 Cleaning

A. Before an area is turned back to SEPTA for use, thoroughly clean areas, and spaces where work has been performed or used as access to work.

B. Thoroughly clean piping, conduit, and similar fixtures before painting or other finishing is applied.

C. Restore items suffering incidental damage, such as pipe covering and miscellaneous finishes, to their original condition.

END OF SECTION

SECTION 01050

FIELD ENGINEERING

PART 1 - GENERAL

1.01 Description

A. This Section covers field engineering services as necessary to correctly complete the work including, but not limited to:

1. Establishing and maintaining lines, levels and other survey controls as dictated by the specific Project parameters.

2. Structural design of sheeting, shoring, formwork, temporary supports/falsework and similar items provided by the Contractor as needed for the execution of the work.

B. Responsibilities:

1. The Contractor is responsible to perform its own field engineering/survey work. The Contractor is also responsible to perform the site survey and stakeout markers for others to use per Article 1.06/D in this Section.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. Section 01700 – Contract Closeout

E. Section 01720 – Project As-Built Documents

1.03 Submittals

A. Comply with pertinent provisions of Section 01300.

B. Contractor(s) in all cases shall submit:

1. Documentation demonstrating qualifications of persons proposed to be engaged for field engineering/survey services.

2. Documentation detailing the methods that the Contractor proposes to use to achieve and verify required survey accuracy.

3. All survey-related submittals shall be accompanied by a certification, signed by the Contractor's retained field engineer, stating that elevations and locations of improvements are in conformance or nonconformance with the requirements of the Contract Documents.

4. Provide shop drawings and design calculations sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania for all falsework and temporary or interim supports including sheeting, shoring, excavation supports, cofferdams, concrete forming systems and steel erection devices among others.

1.04 Quality Assurance

A. Use adequate numbers of skilled professionals and technicians who are thoroughly trained and experienced in the necessary areas and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

B. A Professional Land Surveyor (PLS) Licensed to Practice in the Commonwealth of Pennsylvania shall perform the survey work for the Contractor. The PLS shall be on the work site whenever survey activities are taking place.

C. Temporary support/excavation support shop drawings and calculations shall be prepared, signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

1.05 Engineering Procedures

A. The Contractor's engineer shall design all construction related structures to the satisfaction of SEPTA. All designs must be submitted at least twenty-one (21) days before construction to allow sufficient time for review. SEPTA will not be responsible for delays caused by resubmittals if required.

1.06 Surveying Procedures

A. In addition to procedures executed by the Contractor and his subcontractors for proper performance of the work, the Contractor shall:

1. Locate and protect control points before starting work on the site.
2. Preserve permanent reference points during progress of the work.
3. Do not change or relocate reference points or items of the work without specific approval from SEPTA.
4. Promptly advise SEPTA when a reference point is lost or destroyed or requires relocation because of other changes in the work.
    a. Upon direction of SEPTA, require the Contractor's surveyor to replace reference stakes or markers.
    b. Locate such replacements according to the original survey control.

OR

B. The Contractor shall engage a Professional Land Surveyor (PLS) to:

1. Log elevation of critical points of the Project such as slab on grades and takeoff structures.
2. Log elevations at finish grades and sidewalks.
3. Stakeout the Project property.

C. Before proceeding with the layout of actual work, the Contractor shall verify the layout information shown on the drawings, in relation to the property survey and existing benchmarks. As the work proceeds, the surveyor shall check every major element for line, level and plumb. A surveyor's log or record book of such checks shall be maintained current at all times. Make this log or record book available for SEPTA, SEPTA's Architect and/or

Engineer's reference. The surveyor shall record deviations from the required lines and levels, and shall, upon detection, promptly advise SEPTA of deviations exceeding indicated or recognized tolerances. The Contractor shall update final survey information on as-built drawings.

D. The Contractor shall be responsible for the stakeout of all property lines and corners required to establish the location of fences and other items of work, of which location is referenced thereto.

E. The Contractor shall assume full responsibility for dimensions and elevations taken from benchmarks and baselines and for the setting of lines and grades.

F. The Contractor shall provide SEPTA with any assistance required for checking lines, grades and measurements as may be requested by SEPTA.

1.07 Project Survey Records

A. On completion of any major structural element of the work such as foundations, abutments, piers or other significant site improvement, the Contractor shall prepare and submit a certified survey illustrating dimensions, locations, angles, and elevations of the final construction and site work.

B. The Contractor shall preserve all field books and stakeout data until final acceptance of the work at which time they will be signed and sealed by a land surveyor licensed in the Commonwealth of Pennsylvania and turned over to SEPTA. The Contractor shall comply with any requests by SEPTA to review field books and stakeout data at any time during the course of work. Submit field books and stakeout data to SEPTA as part of project closeout. The field books and stakeout data will become the property of SEPTA.

1.08 Survey Crews

A. The Contractor shall employ a survey crew. The survey crew shall be onsite at all times during construction stages where their work is required, to perform all survey related tasks as necessary to properly execute the work in accordance with the Contract Drawings and Specifications.

B. In addition, the members of the survey crew must be located in such proximity to the work site that mobilization is possible within four (4) hours of notification by SEPTA when an unanticipated need for their services occurs.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

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SECTION 01060

REGULATORY REQUIREMENTS AND SAFETY

PART 1 - GENERAL

1.01 Description

A. This Section specifies the Safety, Health, and Environmental requirements for Contractor personnel involved in construction, maintenance, and rehabilitation Projects on SEPTA property. The Contractor is required to assure that all employees, subcontractors, and suppliers/vendors, while on the job site comply with the provisions of this Section.

B. At those facilities to remain in operation during construction or are adjacent to SEPTA right of way, the Contractor shall take every precaution necessary to assure the safe access and egress of all SEPTA customers and employees, the safe and continuous operation of all SEPTA vehicles, ensure the appropriate protection of the environment as well as the safety and general welfare of the public at large. Depending on the configuration of the Project, the Contractor may be responsible for providing temporary pedestrian access including access which is accessible to those with disabilities. Under no circumstances is the Contractor to block or restrict public or SEPTA entrances or the SEPTA vehicle right of way without prior written approval of the SEPTA Project Manager.

1.02 Related Sections

A. Agreement

B. Section 01010 – Summary of Work

C. Section 01100 – Special Project Procedures

D. Section 01300 – Submittals

E. Section 01305 – Requests for Information

F. Section 01400 – Quality Requirements

G. Section 01500 – Construction Facilities and Temporary Controls

H. Section 01570 - Maintenance and Protection of Vehicles, Pedestrians and Passengers

1.03 Submittals

A. The Contractor shall furnish a copy of the Contractor’s Site Specific Work Plan (SSWP); and corporate program if referenced; and protocols to the SEPTA Project Manager within thirty (30) days from receipt of the Notice to Proceed (NTP). The SEPTA Project Manager may prohibit and/or restrict any work on the job site until this plan has been received and approved.

B. If these Specifications call for certifications or licensures from the Commonwealth of Pennsylvania, it is understood that certification or licensure shall be from the state where the work is occurring and in the case of work in multiple states, then certification or licensure from multiple states may be required.

1.04 Quality Assurance

A. The Contractor shall be responsible for ensuring compliance with the regulations of all applicable occupational safety and health statues and regulations of all the applicable political jurisdictions where the work is being performed including those relating to the U.S. Department of Labor, Federal Railroad Administration (FRA), Federal Transit Administration (FTA) and Occupational Safety and Health Administration (OSHA) standards. The Contractor shall conduct daily monitoring and document the compliance and performance of the requirements outlined in this Section and those required by applicable governmental agencies. This documentation will be based on the applicable code requirements and shall be made available upon request of the SEPTA Project Manager.

B. The SEPTA Project Manager, SEPTA employees and SEPTA's third party consultant staff will monitor compliance with all applicable internal safety and environmental regulations and environmental Contract Specifications.

C. The Contractor's employee safety program, which must be site specific, shall include but not be limited to the following; as applicable:

1. Job Site Orientation:
    a. Safety and health hazards present in the work assignment and general work area.
2. OSHA:
    a. Written programs applicable to the scope of work.
3. Required training, licensing or certification, and documentation of same.
4. Workmen's compensation reporting.
5. Fall protection equipment and requirements.
6. Personal protective equipment.
7. Confined space procedures.
8. Hazardous materials handling and disposal.
9. Trenching and excavation protection.
10. Crane lift plans.
11. Electrical protection.
12. Drug and alcohol prohibitions and testing.
13. Public, SEPTA employee, and passenger protection.
14. Site Emergency Procedures and Contact Information:
    a. Emergency contact numbers.
    b. Emergency escape routes and evacuation meeting place.
15. Nearest hospital including directions from the job site with route maps.

D. The Contractor shall provide a qualified Safety Officer who shall be responsible for all safety-related activities until the completion of the work. The Contractor is also responsible for all safety related activities for all their subcontractors and suppliers working at the job site.

1. The qualifications for a Project Safety Officer are:
    a. Minimum of five (5) years of experience in safety management for heavy/commercial construction.
    b. Completed an OSHA thirty (30) hours construction safety course.
    c. Have the authorization to take prompt corrective measures.
    d. If required, be recognized as the competent person in accordance with OSHA definitions.
    e. Have the ability to recognize hazards associated with the scope of work.
    f. Have a current First Aid and CPR certification.

E. The Safety Officer shall report all on the job injuries immediately to the SEPTA Project Manager and submit all paperwork about such injuries within twenty-four (24) hours or as required by the SEPTA Project Manager.

F. The Contractor's Safety Officer shall, as a minimum, hold weekly (toolbox) safety meetings with all of the Contractor's personnel. Subjects, time, and location may be set at the Contractor's convenience. At least three (3) days before each meeting, SEPTA requires an agenda be submitted to the SEPTA Project Manager, including the time and location of each meeting. Copies of signed attendance sheets and meeting minutes shall be submitted to the SEPTA Project Manager at each regularly scheduled Project coordination meeting.

G. The Contractor is required, by Agreement, to maintain an alcohol and drug free environment. The Contractor shall describe in their employee safety program on how this Contract stipulation is to be accomplished and maintained. Please note that SEPTA reserves the right to restrict access to its property, because of the inherent safety hazard to its employees and the general public. Any person shall be immediately removed and barred from SEPTA property if, in the opinion of SEPTA's Project Manager, and/or other appropriate SEPTA representative, that person constitutes a safety risk.

H. Meet the applicable provisions of the most recent issues of the following references:

1. 25 pa Code 261a, Identification and Listing of Hazardous Waste
2. 25 pa Code 271, Municipal Waste Management – General Provisions
3. 40 CFR 61, National Emission Standards for Hazardous Air Pollutants
4. 40 CFR 141, National Primary Drinking Water Regulation
5. 40 CFR 262.11, Hazard Wase Determination
6. 40 CFR 268.7, Testing, Tracking, and Recordkeeping Requirements for Generators, Reverse Distributors, Treaters, and Disposal Facilities
7. 40 CFR 761, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and use Prohibitions
8. 40 CFR 763, Asbestos
9. ANSI 107, High Visibility Safety Apparel and Accessories
10. ANSI S1.4, Specifications for Sound Level Meters
11. ANSI Z87.1, American National Standard for Occupational and Educational Personal Eye and Face Protection Devices
12. ANSI Z89.1, Personal Protection - Protective Headwear for Industrial Workers

13. ASTM F2413, Standard Specification for Performance Requirements for Protective (Safety) Toe Cap Footwear
14. IEC 179, Precision Sound Level Meters
15. IFC, International Fire Code.
16. NFPA 10, Portable Fire Extinguishers
17. NFPA 30, Flammable and Combustible Liquids
18. NFPA 51B, Standard for Fire Prevention during Welding, Cutting, and Other Hot Work
19. NFPA 55, Compressed Gases and Cryogenic Fluids Code
20. NFPA 58, Liquefied Petroleum Gas Code
21. NFPA 70, National Electrical Code (NEC)
22. NFPA 70E, Standard for Electrical Safety in the Workplace
23. NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations
24. OSHA 29 CFR 1910, Occupational Safety and Health Standards
25. OSHA 29 CFR 1910.95, Occupational Noise Exposure
26. OSHA 29 CFR 1910.120, Hazardous Waste Operations and Emergency Response
27. OSHA 29 CFR 1910.134, Respiratory Protection
28. OSHA 29 CFR 1910.147, The Control of Hazardous Energy (Lockout/Tagout)
29. OSHA 29 CFR 1910.178, Powered Industrial Trucks
30. OSHA 29 CFR 1910.1001, Asbestos
31. OSHA 29 CFR 1910.1025, Lead
32. OSHA 29 CFR 1910.1200, Hazard Communication Standard
33. OSHA 29 CFR 1926 Subpart M, Fall Protection
34. OSHA 29 CFR 1926 Subpart P, Excavations
35. OSHA 29 CFR 1926 Subpart X, Stairways and Ladders
36. OSHA 29 CFR 1926.52, Occupational Noise Exposure
37. OSHA 29 CFR 1926.62, Lead
38. OSHA 29 CFR 1926.103, Respiratory Protection
39. OSHA 29 CFR 1926.354, Welding, Cutting, and Heating in Way of Preservative Coatings
40. OSHA 29 CFR 1926.400, Electrical Standard
41. OSHA 29 CFR 1926.450, Scaffolds
42. OSHA 29 CFR 1926.451(g)(1), Scaffolds
43. OSHA 29 CFR 1926.453, Aerial Lifts
44. OSHA 29 CFR 1926.500, Fall Protection

45. OSHA 29 CFR 1926.502(f)(2), Fall Protection Systems Criteria and Practices
46. OSHA Subpart R 1926.760(a)(3), Fall Protection
47. OSHA 29 CFR 1926.1053, Ladders
48. OSHA 29 CFR 1926.1101, Asbestos
49. Pennsylvania Department of Environmental Protection (PA-DEP)

1.05 Track Safety Requirements

A. All Contractors performing work on SEPTA property will be required to comply with SEPTA's Roadway Worker Protection (RWP) Requirements when the work to be performed has the possibility of fouling the track. The Contractor must ensure all personnel, including subcontractors and suppliers, attend and pass the required SEPTA Roadway and Transit Worker Safety Training. Should the SEPTA Project fall on another railroad's territory, contractors and all those under the Contractor must obtain all required Roadway Worker qualifications for that Railroad. All certifications must be obtained prior to any employee beginning work at the physical Project site location. This covers the rules and procedures for, but not limited to, working in or about stations, yards, tunnels, or track right of way. All personnel are required to wear/display their safety training card. The required training may be obtained by going to the Roadway Worker Training website; https://www.rrtrainers.com/buy-online-classes/; and selecting the Roadway Worker protection class(es) the Contractor employees will require.

1.06 General Safety Requirements

A. The Contractor shall assume responsibility of overall job site safety coordination and shall provide a full time on-site Safety Officer. The Project Safety Officer is required from the first day of the Contractor's mobilization activities; including mobilization activities of the Contractor's subcontractors.

1. A Contractor whose workforce, including all subcontractors and suppliers, exceeding ten (10) workers at any time on the job site are required to designate a Safety Person who is working on the job site full time and whose sole duty is safety.
2. The Contractor shall provide a Competent Person for all high hazard activities. High hazard activities are activities that are determined to have the potential to result in a serious injury or death and may include but not limited to the following activities: fall protection, crane lifts, unusual lifts, extensive scaffolding, demolition, excavation, shaft work, confined space, etc. SEPTA maintains the right to deem an activity as high risk and require a Competent Person for oversight.

B. The Contractor shall supply and furnish all required Personal Protective Equipment (PPE) for their employees. The Contractor is also responsible for ensuring that PPE is worn correctly by all employees on the job site. The Contractor's employees shall wear compliant safety equipment including but not limited to hard hats, safety shoes/boots, safety vests, safety glasses and full body cover clothing, including Flame Retardant (FR) clothing where and when it is required.

1. The minimum PPE standards must be met as outlined below:

a. Hard hats shall be ANSI Z89.1, Class E. Hard hats shall always properly be worn while on the job site.

b. Safety shoes; ASTM F2413 C75/I75; shall have nonslip soles. Permanent metal plates or cleats on the sole or heel of shoes are prohibited. Shoelaces are to be kept short so they do not pose a tripping hazard. Athletic shoes, sandals, open-toed shoes, moccasins and/or shoes with heels higher than 1 inch are not permitted.

c. The Contractor's personnel shall wear eye protection at all times while on the job site. Eye protection shall be safety glasses with rigid side shields that comply with ANSI Z87.1. Prescription eyewear shall also meet the same requirements as described above, or the individual shall wear equivalent eye protection over their prescription glasses or contact lenses. Eye wash/shower stations shall be provided when needed.

d. The safety vest shall be ANSI 107, Class 2 high visibility with a yellow green background and 2 inch retroreflective striping for work on SEPTA owned property within any public right of way, where exposed to vehicular traffic, or otherwise required by rules and regulations.

e. The Contractor’s personnel shall wear long pants; without cuffs; and, at a minimum, short sleeve shirts. Sleeveless shirts and shorts are prohibited

f. Approved hearing protection shall be worn in all designated areas identified by signs or when operating high noise level equipment. The Contractor is responsible for providing acceptable hearing protection for their employees as outline in OSHA 29 CFR 1910.95.

g. The Contractor is responsible for providing acceptable respiratory protection for their employees as outlined in OSHA 29 CFR 1926.103.

h. Gloves shall be worn where hand injuries are likely to occur based on the hazard present.

i. The Contractor must wear FR clothing/suits with a Cal rating appropriate for the available incident energy in accordance with NFPA 70E. Note that the work sites are active Traction Power Substations (TPSSs).

C. The Contractor shall take all necessary precautions and provide protective measures to prevent injury to the public and damage to property of others. To prevent unauthorized access to the work zone and storage areas, the Contractor shall furnish and erect construction fencing or barricades and signage, as specified in the Contract Documents or as directed by the SEPTA Project Manager, for the safeguarding of the public against accident or damage before commencing operations. The Contractor shall maintain the protective measures and/or construction fencing in good condition as evaluated by the SEPTA Project Manager, until removal.

D. The Contractor shall dismantle, remove and/or relocate construction fencing and barricades when directed by the SEPTA Project Manager.

E. The Contractor is required to comply with OSHA’s Occupational Noise Exposure Standard 29 CFR 1910.95 and any local noise ordinances.

F. Where it is permitted to store materials on streets, the Contractor shall place such materials in a secure place in accordance with local jurisdictions so as to cause minimum obstruction to traffic and public safety. The Contractor shall not place materials within 15 feet of fire hydrants nor obstruct drainage gutters and inlets. The Contractor shall obtain and pay for all required permits about materials storage.

1. Material stored on site must be secured to prevent vandals from placing debris or material on the right of way. Material placed on the right of way must be removed by the Contractor immediately upon notification, at any time, at no cost to SEPTA. At no time shall any merchandise, material, or other articles be permitted to remain piled or

assembled on the ground or platforms adjacent to any track at a distance of fewer than 10 feet from the center line of such track.

2. Copies of all Safety Data Sheets (SDS), Product Use sheets, and quantities shall be given to SEPTA's Project Manager and reviewed and approved by SEPTA's System Safety Division before material purchase/delivery to SEPTA property. All training shall be done in accordance with OSHA's Hazard Communication Standard.

3. All SDS must comply with OSHA's Hazard Communication Standard 29 CFR 1910.1200. Also, all contractors must be trained per the Hazard Communication Standard. The Contractor is responsible for maintaining all SDS used at the job site.

4. The storage of hazardous and flammable materials on SEPTA property is restricted and permission of each material must be granted by the SEPTA Project Manager. When storing flammable and hazardous materials and hazardous waste, they must be stored in compliance with all applicable regulations. Flammable materials shall not be stored in confined spaces or other similar areas such as tunnels, underground rooms, and building basements.

5. If hazardous substances are present, such as waste, or if potential for a hazardous release exists, the Contractor is responsible for following their Site Safety Plan covering policies and procedures to protect workers and the public from the potential hazards.

G. Firearms or any items classified as concealed weapons are not permitted on SEPTA's property.

H. All tobacco use is prohibited within the construction Project and all areas subject to restrictions by SEPTA or by local, state, and federal law. Smoking within SEPTA indoor facilities is prohibited. This includes the use of electronic cigarettes/vaping.

I. The Contractor may not block or obstruct access to emergency equipment such as First Aid kits, AED units, eyewash stations, fire extinguishing equipment, fire hydrants, transformers, or emergency generators. Emergency equipment must not be disconnected or relocated by the Contractor without permission from SEPTA's Project Manager.

J. All electronic devices, including smart watches, must be turned OFF or placed in airplane mode when working within the fouling envelope of the right of way. If an individual must make or receive a phone call, they must first step outside the fouling envelope of the right of way to make or receive the call or otherwise use an electronic device. The Contractor and his personnel are liable for all fines assessed by the federal and/or state regulators for a violation of this regulation. Violation of this regulation can result in the individual being prohibited from working on the Project.

K. The use of headphones, ear buds, etc. are prohibited while in a construction area.

1.07 Accident and Injury Reporting

A. The Contractor is responsible for reporting and investigating all work related accidents and incidents. This shall be completed promptly with recommendations for corrective actions to prevent similar accidents or incidents. Accidents and incidents include:

1. Personal injury.

2. Property damage.

3. Near misses.
4. Actual or potential exposure to toxic substances.
5. Hazardous material spills and releases.
6. Fires.

B. The Contractor must notify the SEPTA Project Manager for all accidents and incidents that occur on SEPTA property immediately.

C. SEPTA reserves the right to conduct an independent investigation of all accidents and incidents that occur on the job site with full cooperation of the Contractor, subcontractor and employees.

D. At accident locations where conditions are immediately dangerous to life and health, work shall be suspended until corrective actions are taken to the satisfaction of the appropriate SEPTA representative.

1.08 Emergency Procedures

A. The Contractor shall set up emergency procedures and prepare written guidelines discussing such procedures for the following categories:

1. Fire.
2. Injury to the Contractor's and/or SEPTA employees.
3. Injury to the general public.
4. Property damage, including the property of utilities, i.e., gas, water, sewage, electrical, telephone or pedestrian and vehicle routes.
5. Hazardous/toxic material spill, discharges and/or exposure.
6. Site evacuation.

B. Copies of all guidelines for emergency procedures shall be written and posted before the initiation of actual construction. Posting shall include emergency telephone numbers and directions to and from the nearest hospital. The Contractor shall have standing arrangements for the transportation and hospital treatment of any employees who may be injured, are exposed to hazardous material, or who may become ill. These guidelines shall be included in the Contractor's written safety program and shall be submitted to SEPTA.

C. The Contractor shall provide a fully equipped First Aid kit at the job site. This First Aid kit will be made available to the SEPTA Project Manager or designee for their inspection and approval at any time.

D. The Contractor must discuss site emergency procedures at the beginning of the Project, with the addition of a new worker to the job site and at least monthly with all personnel at toolbox safety meetings. Any changes to the job site emergency procedures must be documented, and employees, suppliers and the SEPTA Project Manager notified.

E. SEPTA emergencies will be handled by the SEPTA Manager on site. SEPTA will assume command of the incident when it directly affects SEPTA Operations. SEPTA will designate an On-Scene Coordinator (OSC) who will be responsible for the coordination of the response efforts along with the Emergency Services Incident Commander (IC), for summoning of

persons, equipment, or materials required by the situation and assignment of all recommended procedures.

1.09 Protection of SEPTA Facilities

A. The Contractor shall be cognizant of and bound by SEPTA's safety rules and regulations specified herein and conduct operations in strict accordance with same.

B. SEPTA shall be the sole judge of protection necessary for the safe operation of its facilities. SEPTA reserves the right to alter this protection at any time.

C. SEPTA's facilities and/or structures shall not be utilized by the Contractor for temporary scaffolding and/or support for the construction effort without permission. The Contractor may request SEPTA's consideration for such action. The Contractor shall provide a detailed plan to utilize SEPTA's facilities and/or structures. The plans will be submitted for SEPTA's review and approval prior to the initiation of any work. SEPTA also reserves the right to have the drawings and supporting calculations signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania, or appropriate jurisdiction, at no cost to SEPTA.

D. Before any work is done in the vicinity of an existing structure, SEPTA must be notified and may require a plan for stabilizing and underpinning the structure prepared and signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania, or appropriate jurisdiction, at no expense to SEPTA.

1.10 Crane, Material Handling, and Erection Safety

A. The Contractor shall take care to prevent any structure from being loaded with weight, for any duration, which will endanger its stability or the safety of persons.

B. The Contractor shall adhere to all local, state, and federal laws about crane operations.

C. All cranes must be inspected annually as well as monthly. The most recent reports shall be submitted to SEPTA prior to the use of the cranes on any job site. SEPTA's Project Manager must ensure that daily safety inspections are completed. The monthly reports for the crane must be submitted to the SEPTA Project Manager on a pre-determined schedule as long as the crane is operating on the Project. The Contractor shall ensure all crane operators are CCO certified by the National Commission for the certification of crane operators or equivalent. Riggers shall be trained and qualified. The Contractor shall provide a competent person to oversee and/or perform lifting operations as required by OSHA. Personnel qualifications will be made available to SEPTA upon request.

D. The Contractor shall submit for review to the SEPTA Project Manager, sketches defining the operations of all cranes, material handling equipment, and erection activities used in support of construction during periods of train operations. The Contractor shall submit, at the SEPTA Project Manager's request, similar information for cranes or other equipment in use and capable of encroachment.

1. These sketches shall include planned locations and movements of the equipment, calculations demonstrating the adequacy of the capacity of the crane for the loads, the interface between the footprint of the equipment, the movement of the boom and loads relative to the existing structure and surrounding buildings, the support grillages

and the protection of existing utilities and facilities, and any other pertinent details required by the SEPTA Project Manager.

2. The following data shall be required for all hoisting operations adjacent to active SEPTA operations and facilities and shall be prepared by and signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.
    a. Plans and sections showing locations of cranes, horizontally and vertically, operating radii, with delivery of disposal locations shown. The location of the SEPTA right of way and all active facilities shall also be shown.
    b. Crane rating sheets showing cranes to be adequate for 150 percent of the actual weight being lifted. A complete set of crane charts, including crane, counterweight, and boom nomenclature is to be submitted.
    c. A location plan showing all obstructions such as wires, poles, adjacent structures, etc., and that the proposed lifts are clear of these obstructions.
    d. A data sheet shall be prepared to list the type, size, and arrangements of slings, shackles, or other connecting equipment, all to be designed for 150 percent of the actual weight being lifted. Copies of a catalog or information sheets for specialized equipment shall be included.
    e. A complete procedure is to be included, indicating the location and order of lifts and any repositioning or rehitching of the crane or cranes.
    f. Temporary support of any components or intermediate stages is to be shown and detailed.
    g. A schedule of the various stages must be shown as well as a schedule for the entire lifting procedure.

E. Specialty slings and hooks shall not be used to set steel or move materials over workers. All sling and crane load line hooks shall have safety latches installed and shall be moussed, except for specialty slings and hooks such as sorting or shake out slings or self-adjusting pipe slings.

F. The Contractor shall not leave suspended loads unattended. When moving loads, the operator shall ensure a clear path free of personnel or other barriers.

G. The Contractor shall establish a restricted work area using barricades and other appropriate controls to minimize the hazards to personnel, customers, and equipment from swinging or falling objects.

1.11 Snow Removal

A. The Contractor shall remove all snow and ice from the Project site as required for the proper protection and prosecution of the work and protect SEPTA employees and the general public. The Contractor shall always provide and maintain adequate protection against weather so as to preserve all work, materials, equipment, apparatus, and fixtures free from damage.

B. The Contractor shall not use sodium chloride; or any chloride; on any facilities adjacent to SEPTA electric rail lines where the possibility exists that melting mixture may leach onto the contact rail within the right of way.

1.12 Welding, Cutting and Other Hot Work

A. Gas or electric cutting, burning, or welding, braising, or grinding shall be done by the guidelines of NFPA 51B, the International Fire Code, federal, state, and local rules and regulations or the provisions below, whichever is more restrictive.

B. If hot work is to be executed at a job site, the Contractor's Safety Officer must have a copy of the current version of NFPA 51B and the SEPTA Hot Work and Sources of Ignition Safety Program, Document #2020 at the job site.

C. The Contractor's Safety Officer shall act as a Permit Authorizing Individual (PAI) and complete the checklist/permit to fulfill the requirements of NFPA 51B and SEPTA Document #2020 for all hot work and sources of ignition work. The Contractor shall obtain the current copy of SEPTA's "Hot Work Checklist/Permit" for this purpose.

D. The SEPTA Project Manager shall be notified at least forty-eight (48) hours in advance of any hot work on the job site. A copy of each checklist/permit completed for that period shall be delivered to the SEPTA Project Manager at the next job progress meeting.

E. Spark shields and a fire watch must be posted when executing hot work for at least four (4) hours after all activity has been completed. The SEPTA Project Manager reserves the right to extend the duration of the fire watch in special circumstances. A supply of water and an approved fire extinguisher shall be readily available to the location where the work was done.

F. All oxygen/acetylene cylinders must be removed and stored outside of all tunnels, underground stations, and other confined spaces at the end of the workday. While in use in a tunnel, underground station or confined space, they shall be attended at all times. At no times when not in use shall oxygen and acetylene cylinders be stored together.

G. Anti-flashback devices must be installed on the fuel side of all gas and oxygen cutting torches.

1.13 Gas Cylinders

A. Compressed gas cylinders shall be handled and properly supported and secured in an upright position away from heat or flame sources. Cylinders that are not being used or being transported must have their caps in place.

B. Regulators, hoses, and torch assemblies must be in working order and checked for leaks prior to initial use or installation. If a leak is discovered, the cylinder must be removed to a safe location.

C. Cylinders must be labeled and stored with compatible gases, in accordance with IFC and NFPA 55 requirements and proper signs posted.

D. Oxygen and acetylene or other fuel-gas cylinders, empty or full, shall not be stored together. Full oxygen cylinders must be separated from acetylene cylinders or other fuel-gas cylinders or combustible materials a minimum distance of 20 feet or by a noncombustible barrier extending not less than 30 inches above and to the sides of the storage area having a fire resistance rating of at least two (2) hours.

E. All cylinder valves must be closed when cylinders are not in use and the hose pressure bled down.

F. All cylinders must be removed from confined spaces at the end of each workday.

1.14 Utilities

A. Before any excavation begins, the Contractor must initiate a PA One Call to determine the location of all utility installations such as but not limited to sewer lines, telephone lines, fuel

lines, underground electric lines, waters lines or any other underground installations that may be present during excavations.

B. As per 73 P.S., § 176, et seq., the Contractor is required to notify utilities prior to all excavations. The Contractor shall be held responsible for any damage done to any utility in the prosecution of the work. The Contractor shall exercise any precautions necessary to prevent damage in working underneath or adjacent to any underground structure. If it becomes necessary for a utility company, through emergency procedures or because of unforeseen conditions, to repair, reconstruct, relay, or relocate utilities within the Contract area, after work has commenced by the Contractor, then the said utility company and the Contractor shall make suitable arrangements to overcome such interference. All work shall be accomplished at no extra cost or charge to SEPTA. No compensation shall be allowed to the Contractor for the disruption to his work. A no-cost time extension may be granted in accordance with the Contract to the Contractor by SEPTA for the delay that has occurred.

1.15 Housekeeping

A. The Contractor shall maintain the job site in an orderly manner.

B. The Contractor should conduct ongoing housekeeping inspections and ensure no accumulation of trash and debris exists throughout the job site. All material and equipment must be stored in a neat and orderly manner to avoid tripping, fire and/or injury hazards to workers and passengers.

C. SEPTA reserves the right to require the Contractor to immediately cleanup the job site and stop all work if poor housekeeping presents an unsafe work environment. The Contractor could remain suspended until the job site conditions are cleaned up and made safe.

D. The Contractor shall provide containers for trash and scrap metal unless prearranged with the SEPTA Project Manager before the start of the Project.

E. The Contractor is responsible for the proper disposal of hazardous, flammable, trash and/or excess waste material. All waste must be removed or secured on site daily. See SEPTA's Program 3000 Environmental Management and Waste Minimization for more information on hazardous waste.

F. The Contractor is responsible for maintaining all disposal records, including chain of custody records for hazardous or untested material, and providing copies to the SEPTA Project Manager where applicable.

G. No on-site burning or burying of waste or material is permitted.

1.16 Electrical

A. The Contractor directly involved with electrical work or work adjacent to electrical hazards shall do so only after details of the work have been planned and approved by SEPTA.

B. All electrical work shall comply with OSHA 29 CFR 1926.400, OSHA 29 CFR 1910.147, the National Electrical Code (NEC), NFPA 70E and any SEPTA standards.

C. All equipment and cords must be free from damage. Frayed or cut electrical cords, or cords with damaged plugs or missing ground plugs shall immediately be removed from service, rendered unusable, and removed from the job site.

D. All electrical tools and equipment must be grounded.

E. Before working on a de-energized circuit, it must be electrically tested to ensure it is de-energized.

F. The Contractor must complete lockout/tagout procedures for all machines, equipment, and systems that require service or maintenance as required by OSHA 29 CFR 1910.147 and SEPTA Lockout Tagout Program #1007.

1. A lock or tag can only be removed by the individual or their designee.

G. After the Contractor performs repairs, maintenance, or installations, and before SEPTA employees attempt to re-energize the electrical equipment, verification shall be performed in the presence of the SEPTA Project Manager to ensure that the electrical equipment components are operationally intact and that no electrical hazard is present upon re-energizing.

1.17 Confined Space

A. The Contractor shall be required to have competent and trained personnel for restricted or confined space entry work.

B. The Contractor is required to utilize and follow SEPTA's Confined Space Program #1003 to include but not limited to utilizing a permit when required.

C. Confined spaces refer to space which by design has limited openings for entry and exit but large enough to enter to perform work and is not designed for continuous occupancy. Confined spaces at SEPTA can include but not limited to storage tanks, boilers, trenches, manholes, lift stations, and valve pits.

D. The Contractor shall coordinate and obtain approval from the SEPTA Project Manager for all confined and restricted space activities.

E. The Contractor must provide emergency rescue based on the work being conducted. Documentation on the rescue procedures, authorized rescuers, training, and equipment must be approved by SEPTA and be available on the job site prior to conducting confined space entries.

1.18 Excavation and Trenches

A. The Contractor shall provide training to all personnel required for safe trenching and excavation projects on SEPTA property and comply with OSHA Excavation Standard 29 CFR 1926 Subpart P.

B. Before any excavations or trenching, the Contractor shall be responsible for utility marking to ensure the area impacted is free from underground hazards.

C. Excavation and trenches 5 feet deep or greater must have appropriate protective systems such as but not limited to sloping, trench shields, and shoring. However, if soil conditions are unstable in excavations less than 5 feet in depth the Competent Person must determine if there is a need for protection. This requirement is in addition to any other regulatory requirements including OSHA requirements.

D. Daily inspections of excavations, adjacent areas, and protective systems must be made by the Contractor's Competent Person to ensure safety systems are functional and effective. The Contractor must keep documentation of daily inspections and readily available for review by SEPTA.

E. The Contractor shall place warning signage and barricades or fencing to prevent unauthorized or accidental access to the excavated area.

F. The Contractor shall cease work immediately and contact the SEPTA Project Manager if a suspect material such as strong odors, discolored soils, pipes, pipe covering or another material indicating the potential presence of asbestos or other hazardous materials is encountered.

1.19 Ladder Safety

A. All ladders and their use must comply with OSHA 29 CFR 1926.1053 and ANSI specifications.

B. Metal or other conductive ladders are prohibited.

C. Ladders must be inspected before use and must be in good condition and free of any broken or defective parts. Defective ladders must be removed from service.

D. The Contractor must provide training to all employees in the proper use of ladders and how to recognize ladders hazards.

E. Job fabricated ladders are prohibited.

1.20 Fall Protection

A. The Contractor shall provide fall protection and proper training for its employees, as required by OSHA 29 CFR 1926.500. Fall protection is required in areas where the fall hazard is 6 feet or greater from the lower working level or surface. Fall protection for scaffold is required at 10 feet above the lower level as required by 29 CFR 1926.451(g)(1). Steel erection will follow OSHA Subpart R 1926.760(a)(3).

B. If compliance with the 6 foot rule is technologically and/or physically infeasible, a pre-planning meeting must be scheduled with SEPTA's Representative, as required, to determine alternatives.

C. A Site Specific Fall Protection Plan should be developed by the Contractor for each high risk stage of work. Plans should include a list of anticipated exposures and anticipated protective systems for each stage of construction.

D. The Contractor and each subcontractor are ultimately responsible for fall protection for their employees. Fall protection should be included in each subcontractor's safety program. A Site Specific Fall Protection Plan should be developed by each subcontractor for the exposures they will encounter on each job site.

E. Pre-planning is required for all high risk activities.

F. This Article does not include work for ladders; refer to OSHA 1926 CFR Subpart X.

G. Contractors whose work will require them to be exposed to fall hazards beyond conventional guardrail systems are to submit a Site Specific Fall Protection Plan before the start of their work, which will specify the location of anchorage points and anticipated exposures.

H. Warning Line System:

1. In addition to OSHA 1926 CFR Subpart M, the warning lines typically used for roofing work and Controlled Access Zones, and other areas covered by OSHA Letters of

Interpretation; as defined under OSHA 29 CFR 1926.500; shall be permitted under the following criteria:

a. All warning lines shall be placed a minimum of 15 feet from all exposed edges.
b. Warning lines shall meet or exceed the requirements in OSHA 29 CFR 1926.502(f)(2).
c. Fall protection signage shall be placed along the warning line at intervals appropriate for the conditions.
d. For Controlled Access Zones, the warning line shall be connected on each side to a guardrail system. The guardrail system shall project 15 feet beyond the warning line connection point.
e. Points of access are not permitted from unguarded edges into the area(s) defined by a warning line unless the access points are protected by conventional fall protection.
f. Conventional fall protection shall be used by all personnel working between the warning line and the exposed edge(s).
g. The employer effectively implements a work rule prohibiting the employees from going past the warning line unless protected by conventional fall protection.

2. Use of a safety monitor shall not be used as a conventional method of fall protection unless all other methods are not feasible and only upon approval from SEPTA's System Safety Division.

3. The Contractor shall maintain and upon request, submit to the SEPTA Representative, all Fall Protection Training Documentation as specified by OSHA.
   a. Fall protection training certification for each employee is to be submitted by the subcontractor which includes the name of the employee, the signature of the trainer and the date of the training.
   b. If the employer relies on training conducted by another employer, the certification record shall indicate the date the employer determined the prior training was adequate rather than the date of the actual training.

4. For dedicated/designated Controlled Access Zones which require the removal of any type of fall protection, wooden or cable guardrail systems, windows, wall panels, etc.:
   a. The immediate area near the Controlled Access Zone must have a hard barricade in place that meets the requirements of a standard guardrail system to prevent other trades working in the area and/or on that floor from being exposed to a fall hazard.
   b. Removal of any fall protection, such as guardrail system, must be replaced with approved personal fall protection.
   c. Workers in Controlled Access Zones shall be required to use a full body harness that they continue to wear and remain hooked until they are on the inside of the guardrail system which provides protection from a fall.
   d. Temporary access zones may use temporary barriers which restrict the access of workers not engaged in that loading activity. At a minimum, Red Danger Tape may be used, set back at least 15 feet from the opening temporarily.
   e. A 4 inch by 6 inch toe board may be required when the possibility exists for motorized equipment to be driven off the edge.
   f. Controlled Access Zones are to have the ability to be locked and controlled by the Contractor.

5. A Guardrail Disruption Policy and supporting permits shall be developed, implemented, and enforced per site requirements.

6. Controlled Access Zone work requires pre-approval. Request for approval must be submitted with a Site Specific Fall Protection Plan, infeasibility statement for each location, and training for each employee. A review of the submitted documentation will be done by the SEPTA Representative.
7. The use of field designed, and field fabricated horizontal lifeline systems must be designed and installed under the supervision of a qualified person. Proof of such design and proper installation must be furnished upon request. The system shall be certified as a whole system, not just the capacities of its parts.
8. The use of Pre-Engineered/Pre-Manufactured horizontal lifeline systems must be installed and used in accordance with the manufacturer's instructions. Design data and written verification of proper installation must be furnished upon request.
9. The Contractor shall isolate work areas to protect persons form falling objects and to prevent unauthorized access to the job site.
10. The Contractor shall perform documented inspections of their fall protection equipment before each use.
11. Work being conducted within 6 feet of a floor opening; skylight, hole, open hatch, etc.; requires the appropriate fall protection.
12. Work being conducted on a roof within 6 feet of the edge requires the appropriate fall protection. The Contractor shall not work on or access roofs without prior approval from the SEPTA Project Manager.

1.21 Scaffolds

A. All scaffolding, staging, and work platforms must satisfy OSHA 29 CFR 1926.450 and the manufacturer's requirements.

B. The Contractor shall ensure that scaffolding be erected under the direction of the Competent Person.

C. The Competent Person shall perform documented pre-use inspections for erected scaffolding.

1.22 Powered Equipment/Work Platforms

A. The Contractor shall not use SEPTA owned or leased powered equipment or aerial work platforms unless approved by the SEPTA Project Manager.

B. The Contractor shall ensure only trained authorized personnel are permitted to operate any powered equipment such as but not limited to forklifts, extendable boom lifts, scissor lift, and cranes.

C. The Contractor shall perform documented inspections of equipment before each day's use to ensure safe operating condition. Defective equipment must be segregated and not be used on the job site.

D. The Contractor must ensure all its employees and subcontractors have had appropriate and effective training in compliance with OSHA 29 CFR 1910.178, OSHA 29 CFR 1926.453, and the manufacturer's recommendations.

1.23 Fire Safety

A. The Contractor's personnel should be familiar with the location of fire alarm pull stations, portable fire extinguishers and exit routes from the work area. The Contractor shall not obstruct access to exits, exit routes, or fire equipment or prop-open stairwell doors.

1. All fire extinguishers shall be maintained and inspected in accordance with NFPA 10.

B. Fires shall be reported by activating the nearest fire alarm pull station and calling 911.

C. The Contractor's personnel shall be trained in the proper use of a portable fire extinguisher and the duties per Article 1.12 in this Section in the event fire watch duties are required.

D. Flammable and combustible materials shall be stored and labeled in accordance with the latest version of IFC, OSHA, NFPA 30, NFPA 55, NFPA 58, NFPA 241, and SEPTA Safety Cabinet Guideline #7028 requirements. For disposal of these materials after use refer to Part 2 in this Section.

E. The Contractor must follow requirements listed in Article 1.12 in this Section if welding, torch cutting, soldering or other forms of "hot work" will be performed.

F. The Contractor must take precautions to prevent damage to fire protection systems. All damage must be reported immediately to the SEPTA Project Manager.

G. The Contractor must not disable a fire protection system; sprinklers, fire alarm system components, etc.; unless prior approval has been provided by the SEPTA Project Manager and local fire department. If a system is disabled, fire watch personnel must be present until that system is reconnected, or other arrangements have been made and approved by the SEPTA Project Manager.

H. Materials or equipment must not be temporarily or permanently suspended on fire alarm systems or sprinkler pipes, valves, or supports.

1.24 Protection of Existing Water and Sewer Lines

A. When the equipment axle load exceeds 15 tons, the Contractor shall provide and work from timber mats placed over existing underground water lines and sewer lines.

B. SEPTA reserves the right to require additional protection and/or protection plans signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

PART 2 - ENVIRONMENTAL

2.01 Submittals

A. The Contractor shall furnish for review by SEPTA the Contractor's Environmental and/or Waste Management Program within thirty (30) days from receipt of Notice to Proceed.

B. Prior to the start of work, the Contractor shall furnish for review by SEPTA a Means and Methods Plan describing the day-to-day activities the Contractor will employ to complete construction in accordance with the Specification requirements. The Means and Methods Plan shall include the following:

1. A detailed, stepwise description of the construction process organized sequentially.

2. A description of any specialized equipment to be utilized to complete the work.

3. Identification of potential hazards in the construction process.
4. A description of the construction mitigation measures that the Contractor will implement to mitigate identified hazards.

C. Prior to the start of work, the Contractor shall furnish for review by SEPTA a copy of asbestos and lead survey findings/reports. If asbestos abatement or lead removal is conducted, the Contractor shall further furnish to SEPTA prior to the start of those activities, all relevant submittals including but not limited to notifications, Work Plans, and Health and Safety Plans. Within thirty (30) days of completion of work, waste disposal records documenting disposal at a SEPTA approved facility shall also be submitted to SEPTA.

2.02 Quality Assurance

A. The Contractor shall be responsible for ensuring compliance with SEPTA work rules and federal, state, and local rules and regulations and all environmental regulations of all of the applicable political jurisdictions where the work is being performed including those relating to the U.S. Department of Labor, FRA, FTA, Commonwealth of Pennsylvania Department of Environmental Protection (PA-DEP), and the Environmental Protection Agency (EPA). The Contractor shall conduct daily monitoring and document the compliance and performance of the requirements outlined in this Section and those required by applicable governmental agencies. This documentation will be based on the applicable code requirements and shall be made available upon request of the SEPTA Project Manager.

B. The Contractor's Environmental and/or Waste Management Program, as a minimum, shall include but not be limited to the following as applicable to the work:

1. Sustainability and recycling. Prior to start of work all contractors and subcontractors must receive SEPTA's Environmental and Sustainability Management System (ESMS) training. Refer to Article 2.06 in this Section.
2. Waste management and disposal.
3. Hazardous materials.
4. Soils management.
5. Erosion and sedimentation control.
6. UST Management; if applicable.
7. Noise control; if applicable.

C. The Contractor shall provide a qualified environmental safety officer who shall be responsible for all environmental safety related activities until the completion of the work. The environmental safety officer shall report all on-the-job environmental incidents at once to the SEPTA Project Manager and submit all paperwork about such incidents as required.

2.03 Emergency Procedures

A. The Contractor's Project Manager; or equivalent; and Project Safety Officer shall conduct a pre-mobilization meeting with SEPTA and SEPTA Representatives to determine and review site specific emergency action requirements.

1. Identify emergency contacts between the Contractor, SEPTA and SEPTA Representatives with exchange of phone numbers, etc. and establish primary means of communication with SEPTA, i.e., radio, telephone, etc.
2. Evaluate the impact and develop plans for pedestrian and vehicular traffic on campus or community.
3. Prepare written guidelines discussing response and notification actions related to hazardous/toxic materials spills, discharges, or releases. Such guidelines shall be incorporated into one or more of the Contractor's required SSWP submittals such as Health and Safety Plan, Work Plan, Contingency Plan, or Environmental and/or Waste Management Program.
4. Address other issues as required.
5. Contact and meet with local fire department, emergency medical services, and technical rescue teams.
6. Develop a site specific emergency action plan, which is to address, at a minimum, the following elements:
    a. Emergency escape procedures and escape routes.
    b. Procedures to be followed by employees who remain to operate critical functions before they evacuate the job site.
    c. Employee emergency evacuation meeting point.
    d. Rescue and medical duties of personnel.
    e. Emergency reporting procedures.
    f. Emergency radio procedures.
    g. Alarm system.
    h. Severe weather alert.

2.04 Storage and Handling of Materials

A. Materials Handling:

1. All scrap material of any kind, type, or nature shall be placed into designated confined areas or containers specifically supplied for this purpose. Containers shall be removed from the job site when full.
2. The Contractor shall assure that all chemicals, paints, solvents, and cleaners are maintained per OSHA's hazard standards. Discarded chemicals shall be dispose of in accordance with applicable PA-DEP and/or EPA requirements. Copies of all Safety Data Sheets (SDS), Product Use sheets, and quantities shall be given to SEPTA's Project Manager and reviewed and approved by SEPTA's System Safety Division before material purchase/delivery to SEPTA property. All training shall be done in accordance with OSHA's Hazard Communication Standard.
3. Materials handling shall be conducted in accordance with the Contractor's Environmental and/or Waste Management Program; refer to Article 2.05 in this Section.
4. Flammable and combustible materials at a minimum must be labeled, properly stored, and disposed. Refer to SEPTA's Program 3000 Environmental Management and Waste Minimization requirements.

2.05 Environmental Protection

A. Environmental protection considerations consist of, but are not limited to, the following factors:

1. Natural resources, including air, water, and land.
2. Solid waste disposal.
3. Noise.
4. Control of toxic substances, hazardous materials, and radiation.
5. The presence of chemical, physical, and biological elements and agents that adversely affect and alter ecological balances.
6. Degradation of the aesthetic use of the environment.
7. Historical, archaeological, and cultural resources.

B. General Requirements:

1. The Contractor shall provide and maintain environmental protection as defined herein or as required by regulation, whichever is more restrictive.
2. The Contractor's operation shall meet all applicable federal, state, and local laws, ordinances, and regulations pertaining to environmental protection.
3. Compliance of subcontractors and suppliers with the provisions of this and all other Sections of these Specifications shall be the responsibility of the Contractor.
4. The Contractor shall not use equipment from which factory installed antipollution and noise control devices have been removed, altered, or rendered ineffective intentionally or through lack of proper maintenance.
5. Unless the Contractor has tested and established the safety of existing paints and coverings, the Contractor shall provide adequate pollution controls for painting and surface preparation in compliance with the PA-DEP regulations.

C. Protection of Natural Resources:

1. General:
   a. It is intended that the natural resources within the Project boundaries and outside the limits of permanent work performed shall be preserved in their existing condition or be restored to an equivalent of the existing condition, as approved by the SEPTA Project Manager upon completion of the work. The Contractor shall confine its on-site construction activities to areas defined by the Contract Drawings and Specifications or directed by the SEPTA Project Manager.
2. Protection of Project Site and Existing Roadways:
   a. Debris or rubbish of any kind shall not be dumped onto the job site or roadways. This shall include paint splatters, cleaning, stripping and surface preparation chemicals and spillage during painting operations. Care shall be taken to prevent damage and injury to personnel, vessels, and vehicles using roadways, or areas accessible to pedestrians. Devices shall be provided and maintained by the Contractor as required to prevent such occurrences. Material or items falling onto roadways shall be promptly removed at the Contractor's expense. All damage to third party property shall be restored by the Contractor to the Owner’s satisfaction at no cost to SEPTA.

b. The operator shall remove from the job site, recycle, or dispose of all building materials and wastes in accordance with the PA-DEP solid waste management regulations at 25 pa code 271. The Contractor shall not illegally bury, dump, or discharge any building material or wastes at the job site.

3. Land Resources:
   a. Except in areas indicated to be cleared or excavated, the Contractor shall not remove, cut, deface, injure, or destroy trees, shrubs, or vegetation. No ropes, cables, or guys shall be fastened or attached to any existing nearby trees for anchorage unless specifically permitted by the SEPTA Project Manager. Where such use is permitted, the Contractor shall be responsible for any resulting damage.
   b. The use of pesticides or herbicides is not permitted unless approved in writing by the SEPTA Project Manager.
   c. The Contractor shall submit a plan for protecting existing trees and vegetation that are to remain and that may be injured, bruised, defaced, or otherwise damaged by construction operations. Rocks that are displaced into areas that are not cleared shall be removed. Monuments, markers and works of art shall be protected prior to the start of the operations. A preconstruction survey, including photographs, shall be performed by the Contractor in the presence of the SEPTA Project Manager, and a written report of the survey shall be furnished to SEPTA within five (5) days of its request by the SEPTA Project Manager.
   d. Repair and Restoration:
      1) All trees, vegetation, and other man-made or natural landscape features that are to remain and become scarred or damaged by the Contractor's equipment or operations shall be repaired and restored to their original condition at the Contractor's expense. The SEPTA Project Manager shall approve the repair and restoration program prior to its initiation and after completion.

4. Water Resources:
   a. At all times, measures shall be taken to prevent oil, gasoline and other hazardous substances and pollutants from entering the ground, drainage areas, sewers, streams, and other local bodies of water.

5. Wildlife Resources:
   a. The Contractor shall not disturb native habitat adjacent to the construction Project area.

D. Erosion and Sediment Controls:
   1. Site burning of any kind, including ground vegetation, is not permitted.
   2. The Contractor shall conform to all applicable requirements of the PA-DEP and the county with respect to erosion and sediment control measures to prevent discharge into storm water discharge systems and active waterways.

E. Toxic Substances:
   1. The Contractor shall comply with the Toxic Substance Control Act, P.L. 94-469 (TSCA).
      a. No toxic chemical substance, mixture, equipment, container, sealant, coating, or dust control agent shall be used except in accordance with all provisions of the TSCA as interpreted by the rules and regulations of 40 CFR 761.
      b. Any toxic chemical substance, mixture, equipment, container, sealant, coating, or dust control agent found stored within the Project area shall be immediately reported to the SEPTA Project Manager in writing and work shall be stopped in the area. The SEPTA Project

Manager shall make arrangements for the removal of the toxic materials and will ensure that the area is safe for the Contractor to continue work in the area.

F. Control and Disposal of Chemical and Sanitary Wastes:

1. Trash shall be picked up and placed in containers that shall be emptied on a regular schedule. Handling and disposal shall be so conducted as to prevent contamination of the site and other areas and shall not be disposed of in wetlands or burned on the right of way. On completion, the area shall be left clean and in natural condition.

2. Disposal of rubbish and debris shall be as follows:

   a. The Contractor shall transport all waste, including excess excavated material, from the job site and dispose of it in a manner that meets the federal, state, and local requirements.

   b. The Contractor shall secure a permit or license prior to transporting any material off the site.

   c. Waste materials shall not be burned on the job site.

   d. The Contractor shall be responsible for the disposal of waste material to a pickup point or disposal area.

3. Chemical waste shall be stored in corrosion resistant containers, removed from the Project site, and disposed of as necessary, but not less frequently as monthly. Disposal of chemical waste shall be in accordance with standard established practices as approved by the SEPTA Project Manager. Fueling and lubricating of equipment and motor vehicles on the job site shall be conducted in a manner that affords the maximum protection against spills and evaporation. Lubricants to be discarded, including burned oil, shall be disposed of in accordance with approved procedures meeting federal, state, and local regulations. For oil and hazardous material spills that may violate federal, state, or local regulations, the SEPTA Project Manager shall be notified immediately.

G. Dust Control:

1. Airborne dust shall be minimized at all times, including non-working hours, weekends, and holidays. Soil at the site, station platforms, haul roads, and other areas disturbed by the Contractor's operations and materials stockpiled for the Project shall be treated with dust suppressors or covered to control dust. Dry power brooming shall not be permitted. Vacuuming, wet mopping, wet sweeping or wet power broom equipment shall be used instead. Air blowing shall be permitted only for cleaning off non-particle debris, such as that from reinforcing bars. Sandblasting shall not be permitted except as otherwise specified elsewhere. Only wet cutting of concrete block, concrete and asphalt shall be permitted.

2. The Contractor shall comply with all applicable provisions of the National Emission Standards 40 CFR 61.

3. The Contractor shall inspect all vehicles for dirt prior to their leaving the construction site. Dirt, soil, and rubble likely to be dislodged during transit shall be removed from the trucks and other vehicles prior to leaving the site.

4. The Contractor shall ensure that equipment transporting material to and from the job site that may become airborne is covered.

5. The Contractor shall not cause or permit fugitive particulate matter to be emitted into the outdoor atmosphere from any source such that emissions are visible beyond the Project property line.

H. Noise Control:

1. The Contractor shall research and determine the applicable jurisdiction requirements for noise control in the Project area. In the event a Project site lies in two or more jurisdictional areas and the requirements conflict, the strictest will govern. City of Philadelphia Air Management regulations govern for any work within the City of Philadelphia. In absence of specific jurisdictional instructions regarding noise control, OSHA 29 CFR 1910 will apply.

I. Asbestos and Lead Containing Materials:

1. Prior to commencement of work, the Contractor shall coordinate performance of a survey of the Project area for Asbestos Containing Materials (ACM) and lead-based paint by asbestos and lead inspectors/investigators properly licensed and certified to perform such work in Pennsylvania and the City of Philadelphia, where applicable. The Contractor shall submit to the SEPTA Project Manager a copy of the findings/report prior to the commencement of work. The report shall include at a minimum, sample locations depicted on a drawing/sketch, photo documentation, and summary of findings, analytical results, and AIR when applicable. SEPTA is a legacy Agency and due to the age, it is possible to encounter suspicious material during the course of Project work.

2. The Contractor shall comply with all applicable federal, state, and local laws including but not limited to the City of Philadelphia Asbestos Control Regulations, OSHA 29 CFR 1926.1101, 40 CFR 763, 40 CFR 141, OSHA 29 CFR 1910.120, OSHA 29 CFR 1910.134, OSHA 29 CFR 1910.1001, OSHA 29 CFR 1926.62, OSHA 29 CFR 1910.1025, 40 CFR 268.7, 40 CFR 262.11, 25 pa code 261a, and Title 6, Health Code, of the Philadelphia Code, Chapter 6-600.

3. All asbestos abatement removal specifications shall be written by a licensed asbestos project designer. The abatement shall be conducted by licensed abatement workers and supervisors; air monitoring shall be conducted by a third party licensed asbestos project inspector.

4. All submittals including but not limited to notifications, Work Plans, and Health and Safety Plans shall be submitted to SEPTA for review prior to the commencement of work. Within thirty (30) days of completion of work, waste disposal records documenting disposal at a SEPTA approved facility shall also be submitted to SEPTA.

5. All newly installed materials shall be asbestos and lead free.

6. For Projects that include the torch cutting or welding of materials with a protective coating, the coating shall be removed down to the substrate at least 4 inches above and below from the area of heat application in accordance with OSHA 29 CFR 1926.354.

2.06 Environmental Training

A. All contractors and subcontractors, prior to the start of work, must receive SEPTA's Environmental and Sustainability Management System (ESMS) training.

B. All contractors and subcontractors must document this training and keep on file for possible review at any time by SEPTA. SEPTA will also retain documentation that this training has

been provided to all contractors and subcontractors that will be contracted and perform work for SEPTA.

PART 3 - MANAGEMENT

3.01 SEPTA Project Manager

A. All Contractor and Subcontractor work shall be performed safely and in a manner that does not interfere with normal operations or construction activities. Should it be necessary for SEPTA and its Representatives to take remedial action to rectify unsafe conditions and/or restore normal operations, all costs incurred by SEPTA will be “back charged” to the responsible contractor. All “back charges” shall include the actual cost of labor and materials plus 20 percent for administrative costs. SEPTA and its representatives shall have full authority to stop work in progress whenever necessary to enforce Project safety requirements. No part of the time lost due to any such stop work order shall be made the subject of a claim for extension of time or increased cost by the Contractor or subcontractors.

B. In the event the Project site or any portion of the Project site is stopped or shut down by any outside agency because of an unsafe condition, the responsible contractor shall bear the total expense for the Project or that part of the Project that is shut down. Said costs shall be for the entire period the Project is stopped or shut down.

C. The Contractor shall not receive additional payment or reimbursement for safety items and procedures which have been identified as required by the Project Safety Requirements.

D. SEPTA and its Representatives shall have full authority to withhold full or partial progress payments for failure to comply with the Project Safety Requirements.

E. SEPTA and its Representatives shall have authority to prohibit any contractor employee from returning to the Project for failure to comply with the Project Safety Requirements.

F. SEPTA reserves the right to terminate this Contract for failure to comply with the Project Safety Requirements.

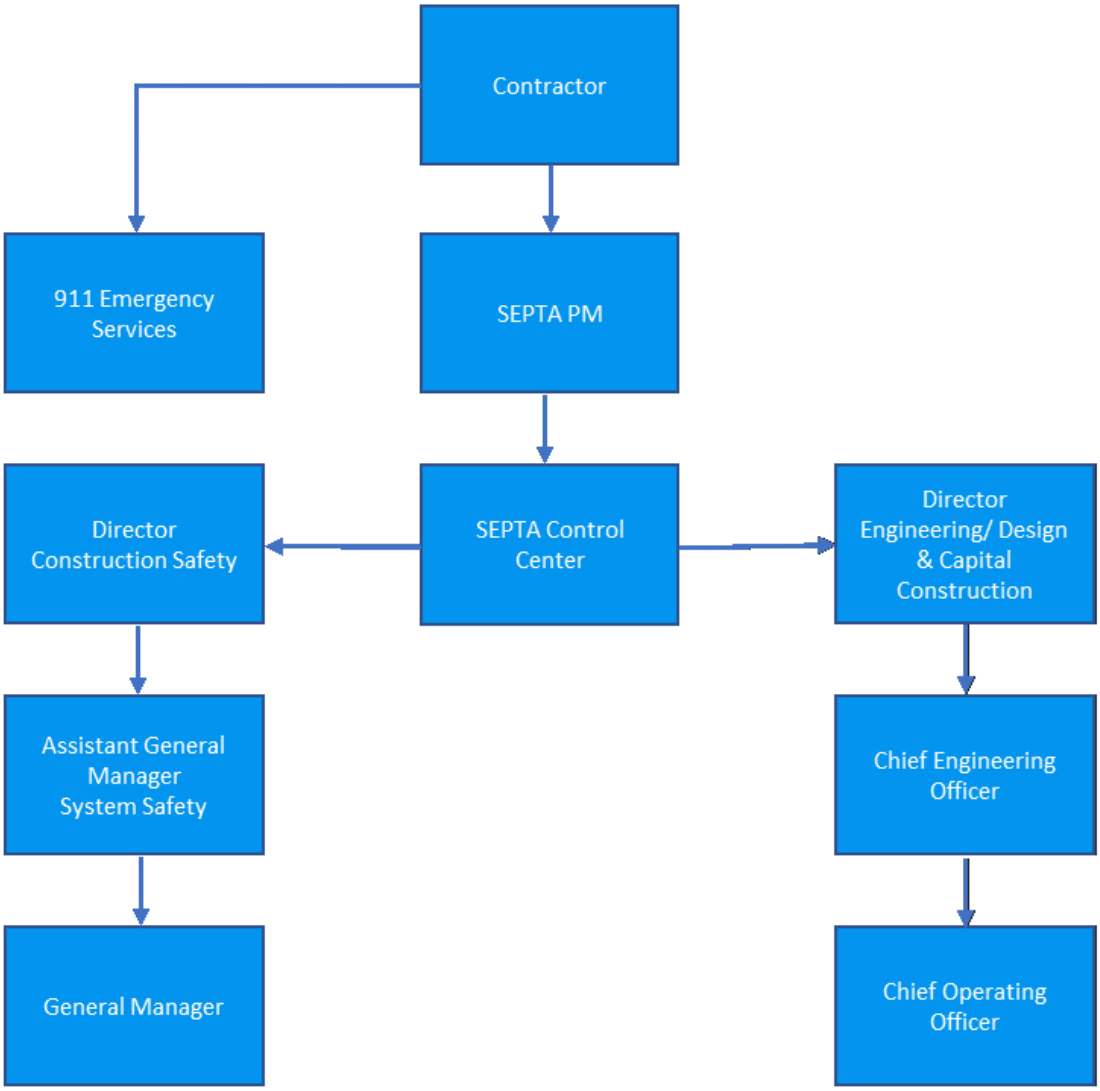
G. In the event of a conflict and/or ambiguity between various safety statues or requirements, the interpretation by SEPTA and its Representatives as to which provision applies or what is implied in a given provision shall be final.

3.02 Emergency Contact Flow Diagram

A. In the event of an emergency, the Contractor shall follow the attached flow chart.

B. In the event of an unforeseen change or incident that has or may affect the operation of revenue or non-revenue services, that attached flow chart shall be followed.

C. Should an event cause damage or have the potential to cause damage to SEPTA or any other property on or near SEPTA property, the attached flow chart shall be followed.



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SECTION 01061

SAFETY AND SECURITY CERTIFICATION REQUIREMENTS

PART 1 - GENERAL

1.01 DEFINITIONS

A. Certifiable Element - Project elements that can affect the safety and security of transit agency passengers, employees, contractors, emergency responders, or the public. Certifiable elements define the scope of the project's certification program.

B. Certifiable Elements List (CEL) - A compilation of all identified certifiable elements for a project. Each element identified in the CEL may be broken into sub-elements.

C. Certifiable Items List (CIL) – A compilation of all identified certifiable items for all certifiable elements of a project.

D. Certificate of Conformance (COC) – Document verifying that all certifiable items have been verified and all hazards and threats related to the project have been sufficiently mitigated.

E. Construction Specification Conformance Checklist (CSCC) – A comprehensive checklist outlining construction and installation specifications associated with each certifiable item. The checklist is used to verify that the project is built or installed in accordance with approved designs, technical specifications, drawings, and contract requirements. The CSCC is contained in the CIL, which is tabbed in the SEPTA SSC workbook.

F. Design-Build Contractor – The firm selected by SEPTA through competitive procurement to advance the project from the 50% design milestone to final 100% design, and to perform all construction, installation, testing, and commissioning activities required under the contract. The Design-Build Contractor is responsible for developing the remaining design deliverables to achieve fully compliant final design documents; incorporating all applicable safety, security, and emergency-management criteria; completing and annotating Means of Verification (MOV) for all construction/installation/testing items; providing all required submittals to the SCWG; performing system integration testing; addressing hazards and verification activities; supporting safety and security analyses (including OHA, TVA, FMEAs/Fault Trees where required); and delivering verification evidence for all Certifiable Items List (CIL) elements through construction, testing, and pre-revenue readiness.

G. The Design-Build Contractor assumes full responsibility for design completion, implementation, and certification through final acceptance and revenue-service readiness.

H. Design Consultant – The professional engineering and architectural firm contracted by SEPTA to develop the project design through the 50% design milestone and to provide continued technical support throughout construction, testing, and safety/security certification. The Design Consultant is responsible for incorporating all applicable safety, security, and emergency-management requirements into the partial design; assisting with the development of the hazard analyses (including PHA) and other documentation; annotating Means of Verification (MOV) for design-phase items; participating in the Safety Certification Working Group (SCWG); supporting the System Safety Division's SSC Consultant; and providing technical review, verification input, and design intent clarification throughout the

Design-Build Contractor's completion of the final design, construction/installation, system integration testing, and pre-revenue phases.

I. Design Criteria Conformance Checklist (DCCC) – A comprehensive checklist identifying design criteria and specifications associated with each certifiable item. The checklist is used to verify that the safety- and security-related technical specifications, drawings, and contract documents for the project are incorporated into the project designs. The DCCC is contained in the CIL, which is tabbed in the SEPTA SSC workbook.

J. Failure Mode Effects Analysis (FMEA) – a structured approach to identify and assess potential failures in a system, process, or product. FMEA can be applied to various aspects of the system, including design, operations, and maintenance to improve reliability, safety, and performance.

K. Failure Mode, Effects, and Criticality Analysis (FMECA) – a risk assessment method used to identify potential failures in a system, analyze their effects, and determine their criticality. FMECA can be applied to identify and prioritize potential failure modes in rolling stock, such as passenger doors or other mechanical systems, to improve reliability and safety.

L. Fire/Life Safety Committee – a subcommittee of the SCWG responsible for reviewing and evaluating fire protection, life safety, and emergency egress elements of capital projects undergoing safety and security certification.

M. Interim Certificate – a temporary certificate that allows a system, facility, vehicle, etc., to be placed into service or use with additional safety precautions and protections implemented, as necessary, until all required certification verification is completed.

N. Operational Hazard Analysis (OHA) – an analysis used to identify, document, analyze, and mitigate operational hazards that are present when a system is used or maintained. The OHA is tabbed in the SEPTA SSC workbook.

O. Preliminary Hazard Analysis (PHA) – the process to identify and categorize potential hazards associated with a proposed or early-stage project. The PHA is tabbed in the SEPTA SSC Workbook.

P. Safety and Security Certification Plan (SSCP) – a management tool used to execute the SSC program for individual projects. The SSCP establishes roles and responsibilities and defines key activities.

Q. Safety and Security Certification Verification Report (SSCVR) – a report summarizing the project's safety and security certification activities.

R. Safety and Security Certification Working Group (SCWG) – a multidisciplinary team established to coordinate and execute the SSC process for a capital project.

S. Safety and Security Management Plan (SSMP) – a plan describing how SEPTA will address safety and security in a Major Capital Project, from initial project planning through initiation into revenue service.

T. Threat & Vulnerability Assessment (TVA) – a process for identifying, assessing, and mitigating security threats and vulnerabilities. The TVA is tabbed in the SEPTA SSC workbook.

U. Testing Verification Conformance Checklist (TVCC) – a comprehensive checklist outlining testing specifications and requirements for each certifiable item. The TVCC is included in the CIL, which is tabbed in the SSC Workbook.

1.02 DESCRIPTION

A. This Section specifies SEPTA's TPSS Contract No. 5 safety and security certification requirements for the Design Consultant and Design-Build Contractor during the project's design, construction/installation, testing, and pre-revenue/start-up phases.

B. Per Federal guidance, these activities are required before allowing SEPTA to commence revenue service or take occupancy of stations, facilities, parking lots, rail platforms, rolling stock, and operating new or upgraded systems.

C. As part of this project's SSC process, the Design Consultant and Design-Build Contractor shall comply with and implement this certification process to ensure adherence to SEPTA's safety goals.

1.03 PURPOSE

A. The SSC program's purpose is to ensure that:

1. The design, construction/installation, testing, and commissioning of all critical safety and security elements (civil, mechanical, electrical, structural, equipment procurements, and systems) have been verified for conformance.

2. SEPTA's vehicles, structures, and systems are operationally safe and secure for customers, employees, consultants, contractors, and the public.

3. A management system is established and utilized to execute the SSC program.

4. A common ground of understanding is established among key project team members regarding specific responsibilities and the execution of the SSC program.

1.04 SSC OBJECTIVES

A. The overall SSC objectives are to achieve acceptable risk levels through a systematic hazard analysis and management approach, adherence to criteria, design, construction/installation and testing certification and review, and formal contract acceptance. These objectives are to conform to all Federal and Commonwealth of Pennsylvania requirements through documentation and verification that:

1. System safety hazards are identified, assessed, and mitigated to acceptable and manageable risk levels.

2. Security vulnerabilities are identified, assessed, and documented action is taken to resolve identified unwarranted security risks.

3. Appropriate codes, guidelines, and standards have been reviewed to provide a basis for safety and security consideration in the final design documents.

4. Facilities, systems, and equipment have been designed, constructed, inspected, and tested in accordance with applicable codes and standards.

1.05 REFERENCES

A. FTA Handbook for Transit Safety & Security Certification

B. FTA Circular 5800.1, Safety and Security Management Guidance for Major Capital Projects

C. 49 CFR Part 633, Project Management Oversight

D. SEPTA Public Transportation Agency Safety Plan (PTASP) – Rail Transit

E. PennDOT SSO Program Standard

F. FTA Project and Construction Management Guidelines

G. 49 CFR Part 674, State Safety Oversight

H. 49 CFR Part 1582, Public Transportation and Passenger Railroad Security

1.06 RESPONSIBILITIES

A. The Design Consultant, Design-Build Contractor, and SSC Consultant are responsible for supporting SEPTA's SSC Program as outlined in the TPSS Contract No. 5 Project Safety and Security Certification Plan (SSCP).

1. The Design Consultant shall:
    a. Attend SEPTA SSC training at the earliest opportunity.
    b. Attend all Safety Certification Working Group (SCWG) meetings for the Project.
    c. Provide the SCWG access to all design, construction/installation, and testing submittals via the project document management software system (e-Builder) for the SSC CIL verification process.
    d. Develop and submit the Preliminary Hazard Analysis (PHA) in accordance with the schedule provided in Section 1.7.
    e. Annotate the Means of Verification (MOV) on the CILs for verification purposes.
    f. Verify and provide supporting documentation for the items listed within the Certifiable Items List (CIL) throughout the design, construction/installation, testing, system integration, and pre-revenue stages of the project to ensure compliance with the identified safety and security requirements.
    g. During the CIL verification process, provide updated CILs at least every 30 days, or at an interval determined by the SCWG, to account for new means of verification annotated on the CILs by the Design Consultant and Design-Build Contractor.
    h. For all change orders and RFIs, the affected CILs, PHAs, and SAs will be reviewed, updated as needed, and submitted to the SCWG and the System Safety Division's SSC Consultant for approval to reflect any change that affects safety and security.

2. The Design-Build Contractor shall:
    a. Attend SEPTA SSC training at the earliest opportunity.
    b. Attend all Safety Certification Working Group (SCWG) meetings for the Project.
    c. Provide the SCWG with access to all construction, installation, and testing submittals via the project document management software system (e-Builder) for the SSC CIL verification process.
    d. Annotate the Means of Verification (MOV) on the CILs for verification purposes.
    e. Verify and provide supporting documentation for the items listed within the Certifiable Items List (CIL) throughout the design, construction/installation, testing, system integration, and pre-revenue stages of the project to ensure compliance with the identified safety and security requirements.
    f. During the CIL verification process, provide updated CILs at least every 30 days, or at an interval determined by the SCWG, to account for new means of verification annotated on the CILs by the Design Consultant and Construction Contractor.

g. For all change orders and RFIs, the affected CILs, PHAs, and SAs will be reviewed, updated as needed, and submitted to the SCWG and the System Safety Division's SSC Consultant for approval to reflect any change that affects safety and security.

3. The SSC Consultant shall:

a. Develop and maintain the project SSCP and SSMP and implement all supporting SSC procedures as needed.

b. Provide SSC training to project managers and other project stakeholders at SEPTA's request.

c. Review and assist (as needed) the Design Consultant's and Construction Contractor's development and maintenance of PHAs, SA's, MOV, CIL's, etc.

d. Develop SSMPs, SSCPs, Certifiable Elements Lists, Certifiable Items Lists, Design Criteria Conformance Checklists, Construction Specification Conformance Checklists, Testing Verification Conformance Checklists, Operational Hazard Analyses, Certificates of Compliance, Interim Certificates, and Safety & Security Certification Verification Reports.

e. Chair the SCWG meetings and ensure that all project SSC documentation and safety hazards and security risks are promptly presented to the committee for decisions to support the project life cycle and schedule.

f. Advise the SSRC on project SSC progress.

g. Ensure the severity and probability of identified hazards is consistent with SEPTA's SRM process.

h. Develop and submit a final SSCVR.

i. Ensure that the Fire Marshal (FM) and the Office of Emergency Preparedness are integrated with all projects with Fire Life Safety requirements.

j. Perform 100% verification efforts on all project published CILs covering design, construction/installation, testing, pre-revenue service, and operational requirements.

k. Review the verification documentation for all project CILs to ensure compliance with the identified safety and security requirements.

1.07 SUBMITTALS

A. As required by the Safety and Security Certification Plan (SSCP) and noted on the SSC Project Assessment Form (PAF), the DBC & DC shall submit the following documents for SCWG approval:

1. Preliminary Hazard Analysis Workshop (PHA) within 90 days of NTP with the PHA as an output of this workshop. (Design Consultant)

2. During the CIL verification process, the Design Consultant and Design-Build Contractor will provide updated CILs every 30 days or at an interval determined by the SCWG to account for new means of verification (MOV) annotated on the CILs. (Design Build Contractor & Design Consultant)

3. Design, Construction/Installation, and Testing Change Order Approvals. The affected CILs, PHAs, and SAs will be reviewed, updated as needed, and submitted to the SCWG for approval to reflect any changes that affect safety and security. (Design Build Contractor & Design Consultant)

4. Where applicable, Fault Tree Analyses will be developed by the designer for review and comment by the SCWG and System Safety Division's SSC Consultant.

B. As required by the SSCP and noted on the Project Assessment Form, the Construction Contractor shall submit the following documents for review and approval by the SCWG:

1. Updated CILs every 30 days or at intervals deemed necessary by the project schedule or SCWG.

C. SEPTA's SSC Consultant is responsible for developing the following documents:

1. Safety and Security Management Plan (SSMP)
2. Safety and Security Certification Plan (SSCP)
3. Certifiable Elements List (CEL) with sub-elements
4. Preliminary Certifiable Items List (CIL) for design, construction and testing
5. Design Criteria Conformance Checklists (DCCC, annotated on the CIL)
6. Construction Specification Conformance Checklists (CSCC, annotated on the CIL)
7. Testing Verification Conformance Checklists (TVCC, annotated on the CIL)
8. Threat and Vulnerability Assessment or Security Assessment (SA)
9. Operational Hazard Analysis (OHA)
10. Certificates of Conformance (COC) and Interim Certificates
11. Safety and Security Certification Verification Report (SSCVR)

1.08 QUALITY

A. The Design Consultant and Construction Contractor SSC representatives shall have SSC knowledge either by completing a recognized SSC training course provided by the Federal Transit Administration (FTA), Transportation Safety Institute (TSI), or SEPTA. To validate this requirement, the contractor shall provide one or more of the following:

1. FTA/TSI Transit Safety and Security (TSSP) Certificate
2. A training certificate from one of the FTA/TSI SSC training courses listed below in paragraph B.
3. A listing of past SSC project experience.
4. Quality Assurance/Quality Control (QA/QC) experience.
5. SSC experience on past SEPTA projects.
6. Certificate of Completion of SEPTA SSC training within the last 5 years.

B. Preferred qualification: a transit safety professional with the FTA/TSI TSSP certificate or who has attended one of the following FTA/TSI SSC-related courses:

1. FT00551, Safety, Security, and Emergency Management Considerations for Capital Improvement Projects
2. FT00538, Transit System Safety and Security Design Review
3. FT00543, Rail System Safety
4. FT00433, Transit Bus System Safety
5. FT00432, Transit System Security

1.09 SAFETY AND SECURITY CERTIFICATION PROCESS

A. SEPTA PMs, Design Consultant PMs, Design-Build Contractor PMs, and their designated SSC representatives will participate in the SEPTA SSC Program per the TPSS Contract No. 5 Safety and Security Certification Plan (SSCP) for the duration of the contract. These stakeholders will manage and implement the following 10 steps of SSC:

Step 1 Identify Certifiable Elements

Step 2 Develop Safety and Security Design Criteria

Step 3 Develop and Complete Design Criteria Conformance Checklist

Step 4 Perform Construction Specification Conformance

Step 5 Identify Additional Safety and Security Test Requirements

Step 6 Perform Testing and Validation

Step 7 Manage Integrated Tests

Step 8 Manage “Open Items”

Step 9 Verify Operational Readiness

Step 10 Conduct Final Determination of Project Readiness and Issue Safety and Security Certification

B. The System Safety Division and its SSC Consultant will provide oversight, implementation guidance, and verify compliance with all SSC requirements outlined in the TPSS Contract No. 5 Safety and Security Certification Plan (SSCP).

C. SEPTA PMs shall manage and oversee compliance with the project SSC program and follow the responsibilities outlined in the TPSS Contract No. 5 Safety and Security Certification Plan (SSCP).

1. Consultant and Contractor PMs and their SSC representatives shall follow the following general responsibilities, and the more comprehensive duties outlined in the TPSS Contract No. 5 Safety and Security Certification Plan (SSCP).
2. Actively support and participate in the Project SSC Program process as outlined in the SSCPP and attend all project SCWG meetings.
3. Attend the SEPTA SSC training session at the earliest possible opportunity.
4. Ensure all SSC-related submittals are submitted, reviewed, and approved by the SCWG before final submittal approval.
5. Provide the SEPTA System Safety Division with access to all design, construction/installation, and testing submittals via the project document management software system for the SSC CIL verification process.
6. Annotate the Means of Verification (MOV) on the CILs where the safety/security and emergency management design criteria and construction/installation and testing report submittals are located for verification purposes.

PART 2 - PRODUCTS

A. Reserved.

PART 3 - EXECUTION

3.01 SSC PROGRAM REPRESENTATIVE

A. The Design Consultant and Construction Contractor PMs shall each appoint an SSC Program Representative with the qualifications noted in this specification to lead and coordinate the SSC process and activities.

3.02 SSC TRAINING PROGRAM

A. SEPTA, Consultant, and Contractor PMs and support staff must attend SEPTA SSC training within 60 days after NTP is given to reinforce SSCP requirements and solidify SSC responsibilities.

3.03 SAFETY CERTIFICATION WORKING GROUP (SCWG)

A. SCWG meetings are established by the System Safety Division and are held monthly or as needed once the project NTP is issued. Once the project kickoff meeting occurs, the first SCWG meeting is scheduled within 2 weeks.

B. SCWG responsibilities and activities are detailed in the TPSS Contract No. 5 Safety and Security Certification Plan (SSCP).

3.04 SSC DOCUMENT MANAGEMENT

A. Prepare, update, and complete all submittal document requirements as listed in paragraph 1.2 throughout the performance of the contract.

B. Establish an SSC documentation management folder in the project document management system (e-Builder). The SSC documents shall be consolidated and become a project closeout requirement and provided by the noted responsible party.

C. As-Built drawings and documentation shall be provided prior to beneficial use, completion, and acceptance by SEPTA.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. No separate measurement and payment will be made for work required under this section. All associated costs shall be considered incidental to the item or items of work to which they pertain.

B. Failure to comply with the requirements of all items specified in this safety and security section may result in SEPTA withholding all pending payments to the non-compliant consultant/designer/contractor including their sub-contractors until the issue is fully resolved.

C. SEPTA may withhold a rolling twenty-five (25%) of the full contract value until all Safety and Security Certification items are satisfied.

D. Document and product reviews relevant to safety and security certification will occur at a time and place specified and directed by SEPTA.

E. If travel is required by the SEPTA team and/or their contractors, the total cost of travel and expenses will be paid by the contractor asking for the review venue to be relocated from SEPTA's Offices, at 1234 Market Street, Philadelphia, Pennsylvania.

END OF SECTION

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SECTION 01100

SPECIAL PROJECT PROCEDURES

PART 1 - GENERAL

1.01 Description

A. This Section outlines the procedural requirements so the Contractor may plan and be granted approval for power outages, track outages, shutdowns, rail diversions, single tracking, etc. specified under this Contract.

B. The actual construction activities interfering with SEPTA operations and passenger movement shall not begin until:

1. The Contractor provides a written Site Specific Work Plan (SSWP) to SEPTA indicating impact to passenger flow and SEPTA operations. The SSWP shall include remedial solutions acceptable to SEPTA.

2. The SSWP is submitted and approved through the Project Management Information System (PMIS), e-Builder. The Contractor shall be responsible for revision and resubmittal of the SSWP until it is approved by SEPTA.

C. If the SSWP calls for the Contractor to gain access to track or facilities, operational constraints may delay actual occupancy, or require the Contractor to give up occupancy early, for a period usually not exceeding one (1) hour.

D. The Contractor requesting approval to procure and operate track cars and/or high rail vehicles shall conform to the procedures detailed below.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01060 – Regulatory Requirements and Safety

C. Section 01300 – Submittals

D. Section 01305 – Requests for Information

E. Section 01400 – Quality Requirements

1.03 Submittals

A. Requests for service disruptions; power outages, track outages, shutdowns, rail diversions, single track, etc.; and SSWPs shall be submitted to the SEPTA Project Manager by the Contractor utilizing the PMIS, e-Builder, SSWP process for approval no less than twenty-eight (28) calendar days prior to a power outage, track outage, shutdown, rail diversion, single tracking, etc. Once reviewed by SEPTA, any changes to the SSWP will be subject to a subsequent review by SEPTA. These submittals must be clearly annotated and reissued weekly to reflect changes to the scope or schedule created during the twenty-eight (28) day period between the original issue and the date of operation. Not later than twenty-eight (28) days before a planned power outage, track outage, shutdown, rail diversion, single tracking, etc., a new revision of the submittal incorporating all changes and reflecting the

final work plan must be submitted to the SEPTA Project Manager. The SEPTA Project Manager reserves the right to request submission of any SSWP earlier than twenty-eight (28) days if the SSWP involves complex coordination of operations, power outages, track outages, shutdowns, rail diversions, single tracking, etc.

B. Should the Contractor desire to cancel an approved power outage, track outage, shutdown, rail diversion, single tracking, etc., the written cancellation request shall be received by the SEPTA Project Manager a minimum of seven (7) calendar days prior to the power outage, tack outage, shutdown, rail diversion, single tracking, etc. date, so that affected SEPTA operations can be provided sufficient notification of the cancellation. Late cancellation requests shall result in the outage costs being assessed against the Contractor.

1.04 Request for Power Outage, Track Outage, Shutdown, Rail Diversion, Single Tracking, Etc.

A. The request for a power outage, track outage, shutdown, rail diversion, single tracking, etc. shall be a time-scaled logic network. This network is to fully detail the extent of work proposed and the Contractor's plan and means for accomplishing same in the requested outage/service disruption window. Specific separate operations and planned service disruptions should be highlighted in these submittals.

1. The SSWP shall provide a description of work; time scaled hourly logic network, breakdown of labor force, materials, and the type of equipment that will be utilized. The SSWP shall include the Contractor's watchperson, required SEPTA flagging and support, construction methods, arrangements for emergency clearing and restoration of service, and sketches for defining the configuration of rail service and other operational elements at the end of the Contractor's outage.

2. All work by SEPTA Force Account Track, Power, Signals, etc. or other Contracts that are defined in Section 01010 and subsequent reviews that have the potential of delaying either the work by this Contractor, or the restoration of service, must be identified clearly in terms of scope and schedule for coordination with others.

3. The proposed work of this Contract will require track and power outages for the purpose of substation equipment demolition, the cutover of; communication cables, control cables, traction power feeder cables, circuit breakers, and any other device that affects the safe operation of rail traffic.

4. All track and power outages as requested by the Contractor are restricted to the window between 1:30 am and 4:30 am Monday thru Friday (this window includes the necessary switching and grounding required by SEPTA forces).

5. The Contractor shall minimize the amount of work that affects or requires track access.

B. SEPTA will not grant usage for a power outage, track outage, shutdown, rail diversion, single tracking, etc. until the Contractor's SSWP has been reviewed and approved by SEPTA in writing.

C. The Contractor shall not perform any of the work requiring a power outage, track outage, shutdown, rail diversion, single tracking, etc. until written approval has been received from SEPTA, the circuit and/or rail has been taken out of service, proper protection is in place and a SEPTA Representative has authorized the Contractor to commence work.

1.05 Request for Surface Diversion (Bus, Light Rail)

A. Not Used.

1.06 Request for SEPTA Support

A. All request for SEPTA force account support shall be communicated with the SEPTA Project Manager, in a manner acceptable to SEPTA. It is expected that force account support will minimally be required for track work zone/flagging, circuit identification, isolation, and restoration, communication cable identification, isolation, and restoration, etc.

1.07 Request for Area Relocations

A. Not Used.

1.08 Request for SEPTA Services

A. Not Used.

1.09 High Rail Vehicle (HRV)

A. The Contractor shall formerly request, by submittal, all track or high rail equipment proposed to be utilized for the work of this Contract. The submittal shall be directed to the SEPTA Project Manager for review and approval. This submittal shall include the equipment's physical characteristics which include but are not limited to the following:

1. Manufacturer's catalog cuts by showing all dimensions.
2. Any subsequent modifications noted and dimensioned.
3. Vehicle Identification Number (VIN) or serial number.
4. Must have a current Pennsylvania vehicle safety inspection sticker if rubber tired.
5. If subway operation is planned, it must be diesel powered and equipped with either a catalytic converter or exhaust scrubber meeting U.S. Bureau of Mines Schedule 24 emissions.
6. Limit physical dimensions of the operating mode if appropriate.
7. The SEPTA Project Manager will provide a clearance diagram and attach to their section if available. The Contractor shall also provide the following onboard equipment.
    a. All powered vehicles will be equipped with a steering wheel lock.
    b. Hydraulic outriggers will be equipped with locking pins. (Outriggers cannot be used on tracks in 3rd rail territory).
    c. Guards will be installed at all wheel pinch points.
    d. All powered vehicles will have an ABC type fire extinguisher.
    e. A tow bar and coupler adapter for rescue.
    f. A clearance placard in the cab using the correct print.
    g. Boom tie-down if applicable.
    h. Wheel chocks to secure on rail if left unattended.
    i. Railroad lighting package to provide marker lights for the end of consist.
    j. Horn.

k. Operators Manual

8. Each vehicle shall have a unit number clearly marked on its exterior.

9. A recovery plan shall also be provided for review detailing how the Contractor proposes to re-rail or recover disabled on-track equipment once it is operating on the rail.

B. Testing:

1. SEPTA will inspect the equipment and grant approval if it meets safety standards or refuse operation of the equipment if it is not in safe condition before any equipment may be placed on the rail. Any repairs or modifications found to be required will be done at no cost to SEPTA and a yard retest will be held. SEPTA will yard test equipment to determine actual performance in curves and crossover before granting permission for use. If the equipment is utilized to deliver materials the loading shall also be reviewed for clearance. All requested high rail equipment will be tested at this time.

a. If any modifications are made after the initial yard test, the Contractor will notify the SEPTA Project Manager in writing with details and the vehicle must be re-inspected by a qualified SEPTA hi-rail Inspection Manager at no additional cost to SEPTA.

b. If the approved vehicle or track car is taken off the Project for another job and then returned, the Contractor must certify in writing that it is still in its original condition and the vehicle must be re-inspected by qualified SEPTA hi-rail inspection Manager. If there is any question, a yard test and inspection will be scheduled at no additional cost to SEPTA.

c. Any high rail vehicle involved in an accident must be re-inspected by a qualified SEPTA hi-rail Inspection Manager at no additional cost to SEPTA.

C. Operation:

1. A SEPTA Qualified Protection Employee (QPE) is an employee who is qualified on operating rules, physical characteristics, and on-track protection procedures and is responsible for establishing on-track protection and safety. The QPE is responsible for conducting Job Briefings relative to on-track protection and works with the contractor's PAR to ensure proper oversight of activities.

2. If the contractor wishes to occupy live or operating tracks with on-track equipment, the contractor shall request a SEPTA pilot who will obtain exclusive track occupancy on the track. All SEPTA pilots shall be requested from the Project Manager a minimum of 1 week in advance of the required starting time.

3. The Contractor shall operate this equipment within the work zone specified in the Bulletin Order issued for that work. In addition, the following rules apply to the Contractor's personnel when placing equipment on the rail after receiving authorization from a qualified SEPTA employee.

a. The high rail vehicle driver shall complete a pre-trip inspection and fill out pre-trip inspection form, to ensure that the high rail vehicle is in a safe operating condition before being operated. High rail vehicles shall not be operated if an unsafe condition exists.

b. The high rail vehicle shall display a white light to the front and red light to the rear when visibility is restricted and at night. High rail vehicles shall have headlights on high beam when moving.

c. The high rail vehicle shall not travel through any track switches unless the switches are confirmed by the SEPTA pilot to be properly lined.

d. The maximum speed for the movement of any high rail vehicle is governed by the appropriate operating rule book.

e. The high rail vehicle shall be operated at a speed, which will permit them to stop short of any obstruction, improperly lined switch, or broken rail.

4. The Contractor shall include training of high rail vehicle drivers in the appropriate part of their safety plan and develop and maintain an updated log of these personnel.

5. The recovery plan will be kept in each powered vehicle and updated as changes are made.

D. The Project Manager or a duly authorized representative shall have complete authority in matters related to the safety of SEPTA's operations and facilities. The Project Manager shall have the right to restrict the operations of fouling or on-track equipment when, in the Project Manager's opinion, the equipment is not in satisfactory condition to be safely operated or where operation will adversely affect the track structure. The Project Manager shall also have the right to prohibit the operation of any fouling or on-track equipment by any contractor-employed operator who is, in the Project Manager's opinion, not qualified or able to operate said equipment in a safe manner.

E. All equipment shall comply with the appropriate requirements of 49 CFR part 214; Final Rule, Roadway Maintenance Machine Safety.

1.10 Damages for Failure to Return to Service

A. All costs, such as protection or operating costs, if the Contractor fails to properly utilize a track outage or service diversion at no fault to SEPTA and additional outage hours are required to return the track(s), facility and/or services within an allotted time, shall be assessed against the Contractor.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

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SECTION 01200

PROJECT PROGRESS MEETINGS

PART 1 - GENERAL

1.01 Description

A. This Section enables the orderly review of the progress of the work and to provide for systematic discussion of problems. The SEPTA Project Manager or a designee will conduct Project meetings throughout the construction period.

B. The progress meetings are in addition to the coordination, pre-construction and scheduling meetings noted elsewhere in the Contract Documents.

C. The Contractor's relations with its subcontractors, and discussions relative thereto, are the Contractor's responsibility and are not agenda items in the Project progress meetings.

D. The discussions and minutes of meetings shall exclude any claims related issues not directly impacting the progress of the work, and other items for which SEPTA has provided clarifications/directives/change order(s) but remain disputed by the Contractor.

1.02 Related Sections

A. Agreement and Division 1.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Meeting Schedule

A. Project meetings will be held every two (2) weeks as arranged and organized by the SEPTA Project Manager.

B. The SEPTA Project Manager will coordinate with the Contractor to establish a mutually acceptable meeting schedule.

3.02 Meeting Location

A. The SEPTA Project Manager will determine meeting location. To the maximum extent practicable, meetings will be held at the job site.

3.03 Project Meetings

A. Attendance:

1. The Contractor's Superintendent shall attend and participate in each Project meeting and shall represent the Contractor consistent with the Contract and commit the Contractor to solutions agreed upon during the Project meetings.

2. Subcontractors and others may be invited to attend those Project meetings in which their aspect of the work is involved.
3. If notified of the need seven (7) days in advance, the SEPTA Project Manager will request the attendance of the appropriate members of the design team to participate in technical discussions.
4. SEPTA shall have a meeting attendance sign in sheet which all attending Contractors, their representatives, and subcontractors will be required to sign to verify attendance.

B. Minimum Agenda for Each Project Meeting:

1. Review and revise the minutes of previous Project meetings.
2. Safety including the presence of hazardous materials and other environmental issues.
3. Quality control issues including outstanding non-conformance reports/issues.
4. Review progress of the work since last Project meeting, including status of submittals for approval.
5. Status of coordination and installation meetings with subcontractors engaged in the work of the Project.
6. Identify problems which impede planned progress.
7. Develop corrective measures and procedures to regain planned schedule, if applicable.
8. The status of Requests for Information (RFI) and all Potential Change Orders (PCO) shall be discussed and updated. The Contractor’s PCO listing shall conform to SEPTA’s listing.
9. The Contractor shall provide and discuss "thirty (30) day look ahead" activity schedule if the work is not progressing per the early start/finish activity dates as noted in the latest update of the approved schedule.
10. Discuss and review as-built drawings/specification status.
11. Complete other current business.
12. To the maximum extent practicable, the Contractor shall advise the SEPTA Project Manager at least forty-eight (48) hours in advance of Project meetings regarding items to be discussed during the Project meeting. The agenda shall be set in the Project Management Information System (PMIS), e-Builder, calendar module.
13. Technical questions or issues requiring a response from the Engineer of record must be submitted in writing at least three (3) business days before the Project meeting.

C. Composition and Availability of Meeting Minutes:

1. The SEPTA Project Manager of their designee shall compose and make available meeting minutes following each progress meeting via the SEPTA electronic PMIS, e-Builder.
2. The Contractor shall be required to receive and exchange information regarding meeting minutes in SEPTA's electronic PMIS, e-Builder, environment.
3. Meeting minutes shall be contained within the PMIS, e-Builder, calendar. The Contractor will have the ability to access meeting minutes at any time. SEPTA will not be printing or sending out meeting minutes following these meetings.

4. The SEPTA Project Manager will complete meeting minutes of each Project meeting within the PMIS, e-Builder, calendar module, which all attendees and designees will have access to and get an email copy when published.
5. The Contractor may forward and distribute to Project participants as required.

D. Revisions to Meeting Minutes:

1. Unless published meeting minutes are challenged in writing, within five (5) working days of the distribution date, they will be accepted as properly stating the activities and decisions made at the meeting.
2. Any individual challenging published meeting minutes shall provide proper supporting documentation acceptable to the SEPTA Project Manager to verify that the challenged item was truly discussed during the subject meeting.
3. Challenge to meeting minutes shall be settled as priority portion of "old business" at the next regularly scheduled Project meeting. The SEPTA Project Manager's decision(s) concerning challenged item(s) shall be binding on the Contractor.

END OF SECTION

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SECTION 01300

SUBMITTALS

PART 1 - GENERAL

1.01 Description

A. This Section covers all submittals including shop drawing submittals, samples, manufacturer's cut sheets and "or equal" submittals. It complements the requirements of Paragraph VIII.N. of the Agreement. Make submittals required by the Contract Documents, and revise and resubmit as necessary to establish compliance with the specified requirements.

B. Requirements relating to traction power equipment are included in Section 01452. In case of conflict, the more stringent requirement shall prevail.

C. Some products and procedures only require a submittal for information and may not require a response from SEPTA. However, it is not applicable to the traction power equipment.

1. Products which match exactly something specified by manufacturer's name and catalog model number.

2. Other items at the SEPTA Project Manager's discretion including but not limited to any of the following:

a. Products list.

b. Test section.

c. Manufacturer’s installation instructions.

d. Manufacturer’s certificates.

e. Shop drawing.

f. Manufacturer’s samples.

g. Certifications.

h. Testing.

i. Warranties.

j. Equipment.

D. SEPTA reserves the right to not formally respond to any submittal which is not required.

E. The Contractor may require subcontractors to provide drawings, installation diagrams and similar information to help coordinate the work, but such data shall not be reviewed by SEPTA unless it is required by other pertinent Sections of the Specifications.

F. The Contractor is required to submit all information through the SEPTA Project Management Information System (PMIS), e-Builder.

G. SEPTA has a PMIS in place used for tracking Key Performance Indicators (KPI) through integrated reporting and dashboards populating capital projects with 'real time' information essential for performance tracking and benchmarking which are essential to achieving SETPA's project management goals.

H. SEPTA shall make access available, to the Contractor, to SEPTA's PMIS for the Contractor's use to exchange Project information as required throughout the life of the Project at no

additional cost to the Contractor. User access licenses are not required for the Contractor's use of SEPTA's PMIS. The SEPTA Project Manager shall create user accounts with appropriate permissions for the Contractor's use throughout the life of the Project.

I. The Contractor is required to coordinate with the SEPTA Project Manager regarding hands-on training for Contractor Project employees on the SEPTA PMIS program, e-Builder. SEPTA will not compensate the Contractor or their personnel for any formal and/or informal training of the Contractor's staff on the SEPTA PMIS.

J. The Contractor shall submit all Project information/communications through SEPTA's current PMIS. Document distribution to Project members shall be accomplished both within the PMIS system and via email as appropriate. Project document distribution to parties outside of the Project communication system shall be accomplished by secure email of outgoing documents and attachments, readable by standard email client.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. Section 01410 – Inspection and Test Plans

E. Section 01452 – Contractor Quality Control – Traction Power Equipment

F. Section 01700 – Contract Closeout

G. Section 01720 – Project As-Built Documents

H. Section 01830 – Operations and Maintenance Data

I. Section 16953 – Electrical Testing - Traction Power Equipment (CTD)

1.03 Submittals

A. Submittal Preparation:

1. The Contractor, within two (2) weeks of the receipt of the Engineer of record's computerized listing of the Contractor(s) submittals, shall review, revise and/or amend, if applicable, and resubmit the revised listing of submittals.

2. The Contractor will assess material availability and all long lead items shall be identified.

3. After checking and verifying all field measurements and after complying with the applicable procedures of the Contract, the Contractor shall submit shop drawings, catalog cuts, samples and substitution(s) for review and action.

4. The Contractor shall be responsible for coordination between the Contractor/Fabricator/Detailer and SEPTA for each complex submittal requiring detailed coordination, including all structural items. This coordination may be executed in a meeting called at the request for the Contractor or SEPTA. The purpose of the meeting(s) shall be to establish guidelines for details and information necessary to prepare the shop drawings.

B. Submittal Review:

1. The results of review of submittals will be a status as follows:
   a. NO EXCEPTIONS TAKEN (NET).
   b. PROCEED AS NOTED (PAN).
   c. DO NOT PROCEED; REVISE AND RESUBMIT (DNP).
   d. REJECTED (REJ).
   e. FOR RECORD ONLY (FRO).
2. Submittals not in compliance with the Contract will be returned to the Contractor for revision. Any losses of time and additional costs associated with resubmittal(s) are the Contractor's responsibility.
3. Each submission and re-submission shall give specific written notice on the transmittal of each variation that the shop drawings or samples may have from the requirements of the Contract Documents and, in addition, shall cause a specific notation to be made on each shop drawing submitted for review and approval of each such variation.
4. Each resubmission shall clearly identify and make specific notation(s) on each shop drawing concerning the:
   a. Changes that are made as a result of comments on the previous submittal(s).
   b. Changes that are not made but commented on the previous submittal(s). The Contractor shall provide detailed explanations and justifications as to why the comments are not addressed.
   c. Changes that are solely made by the Contractor but were not commented on the previous submittal(s). The Contractor shall provide a detailed explanation and justification for such changes.
5. Submittals that are "Proceed as Noted" are for the purpose of expediting procurement/ fabrication/installation of the intended work. If resubmittal is required, the Contractor shall incorporate all corrections and resubmit original drawings and required copies of drawings to SEPTA, within thirty (30) days. If a resubmittal is not required, then it is understood that the Contractor will proceed in accordance with the comments.

1.04 Quality Assurance

A. SEPTA reserves the right to require mock-ups of any material and/or assembly, at any time during the construction process. Once approved, the mock-ups will set a minimum standard of performance and/or appearance for the work. Mock-ups will be provided at no cost to SEPTA. The approved mock-up may, at the discretion of the SEPTA Project Manager, become part of the work.

B. Electronic Submittals:

1. SEPTA uses PMIS, e-Builder, to track submittals. The Contractor is required per Article 1.01 in this Section to submit all submittals using the SEPTA PMIS, e-Builder.

C. Coordination of Submittals:

1. Prior to submitting each submittal, the Contractor shall carefully review and coordinate all aspects of each item being submitted. Shop drawings of systems containing closely related items and components must be submitted, as a single submission showing the interrelationship of the components required for that system.

2. The Contractor shall verify prior to submission that each shop drawing is well prepared, and that the submittal conforms in all respects with the specified requirements. The drawings shall provide complete information regarding proper fabrication and installation.
3. The Contractor shall sign each submittal or shop drawing original and affix a stamp with specific written indication that the Contractor has reviewed the submittal and is satisfied that it conforms to the requirements of the Contract Documents. Refer to Article 1.05 in this Section for submittals that are substitutions.
4. Shop drawings shall be tailored to the specific Project need including coordination of various trades and should include material descriptions, quantities, dimensions, design criteria and similar data to enable review information as required. The shop drawings must show clear and complete information for the fabrication and installation of materials.
5. Where feasible, orient the plan(s) on the shop drawing(s) in the same manner as the plans on the Contract Drawings.
6. Shop drawings with reproduction(s) of the Contract Drawings will not be accepted.
7. Structural fabrication and erection drawings shall be prepared, checked, signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania with proven qualifications and similar experience. Unless the Contract Documents indicate specific steel connections, the Contractor shall design steel connections, signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania and provide sufficient details for SEPTA's review and approval.

D. Responsibility:

1. The Contractor is solely responsible and accountable for:
   a. Means, methods, techniques, sequences and procedures of construction including fabrication, assembly, installation/erection, safety precautions and programs incidental to any submittal.
   b. Accuracy of all submittals and shop drawings and final installation.
   c. Arranging submittals and shop drawing standards review meetings with SEPTA.
   d. Converting all approved submittals to an agreed on electronic format; PDF unless otherwise noted; for uploading to the SEPTA PMIS, e-Builder, and providing these files to SEPTA at no cost to SEPTA.

1.05 Substitutions

A. "Or Equals" Substitutions:

1. Restricted Items (Sole Sourced Items):
   a. Where the Contract Documents specifically require the use of certain equipment and/or materials they will indicate that substitutions will not be allowed.
2. Equals Considered:
   a. Unless otherwise noted, whenever a material or article required is specified or shown on the plans by using the name of the proprietary product or of a particular manufacturer or vendor, any material or article with matching characteristics, will be considered equal and satisfactory provided material or article has equal properties and function in the opinion of

SEPTA's Project Manager. It shall not be purchased or installed without the SEPTA Project Manager's written approval. The Contractor shall document each request with complete data substantiating compliance of the proposed substitution with the Contract Documents. "Or equal" requests will be considered only when substantiated by the Contractor's submittal of data documenting the "or equal" nature of material or article within thirty-five (35) calendar days after the date of receipt of Notice to Proceed. A request constitutes a representation that the Contractor:

1) Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.
2) Shall provide the same warranty for the substitution as for the specified product.
3) Shall coordinate installation and make changes to other work, which may be required for the work to be complete with no additional cost to SEPTA.
4) Shall waive claims for additional costs or time extension, which may subsequently become apparent.
5) Shall reimburse SEPTA (if applicable) for review or redesign services associated with review and approval by SEPTA, if the substitution is rejected as not being equivalent.

B. Other Substitutions:

1. For any reason, including a lack of availability of the original material, the Contractor may ask permission to substitute a material or assembly which is not fully equal to the one specified. This will be processed as a change order; a no cost change order only if there is no cost difference compared to the original specified material. All substitutions will be evaluated following value engineering principles. The result of SEPTA's evaluation will be final, and SEPTA has the right to make a final determination over which items are judged to be acceptable. The Contractor shall document each request with complete data substantiating compliance of proposed substitution with the Contract Documents. A request constitutes a representation that the Contractor:
   a. Has investigated the proposed product and determined that it meets or exceeds the quality level of the specified product.
   b. Shall provide the same warranty for the substitution as for the specified product.
   c. Shall coordinate installation and make changes to other work, which may be required for the work to be complete with no additional cost to SEPTA.
   d. Shall waive claims for additional costs or time extension, which may subsequently become apparent.

PART 2 - PRODUCTS

2.01 Shop (Fabrication/Installation) Drawings

A. Shop drawings shall be based on field dimensions and other information gathered by the Contractor and his agents. When SEPTA or the Engineer of record takes no exceptions to the drawings or directs the Contractor to proceed a noted, it is only claiming that there are no apparent deviations from the design intent of the Contract Documents.

B. Final fit and placement may be affected by fabrication and field installation tolerances as well as other factors beyond the knowledge of SEPTA and the Engineer of record. Installation and final fit remains the sole responsibility of the Contractor. Language placing this responsibility on SEPTA or the Engineer of record is strictly prohibited.

C. The Contractor shall coordinate all shop drawings and review them for accuracy, completeness, and compliance with Contract requirements, and shall indicate its approval thereon as evidence of such coordination and review. Shop drawings submitted to SEPTA without evidence of the Contractor's approval may be returned for resubmission. SEPTA will indicate its approval or disapproval of the shop drawings, and if not approved as submitted shall indicate his reasons thereof. Shop drawings shall be submitted to SEPTA in time to allow at least twenty-one (21) calendar days for checking and processing, unless otherwise specified elsewhere in this Contract. Any work done prior to such approval shall be at the Contractor's risk. Approval by SEPTA shall not relieve the Contractor from responsibility for any errors or omissions in such drawings, nor from responsibility for meeting the requirements of this Contract, except with respect to variations described and approved in accordance with Article 2.01/D in this Section.

D. If shop drawings show variations from the Contract requirements, the Contractor shall describe such variations in writing, separate from the drawings, at the time of submission. If SEPTA approves any such variation(s), it shall issue an appropriate Contract modification, except that, if the variation is minor and does not involve a change in price or in time of performance, a modification need not be issued.

E. All submittals shall be properly referenced to clearly indicate the location, service, and function of each particular item, and shall include proper reference to the appropriate section, drawing numbers and details. Where manufacturer's publications in the form of catalogues, pamphlets or other data sheets are submitted in lieu of prepared shop drawings, such submissions shall specifically indicate the item for which such approval is requested. Identification of items shall be made in ink and submissions showing only general information will not be acceptable.

F. Design drawings for the 60 percent, 90 percent, and 100 percent submittals shall be submitted to SEPTA for its review in accordance with the following:

1. One (1) reproducible copy and five (5) prints of each design document or plan for the intermediate design stages.

2. One (1) reproducible copy and five (5) prints of each design document or plan for the final submittal and as-builts. All documentation shall be provided in CAD and PDF. One (1) full size set of original signed and sealed plans shall be provided.

G. Shop drawings for construction means drawings, submitted to SEPTA by the Contractor, subcontractor or any lower tier subcontractor pursuant to a construction subcontract, showing in detail the proposed fabrication and the installation (i.e. form, fit and attachment details) of materials or equipment. SEPTA may duplicate, use and disclose in any manner, and for any purpose, shop drawings delivered under this Contract.

H. Shop drawings are defined as original drawings, prepared by the Contractor, subcontractor, supplier or distributor, which illustrate some portion of the work; showing fabrication, layout, setting or erection details. They shall:

1. Be prepared by a qualified detailer.

2. Identify details by definitive title and by reference to sheet and detail numbers shown on the Contract Drawings.

I. Scale and Measurements:

1. Shop drawings shall be made accurately to a scale sufficiently large to show all pertinent aspects of the item and its method of connection to the work. SEPTA reserves the right to demand additional detail and information to facilitate the submittal process.

J. Required Copies:

1. Shop drawings shall be submitted by the Contractor to the SEPTA Project Manager via SEPTA's PMIS, e-Builder.

K. Review comments will be complied and returned to the Contractor via SEPTA's PMIS, e-Builder, for the Contractor's use or addressing.

L. Submittals not meeting the requirements of Article 3.02 in this Section shall be summarily rejected.

M. Submittals involving design and calculations by the Contractor or supplier should be signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania if appropriate.

2.02 Manufacturer's Literature (Including Catalog Cuts)

A. The term "product data" includes manufacturer's specifications, catalog cuts, performance and test data, applicable standards such as AASHTO, ANSI, ASTM, IEEE, AREMA and other industry standards of compliance, assembly and erection diagrams, parts lists, and where applicable, certificates of compliance verifying compliance with the specified and referenced standards as specified herein and in Section 01400.

B. Product data submittals shall indicate all modifications made to the manufacturer's standard product. Where submitted literature from manufacturers includes data not pertinent to the submittal, the Contractor shall clearly show which portions of the contents are being submitted for review. The product data shall include dimensions, clearances, performance characteristics, capacities, and any other information or diagrams, as applicable. All product data submittals shall include the following:

1. Contract title and number.
2. Applicable Contract Drawing numbers.
3. Applicable Specification Section numbers.
4. Applicable standards, such as ASTM or Federal Specification number, AREMA, AASHTO and pertinent railroad authority Specifications or standards.
5. Identification of deviations from the Contract Drawings and Specifications.
6. The Contractor's stamp, initialed or signed, certifying:
    a. Dimensional compatibility of the product with the space in which it is intended to be used.
    b. Review of submittals for compliance with Contract requirements.
    c. Compatibility of the work shown thereon with that of affected trades.

C. Certificates of compliance shall be submitted for those products for which no samples and test results are specified. A copy of the certificate shall also accompany the product for which the certificate is prepared. The certificates shall:

1. State that the product meets the respective Specification and Contract Drawing requirements.

2. Be accompanied by a certified copy of test results pertaining to the product.
3. Show the submittal date, subcontractor's name and address, Contract title and number, product represented and its location in the Contract, producer's name, product trade name and catalogue number, place of product origin, test date, testing organization's name and address, quantity of the product to be furnished, and related Contract Drawing and Specification Section numbers.
4. Be signed by an officer or another authorized representative of the producer.

D. Procedures for submittal and approval of product data shall follow the procedures for shop drawings as specified in Article 3.02 in this Section.

E. The Contractor shall submit the product literature and data sheets available from the manufacturer(s) to SEPTA via SEPTA's PMIS, e-Builder.

2.03 Software for System Components

A. The Contractor shall provide to SEPTA all software, with required documentation, used for system components, regardless of all proprietary rights, from all vendors and suppliers. The software and documentation shall be in sufficient detail to allow SEPTA to make minor changes in the system configuration during the operational life of the system. The Contractor shall provide sufficient training to SEPTA personnel for using the software.

2.04 Samples

A. The Contractor shall provide physical sample(s) identical to the precise article proposed to be provided. Identify as described in Article 3.02 in this Section.

B. Number of Samples Required:

1. Unless otherwise specified, the Contractor shall submit two (2) samples, one (1) of which will be retained by SEPTA.
2. By prearrangement in specific cases, a single sample may be submitted for review and, when approved, be installed in the work at a location agreed upon by SEPTA.

2.05 Colors and Patterns

A. Unless waived in the specific section of the Contract Documents, whenever a choice of color or pattern is available in the specified products, the Contractor shall submit accurate color and pattern charts for selection.

B. SEPTA reserves the right to require samples and/or a mock-up of any material to determine actual appearance.

C. Unless waived elsewhere, two (2) copies of each sign face in accurately color matched proofs of all permanent signage, at a scale specified by the SEPTA Project Manager, will be submitted.

PART 3 - EXECUTION

3.01 Submittal Requirements

A. Submittals shall include:

1. Date and revision dates.
2. Project title and number.
3. The names of:
   a. SEPTA (Office of the Chief Engineer).
   b. Contractor.
   c. Subcontractor, supplier and/or manufacturer, as applicable.
4. Identification of product or material and whether item is domestic construction material or foreign construction material as approved by SEPTA.
5. Relationship and method of attachment to adjacent structure or material.
6. Field dimensions clearly identified as such.
7. Specification Section number.
8. Applicable standards, such as ASTM or Federal Specification number.
9. Identification of deviations from Construction Documents.
10. The Contractor's stamp, initialed or signed, certifying to the review of submittal, verification of field measurements and compliance with the Contract Documents.

3.02 Identification of Submittals

A. The Contractor shall assign a date and unique number to each submittal and an indication that the Contractor has reviewed the submittal for conformance to the Contract Documents. This information shall appear on each submittal original and copy.

1. Each submittal subject to approval must receive a separate number not shared by any other component, information or process. Only one (1) approval/rejection will be given per submittal number.
2. Each submittal number must include the Specification Section that the submittal most applies to, followed by a hyphen and a sequential number; the first submittal for Section 05500 would be 05500-1 and so on.
3. When a resubmittal is made for any reason, the Contractor shall resubmit using SEPTA's PMIS, e-Builder.

B. The Contractor shall maintain an accurate submittal log for the duration of the work, showing current status of all submittals at all times. The Contractor shall make the submittal log available for review upon request.

3.03 Timing of Submittals

A. The Contractor shall make submittals consistent with early start dates shown on the approved baseline schedule, but sufficiently in advance of early scheduled dates for installation to provide the necessary time required for reviews, for securing necessary

approvals, for possible revisions and resubmittals, and for placing orders and securing delivery.

B. In scheduling, the Contractor shall allow twenty-one (21) calendar days for review and processing by SEPTA following its receipt of the submittal. This review time will be increased for the submittal(s) that are so extensive that twenty-one (21) calendar days of turnaround period is unreasonable as determined by SEPTA. This determination shall be binding on the Contractor.

C. Continued submission of material and repetitious submittals which clearly fail to meet the requirements of the Contract Documents which may cause delays in the completion of the Contract and any such delays shall be the sole responsibility of the Contractor.

3.04 SEPTA's Review

A. Review and processing shall not relieve the Contractor from their responsibility for correcting errors, which may exist in the submitted data.

B. SEPTA does not confirm dimensions or make any representation that parts will fit together properly if fabricated in the sizes shown on the shop drawings. SEPTA requires that the Contractor take all necessary site measurements and that the shop drawings represent an accurate documentation of these dimensions.

C. The Contractor assumes responsibility to exercise control over all construction tolerances and ensure that these tolerances do not result in construction which violates regulations, codes or clearances.

D. Revisions:

1. The Contractor shall make required revisions as noted on the initial submittal.

2. If the Contractor considers any required revision to be a change, it shall so notify SEPTA as provided for in the Agreement. Such notification shall be made no later than ten (10) calendar days from the date of return of such submittals by SEPTA to the Contractor.

3.05 Shop Drawing and Submittal Conflicts with the Contract Documents

A. Unless the Contractor submits data as a substitution as specified in Article 1.05 in this Section, submitted information which departs from the Contract Documents will be understood to be Contractor/subcontractor errors and have no effect on the Contract, even if not identified by SEPTA during the review process.

3.06 Design Submittals, Special Requirements for Traction Power

A. The Contractor shall submit all traction power design submittals at the following levels of design completion:

1. Within thirty (30) days of the award of the Contract, submit the details of the major traction power equipment (switchgear, circuit breakers, transformers, current transformers, potential transformers and disconnect switches) proposed to be used to enable proper interface.

2. Include control schematic drawings of the switchgear and circuit breakers, details of the protective relays, current transformers and potential transformers and calculations necessary to permit understanding of the direction of the design. Include drawings and

schematics for all system components NOT limited to remote terminal unit, protective relays and network connection devices are to be the property of SEPTA once submitted.

3. In-progress design submission at 60 percent design completion level. Provide essentially completed design, although some special designs may not have been finalized. Include documentation, drawings, data and calculations necessary to permit full understanding of the design. Submit studies related to switchgear, as necessary. All studies specified in Section 16953 would have been completed by this time.
4. Pre-final design submission at 90 percent design completion level. Provide all design documentation.
5. Final design submission at 100 percent design completion level. Provide all design documentation sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania as a Professional Engineer in the disciplines applicable to the work.

END OF SECTION

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SECTION 01305

REQUESTS FOR INFORMATION

PART 1 - GENERAL

1.01 Description

A. This Section stipulates procedural requirements for processing of Contractor Request(s) for Information (RFI) and complements the requirements of the Contract Agreement, Paragraphs V.B and VIII.B.

B. An RFI is a written communication originated by a construction Contractor to request clarification of the intent of the Construction Documents. An RFI results in an exchange of information only. If the Contractor believes an RFI response triggers a change in the Project scope he must submit a change order request. No response to an RFI may NOT be interpreted as a change order request or approval.

1.02 Related Sections

A. Agreement.

B. Section 01010 – Summary of Work

C. Section 01300 – Submittals

D. Section 01400 – Quality Requirements

E. Section 01700 – Contract Closeout

F. Section 01720 – Project As-Built Documents

1.03 Submittals

A. The Contractor shall comply with the provisions of Section 01300.

B. The Contractor shall submit RFIs using the SEPTA Project Management Information System (PMIS), e-Builder, and shall provide specific reference to the section of the Construction Documents to which an RFI refers. RFIs that are incomplete, unsigned, or otherwise not submitted in compliance with the Contract, will be returned to the Contractor via the SEPTA PMIS, e-Builder, as rejected.

C. Any losses of time and/or additional costs associated with frivolous RFI submittals are the responsibility of the Contractor.

1.04 Quality Assurance

A. The primary purpose of an RFI is to clarify the Contract Documents.

1. The Contractor has the responsibility to be familiar with the Contract Documents. RFIs that request clarification of items that in the judgment of the SEPTA Project Manager, are clearly evident in the Contract Documents, shall be rejected by SEPTA.

2. The Contractor shall not use RFIs for the following:

a. To facilitate construction coordination between Contractors and subcontractors/vendors.

b. To initiate substitutions in material, methods and/or systems.

c. To transfer their responsibility for reviewing Contract Documents to SEPTA.

3. RFIs, which fail to reference the specific Contract Documents in question, will be rejected. If the Contractor uses an RFI for the purposes described Article 1.04/A/2 in this Section, it will also be rejected. In these cases, the Contractor will be directed to meet the requirements specified in Section 01300 by the SEPTA Project Manager.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Identification of Request(s) for Information

A. The Contractor shall designate the type of RFI by choosing from the options shown within the RFI process in the SEPTA PMIS, e-Builder, (GC, MC, or EC). The RFIs on the Project will be automatically numbered sequentially within the SEPTA PMIS, e-Builder.

3.02 Timing of Request(s) for Information

A. The Contractor shall submit RFIs sufficiently in advance of early construction schedule "Start" dates for fabrication and/or installation activities in order to provide the necessary time required for reviews, possible revisions, and subsequent resubmittals.

B. For scheduling purposes, the Contractor shall allow seven (7) working days for review and response by SEPTA following their receipt of an RFI. This review time will be increased for RFIs that are sufficiently extensive or complex that the above turnaround period is unreasonable as determined by SEPTA. This determination shall be binding on the Contractor.

C. The Contractor shall be solely responsible for delays in the completion of the Contract that result from the submission of RFIs which clearly fail to meet the requirements of this Section.

3.03 SEPTA’s Review

A. All RFIs will be submitted to the SEPTA Project Manager. The Engineer of record is responsible for reviewing the Contractor's RFIs to provide clarifications and/or interpretations as they relate to design documents. The SEPTA Project Manager is responsible to provide clarifications and/or interpretations to RFIs that are related to the Agreement or SEPTA operational issues and service. An answer to an RFI shall never be considered as an approval for extra work and/or a change in scope or any other directive which results in a change to the Construction Contract cost. All such changes must follow the change order process.

B. If the Contractor considers any clarifications to an RFI to be a change; it shall so notify SEPTA in the manner provided for in the Agreement. Such notification shall be made no later than fourteen (14) calendar days from the date of the return of such clarifications by the Engineer of record or SEPTA to the Contractor.

END OF SECTION

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SECTION 01380

CONSTRUCTION PHOTOGRAPHS

PART 1 - GENERAL

1.01 Description

A. The Contractor shall provide professional quality construction record photographs periodically during course of the work as determined by the SEPTA Project Manager.

B. In addition to photographs generally describing the progress of the work, the SEPTA Project Manager will require specific components and processes be documented.

C. SEPTA reserves the right to require that an approved professional photographer be used if, in the opinion of the SEPTA Project Manager, the photographs submitted at any time are inadequate in quality or coverage.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01300 – Submittals

C. Section 01305 – Requests for Information

D. Section 01400 – Quality Requirements

E. Section 01720 – Project As-Built Documents

1.03 Submittals

A. The Contractor shall provide SEPTA with the photographs taken. Photographs shall only be used for the purpose of fulfilling the requirements of this Section. Other uses without the written permission from SEPTA's Project Manager are prohibited. The Contractor may not take photographs for any other purpose on SEPTA property without the written consent of SEPTA.

B. Additionally, provide photographs of important events relating to the traction power switchgear, transformers, circuit breakers, Remote Terminal Unit (RTU) and other major structures. Such events include, but are not limited to, factory test set ups, unloading at site, placement on the foundation etc. to highlight the site specific difficulties for future guidance.

C. Also, provide at least twenty (20) external and twenty (20) internal views of each Traction Power Substation (TPSS) before and after rehabilitation taken from similar angles.

D. Views and Quantities Required:

1. At each specified time, photograph the equipment from ten (10) different views, as directed by SEPTA.

2. Provide two (2) sets of prints of each view, enclosed in two (2) separate binders with double-faced plastic sleeves.

E. Ownership of Electronic Files:

1. The prints and electronic files shall be furnished to SEPTA at the Contractor's expense and all images collected during the course of the Contract shall become the sole property of SEPTA. The Contractor shall turn over all copyright rights to SEPTA in a written document to be approved by SEPTA.

PART 2 - PRODUCTS

2.01 Prints

A. Prints shall be provided in glossy finish color, date encoded and of sufficient quality to render detail in a satisfactory manner as determined by the SEPTA Project Manager.

1. Size:
   a. 8 inch by 10 inch or as directed by the SEPTA Project Manager.

B. The Contractor shall identify each print on back, listing:

1. Southeastern Pennsylvania Transportation Authority (SEPTA).
2. FTA project number.
3. SEPTA project number, if applicable.
4. Project name.
5. Bi-weekly progress photographs, if applicable.
6. Date that construction photographs are submitted.
7. Description/Key Plan:
   a. Orientation of view.
   b. Date and time of exposure.
   c. Kay plan in lower right hand corner permanently affixed.
8. Name and address of photographer.

2.02 Digital Files (JPEG Format)

A. Digital files from a 16.1 megapixels or higher resolution camera.

B. Provide a digital photo log in Word or Excel format listing the information contained in Article 2.01/B in this Section for each photograph submitted.

PART 3 - EXECUTION

3.01 Technique

A. Paramount importance shall be given to factual detailed presentation with maximum depth of field, proper exposure with adequate shadow and highlight detail and minimum distortion.

B. The photographer will be required to use fill in electronic flash technique to adequately light high contrast scenes and assemblies. Electronic flash shall also be used at all interior

locations and other locations where the available light is not adequate for recording appropriate detail.

C. Camera capture; non-enhanced; must provide a minimum image size of 3500 by 2500 pixels unless otherwise determined by the SEPTA Project Manager.

D. Take views as directed and in the presence of SEPTA's Project Manager.

3.02 Delivery of Prints and Final Delivery of Electronic Files

A. The Contractor shall submit; via the SEPTA Project Management Information System (PMIS), e-Builder, JPG files of adequate quality as determined by the SEPTA Project Manager with each application for payment.

B. At the conclusion of the Project, the Contractor will provide a complete set of all electronic files submitted via the SEPTA PMIS, e-Builder, as directed by the SEPTA Project Manager.

END OF SECTION

THIS PAGE NOT USED

SECTION 01400

QUALITY REQUIREMENTS

PART 1 - GENERAL

1.01 Description

A. The Contractor shall establish and maintain a Project specific Quality Assurance/Quality Control (QA/QC) system documented by a program manual and supporting plans and/or procedures. These documents will address the methods to be used to control the quality related aspects of all materials, components, and assemblies to be furnished and installed under the Contract Documents.

B. The Contractor shall have the primary responsibility for the quality of all of its work and shall ensure that the pertinent requirements for the achievement of quality are included and implemented in all relevant sub-contracts.

C. The QA/QC program shall include a description of the organization the Contractor will establish and shall identify the responsibilities and accountabilities of all personnel performing quality affecting activities.

D. The QA/QC program and/or procedures shall include those checklists and test and inspection forms the Contractor will use to properly document the activities performed to achieve the quality of the work. The Contractor will be responsible for completing the checklists and activities called for in SEPTA's Construction Inspection/Monitoring Program as part of their QA/QC program.

E. The Contractor will cooperate fully with SEPTA's QA/QC efforts including but not limited to providing requested information in a timely fashion when SEPTA executes quality audits of the Project. All information generated during the Project, of a non-confidential nature, including but not limited to the internal QA/QC audits executed by the Contractor must be made available to SEPTA in a timely manner.

F. In view of the critical and developmental nature, additional requirements for traction power equipment are included in Section 01452. In case of conflict, the more stringent requirement shall prevail.

1.02 Definitions

A. The following definitions pertain to requirements of this Section.

1. Quality Assurance (QA): QA is a program of planned and systematic actions that provide adequate confidence that all activities affecting quality have been accomplished in accordance with governing codes, standards, and Contract requirements. QA oversight of activities affecting quality is accomplished through field and manufacturing facility surveillance, audits, or other documented measures conducted to verify that requirements have been met.

2. Quality Control (QC): QC is that act of examining, witnessing, inspecting, checking and/or testing of in-process or completed work to determine conformity with specified requirements and documenting the results.

3. QA Audit: A documented activity performed by written procedure or checklist to verify the selected elements of the QA/QC program have been developed, documented, and implemented in accordance with specified requirements.
4. Calibration: Comparison of two instruments or measuring devices, one of which is of known accuracy traceable to national standards, to detect, correlate, report, or eliminate by adjustment any discrepancy in the accuracy of the instrument or measuring device being compared with the standard.
5. Certification: The action of determining, verifying, and attesting, in writing, to the qualifications of personnel, materials and/or equipment.
6. Inspection: A phase of QC, which be means of examination, observation, or measurement, determines the conformance of materials, components, parts, appurtenances, systems, processes, installations, or structures to predetermined quality requirements.
7. Source Inspection: Source inspection consists of the review, monitoring, observation and/or inspection, random or consistent, or at selected stages of manufacture or construction, of manufacturer or sub-manufacturer's personnel, material, equipment, processes, or tests.
8. Site Inspection: Site inspection consists of reviewing, monitoring, observing, and inspecting the work at the Project site.
9. Surveillance: Term used to describe a review performed for the purpose of verifying that applicable quality requirements are properly accomplished.

1.03 Related Sections

A. Requirements of the Agreement.

B. Specific Requirements of Agreement Paragraph XVII.

C. Section 01300 – Submittals

D. Section 01305 – Requests for Information

E. Section 01410 – Inspection and Test Plans

F. Section 01420 – Testing and Inspection Services

G. Section 01452 – Contractor Quality Control — Traction Power Equipment

H. Section 01700 – Contract Closeout

1.04 Submittals

A. SEPTA reserves the right to require mock-ups of any material and/or assembly, at any time during the construction process of a size determined by the SEPTA Project Manager. Once approved, the mock-up will set a minimum standard of performance and/or appearance for the work. Mock-ups will be provided at no cost to SEPTA. The approved mock-up may, at the discretion of the SEPTA Project Manager, become part of the work

B. The Contractor will create a job specific Quality Assurance and Control Plan (QACP) which clearly and comprehensively specifies the actions the Contractor will take to achieve the quality required by the Contract Documents. This plan will be submitted no later than

fifteen (15) days from the Notice to Proceed (NTP). No work may take place until the QACP has been accepted by SEPTA. The following areas will be addressed in this plan:

1. The QA procedures shall define the organizational structure within which the programs are to be implemented and delineate the responsibility and authority of the various personnel involved.
2. Shop Fabrication:
    a. The Contractor shall develop and submit inspection and test plans and procedures for all elements of the work that will be shop fabricated and tested. The inspection plans/procedures shall include source inspection and testing that will be performed, accept/reject criteria and the witness/hold points to be implemented to control the quality of work.
3. Site Construction/Installation:
    a. The Contractor shall develop and explain inspection and test plans and procedures for all elements of the work that will be site constructed and installed, including the storage and installation of shop fabricated items. The installation plans and procedures shall include checklists, which outline the sequence of construction/installation activities and describe the verification checks for each step in the sequence, which must be found acceptable prior to proceeding. The plans and checklists shall be submitted to SEPTA for the identification of hold and/or witness points by SEPTA.
4. The Contractor shall develop and explain the QACP and surveillance methods to verify that reviewed inspection, testing, and documentation activities have been performed to assure that shop fabricated, and site construction/installation comply with the quality standards defined in the Contract Documents.

C. SEPTA's review of the QACP shall not relieve the Contractor from its primary responsibility for the quality of the work.

D. SEPTA reserves the right to require mock-ups of any material and/or assembly, at any time during the construction process of a size prescribed by the SEPTA Project Manager. Once approved, the mock-up will set a minimum standard of performance and/or appearance for the work. Mock-ups will be provided at no cost to SEPTA. The approved mock-up may, at the discretion of the SEPTA Project Manager, become part of the work.

1.05 Quality Assurance Responsibilities of the Contractor

A. Engage an adequate number of skilled professionals who are thoroughly trained, experienced and familiar with the specific requirements and methods needed for the proper performance of the work.

B. Establish technical and administrative surveillance and/or audit methods to ensure the highest degree of quality and to correct potential problems without affecting the Contract schedule.

C. Verify that the required QC inspection, testing, and documentation activities have been performed to assure that the equipment, materials, and construction meet all the requirements of the Contract Documents.

D. Monitor QC over suppliers, manufacturers, fabricators, products, services, site conditions, workmanship, and installation to produce work of the quality required by the Contract Documents.

E. Take corrective actions in a timely manner to identify conditions adversely affecting the quality of work and the Contract schedule.

F. All test results shall clearly include a statement that the item tested or analyzed conforms or fails to conform to the Contract requirements. Each report shall be conspicuously stamped on the cover sheet in large red letters a minimum of 1/2 inch high “CONFORMS” or “DOES NOT CONFORM” to the Specifications as the case may be.

G. All test reports shall be signed by a testing laboratory’s authorized person and counter signed by the Contractor. The testing agency shall provide all tests, reports, certifications, and other documentation sent directly to the SEPTA Project Manager at the same time results are made available to the Contractor.

H. The QA functions shall include but not be limited to:

1. Contract review.
2. Document control.
3. Procurement.
4. Shop fabrication.
5. Field fabrication.
6. Field installation.
7. Field assembly.
8. Receiving inspections.
9. Final inspection.
10. In-process inspections.
11. Factory and field testing.
12. Handling and storage.
13. Packaging and shipping.
14. Quality records.
15. Non-conformance reporting.
16. Corrective action(s).
17. QA audits.
18. Training.
19. Control of in-process activities.
20. Identification and traceability.

I. The Contractor shall promptly reject work which does not comply with the requirements of the Contract Documents. If the Contractor elects to propose that SEPTA accept work that is non-conforming, the Contractor shall reimburse SEPTA for the costs associated with the review of the non-conforming work by the Engineer of record.

J. Develop QA forms in a format acceptable to SEPTA for all major elements of the work including additional elements.

K. The Contractor shall perform audits periodically, no less than four (4) times a year, to maintain level of quality. The results of these audits must be documented and shown to SEPTA on request.

1.06 Source Quality Control Responsibilities of the Contractor

A. Document that each material, manufactured product and fabricated item is produced and tested to comply with quality standards required by the Contract Documents. The Contractor shall perform audits periodically, no less than four (4) times a year, to maintain level of quality.

B. Do not deliver material, manufactured product, or fabricated item until certified quality assurance documents are satisfactorily reviewed by SEPTA.

C. Do not schedule any factory tests/inspections by SEPTA until these documents are satisfactorily reviewed by SEPTA. Twenty-one (21) day's prior written notice is mandatory for (re) scheduling any factory tests or inspections by SEPTA.

D. SEPTA reserves the right to source inspect all material, manufactured product, or fabricated item after acceptance of the certified QA documents. Any and all costs related to re-inspection(s) by SEPTA shall be the responsibility of the Contractor.

E. The QA documents shall identify any changes made to the material, manufactured product or fabricated item as compared to the Contract requirements and approved shop drawings. The Contractor shall describe as to how each change will affect the installation, space, and subsequent operations.

F. SEPTA's review of QA documents and inspections shall not relieve the Contractor from its primary responsibility for the quality of work.

1.07 Contractor Quality Manager (QM)

A. The Contractor shall identify an individual QM within its organization at the site of the work who shall be responsible for overall management of the Contractor's QA/QC program. The responsibilities of the QM may be executed by the Contractor's Superintendent. SEPTA reserves the right to demand a separate full time QM who reports directly to the construction company director at any time during the duration of the Contract, without cause.

1. The QM shall be experienced in the performance and supervision of the inspections and tests required by the Specifications.

2. The QM shall be on the job site at all times that work is taking place and have complete authority to take any action necessary to ensure conformance with the Contract.

3. The QM will be the point-of-contact for all quality matters. The QM is expected to represent the Contractor with respect to all QA audit and review activities performed on the Contractor by outside parties.

4. The QM shall be appointed by letter and may not be replaced without written permission from SEPTA.

5. The QM may take daily direction from the Contractor's Superintendent.

6. The QM shall be responsible for the documented incoming inspection and determination of acceptability in conformance with Contract requirements of all materials arriving at the job site.
7. Receiving inspection(s) shall include the review of associated documentation where necessary to verify the compliance of the item. Segregate and remove from the job site any non-conforming material.

1.08 Site Quality Control Responsibilities of the Contractor

A. Unless specifically allowed elsewhere in the Contract, do not deliver reconditioned material to the job site. Protect all stenciled markings, labels, and any other type of identification(s) to clearly identify the originality of the material.

B. As soon as the material arrives at the job site; but before beginning installation; provide to SEPTA the original bill of lading and certification that the material complies with the requirements of the Contract Documents.

C. Installation shall comply with the approved shop drawings. Do not begin installation until relevant installation shop drawings have been appropriately reviewed by SEPTA. If for any reason the material or component cannot be installed according to the approved shop drawing and the installation instructions provided by the manufacturer/fabricator, the Contractor is to alert SEPTA immediately and not begin installation without concurrence from the SEPTA Project Manager.

D. Perform necessary and specified tests and document the results. Replace material that fails the tests at no cost to SEPTA.

E. Remove and replace material that is damaged in storage or in the performance of work unless specifically accepted in writing by SEPTA's Project Manager.

F. No work shall be performed at the job site if the Contractor's Superintendent or his authorized representative, as approved by SEPTA, is not present at the location where work is being performed.

1.09 Non-Conformance Reports

A. A Non-Conformance Report (NCR) shall be issued when any material or component does not meet the requirements of the Contract Documents in the opinion of the SEPTA Project Manager or other approved SEPTA personnel.

B. Once issued, the Contractor has ten (10) days to challenge the NCR in a written response to the SEPTA Project Manager.

C. Any NCR not withdrawn in writing by the SEPTA Project Manager or other approved SEPTA personnel, must be corrected in a timely manner.

D. The Contractor is obliged not to proceed with any work which would cover or reduce access to the non-conforming work.

1.10 Construction Inspection and Monitoring Program

A. The Contractor will be required to complete checklists, usually in the presence of a member of the SEPTA Project team, at specific critical points of the Project's execution to verify QA

procedures. SEPTA reserves the right to provide these checklists and require their completion in a timely manner without prior notification.

1.11 Suggested Contents of a QA/QC Program

A. The Contractor's inspection and testing plan must be specific and not generic; tailored to the actual requirements of the Project. Most programs will include many of the following items:

1. Organization and Responsibilities:
    a. Provide an organizational chart showing who has responsibility for QC functions and how they interact with the rest of the Project team. The QA/QC team must report directly to upper management and not to the Project Manager overseeing day-to-day activities of the Project.
    b. Supply brief resumes of key personnel.
    c. Document how the QA/QC personnel will oversee the QA/QC activities of subcontractors and fabricators.
2. Procedures and Documentation:
    a. Samples of logs and checklists to be used in QA/QC activities.
    b. A schedule of tests, inspections and mock-ups required by the Contract Documents and governmental authorities.
    c. Procedures which guarantee that any material which must meet a specific test or other definition of quality is delivered to the job site accompanied by written verification that the material does meet these requirements. Included in this procedure is the process of gathering this information and retaining it by the Contractor.
    d. Procedures which ensure that handling, and storage instructions are obtained and followed for all material.
    e. Procedures that ensure that the Contractor effectively controls documents at the job site. Included in this responsibility is a requirement that a copy of the most current construction documents is present at the job site at all times; including but not limited to drawings, specifications, addendum items, change orders and RFI's.
3. Inspection and Testing Activities:
    a. List of inspection devices to be used by the Contractor or a subcontractor which must be calibrated, the proposed frequency of calibration and who will calibrate them.
    b. Procedures to ensure that testing, and inspections will be done in a timely manner and will not negatively impact the progress of the work.
    c. Procedures to ensure that mock-ups and pre-installation conferences are done in a timely manner and give the SEPTA Project Manager sufficient time to participate and review them without negatively impacting the schedule.
    d. Procedures that ensure that material which fail tests or inspections is identified and segregated.
4. Audit Activities:
    a. Define how and how often the QA/QC efforts for key construction activities will be audited and how the results of this audit will be presented to the job superintendent.
    b. Define when anticipated audits may be implemented.
    c. Provide a list of types and a schedule for audits to be implemented.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01410

INSPECTION AND TEST PLANS

PART 1 - GENERAL

1.01 Description

A. The Contractor shall establish and maintain a Project specific Quality Assurance/Quality Control (QA/QC) system in the form of Inspection and Test Plans (ITPs) for the work executed under the Contract Documents.

B. The Contractor shall have the primary responsibility for the quality of all of its work as well as the work of its subcontractors and fabricators. The QA/QC program shall include organization, personnel, procedures, instructions, and records/documentation to properly maintain the quality of the work.

C. ITPs shall be based on the requirements of each technical Specification and shall include reference to the attribute(s) of the item(s) to be tested and/or inspected, the frequency (as applicable), the person or organization responsible for the activity and the method of documentation, if required. The Contractor shall monitor implementation of ITPs to the extent necessary to control the quality of the work.

D. The ITP may be based on the QACP submitted by the inspection and testing service hired by the Contractor; refer to Section 01420; but augmented by the contractor to include activities beyond the scope of that service.

E. The primary responsibility for quality during construction remains with the Contractor and he must take all steps necessary to control the quality of the completed Project.

F. The Contractor will cooperate fully with SEPTA's QA/QC efforts including, but not limited to, providing requested information in a timely fashion when SEPTA executes quality audits of the Project.

G. The Contractor will be responsible for completing the checklists which supports SEPTA's Construction Inspection/ Monitoring Program as part of their QA/QC program.

1.02 Related Sections

A. Agreement.

B. Section 01300 – Submittals

C. Section 01400 – Quality Requirements

D. Section 01420 – Testing and Inspection Services

E. Section 01600 – Materials and Equipment

F. Section 01700 – Contract Closeout

1.03 Submittals

A. The Contractor shall develop and document the ITPs and procedures for all elements of the work. ITPs shall be based on the requirements of each Section of the technical Specifications

and demonstrate how the quality of materials and workmanship required by the Contract Documents will be verified by the Contractor.

B. ITPs shall address inspection and test activities at the both the source of manufacture, at receipt at the job site and during installation. The complete set of ITPs for the Project and any additional material required by the SEPTA Project Manager to demonstrate the Contractor's QA/QC activities will constitute the Contractor's Quality Assurance and Control Plan (QACP) for the work. This QACP shall be submitted no later than fifteen (15) days from the Notice to Proceed (NTP).

C. SEPTA's review of the QACP shall not relieve the Contractor from its primary responsibility for the quality of the work.

D. SEPTA reserves the right to require mock-ups of any material and/or assembly, at any time during the construction process of a size determined by the SEPTA Project Manager. Once approved, the mock-up will set a minimum standard of performance and/or appearance for the work. Mock-ups will be provided at no cost to SEPTA. The approved mock-up may, at the discretion of the SEPTA Project Manager, become part of the work.

1.04 Quality Definitions and Responsibilities

A. The following definitions pertain to requirements of this Section.

1. Quality Assurance (QA): QA is a program of planned and systematic actions that provide adequate confidence that all activities affecting quality have been accomplished in accordance with governing codes, standards, and Contract requirements. QA oversight of activities affecting quality is accomplished through field and manufacturing facility surveillance, audits, or other documented measures conducted to verify that requirements have been met.

2. Quality Control (QC): QC is that act of examining, witnessing, inspecting, checking and/or testing of in-process or completed work to determine conformity with specified requirements and documenting the results.

3. Calibration: Comparison of two instruments or measuring devices, one of which is of known accuracy traceable to national standards, to detect, correlate, report, or eliminate by adjustment any discrepancy in the accuracy of the instrument or measuring device being compared with the standard.

4. Inspection: A phase of QC, which be means of examination, observation, or measurement, determines the conformance of materials, components, parts, appurtenances, systems, processes, installations, or structures to predetermined quality requirements.

5. Source Inspection: Source inspection consists of the review, monitoring, observation and/or inspection, random or consistent, or at selected stages of manufacture or construction, of manufacturer or sub-manufacturer's personnel, material, equipment, processes, or tests.

6. Site Inspection: Site inspection consists of reviewing, monitoring, observing, and inspecting the work at the Project site.

B. Contractor Quality Manager (QM):

1. The Contractor shall identify an individual QM within its organization at the site of the work who shall be responsible for overall management of the Contractor's QA/QC program. The responsibilities of the QM may be executed by the Contractor's Superintendent. SEPTA reserves the right to demand a separate full time QM who reports directly to the construction company director at any time during the duration of the Contract, without cause.
    a. The QM shall be experienced in the performance and supervision of the inspections and tests required by the Specifications.
    b. The QM shall be on the job site at all times that work is taking place and have complete authority to take any action necessary to ensure conformance with the Contract.
    c. The QM will be the point-of-contact for all quality matters. The QM is expected to represent the Contractor with respect to all QA audit and review activities performed on the Contractor by outside parties.
    d. The QM shall be appointed by letter and may not be replaced without written permission from SEPTA.
    e. The QM may take daily direction from the Contractor's Superintendent.
    f. The QM shall be responsible for the documented incoming inspection and determination of acceptability in conformance with Contract requirements of all materials arriving at the job site.
    g. Receiving inspection(s) shall include the review of associated documentation where necessary to verify the compliance of the item. Segregate and remove from the job site any non-conforming material.

1.05 Source Quality Assurance Issues to be Addressed by the Contractor

A. Engage subcontractors and suppliers who are thoroughly trained, experienced and familiar with the specific requirements and methods needed for the proper performance of the work.

B. Take steps to investigate the authenticity of manufactured components and ensure that counterfeit components are not being used in the work.

C. Establish technical and administrative surveillance and/or audit methods to ensure the highest degree of quality and to correct potential problems without affecting the Contract schedule.

D. Verify that the required QC inspection, testing, and documentation activities have been performed and assure that the equipment, material, and assemblies meet all the requirements of the Contract Documents.

E. Take corrective actions in a timely manner to identify conditions adversely affecting the quality of work and the Contract schedule.

F. Verify the use of appropriately scaled and calibrated measuring and test equipment to perform inspections and tests. Calibration records shall be traceable to national standards and shall reflect the as-found condition of the equipment at the point of calibration. Verify that all equipment has been calibrated at a frequency acceptable to SEPTA and inspect logs of these calibration efforts.

G. All test results shall clearly include a statement that the item tested or analyzed conforms or fails to conform to the Contract requirements. Each report shall be conspicuously stamped

on the cover sheet in large red letters a minimum of 1/2 inch high "CONFORMS" or "DOES NOT CONFORM" to the Specifications as the case may be.

H. All test reports shall be signed by a testing laboratory's authorized person and counter signed by the Contractor. The testing agency shall provide all tests, reports, certifications, and other documentation sent directly to the SEPTA Project Manager at the same time results are made available to the Contractor.

I. The Contractor shall promptly reject work which does not comply with the requirements of the Contract Documents. If the Contractor elects to propose that SEPTA accept work that is non-conforming, the Contractor shall reimburse SEPTA for the costs associated with the review of the non-conforming work by the Engineer of record.

J. Develop QA forms in a format acceptable to SEPTA for all major elements of the work including any additional elements.

K. The Contractor shall meet the requirements of Section 01600.

L. The Contractor shall promptly process and submit required copies of test reports and related instructions to assure necessary retesting and replacement of materials without any possible delay in the progress of the work.

1.06 Source Quality Control Issued to be Addressed by the Contractor

A. Document that each material, manufactured product, and fabricated item is produced and tested to comply with the quality standards required by the Contract Documents.

B. Do not deliver material, manufactured product, or fabricated item until certified quality assurance documents are satisfactorily reviewed by SEPTA.

C. Factory test/inspection schedules shall be submitted to SEPTA a minimum of twenty-one (21) days prior to the test/inspection.

D. SEPTA reserves the right to source inspect any material, manufactured product, or fabricated item after acceptance of the certified QA documents. Any and all costs related to re-inspection(s) by SEPTA shall be the responsibility of the Contractor.

E. SEPTA's review of QA documents and inspections shall not relieve the Contractor from its primary responsibility for the quality of work.

F. Notify SEPTA and testing agency forty-eight (48) hours prior to expected time for operations requiring inspecting and testing services.

1.07 Site Quality Control Issues to be Addressed by the Contractor

A. The QM shall inspect and document material arriving at the job site to insure conformance to Contract requirements. Non-conforming and damaged material shall be marked and segregated from conforming material to prevent its use until such time as it is removed from the job site.

B. All materials and equipment shall be protected from rust, corrosion and other damage by either factory applied or field applied protective coatings. Clean and touch-up all surfaces that become scratched, marred, or otherwise damaged. SEPTA reserves the right to require replacement of damaged material.

C. Unless specifically allowed elsewhere in the Contract, do not deliver reconditioned material to the job site. Protect all stenciled markings, labels, and any other type of identification(s) to clearly identify the originality of the material.

D. As soon as the material arrives at the job site; but before beginning installation; provide to SEPTA the original bill of lading and certification that the material complies with the requirements of the Contract Documents.

E. Do not begin installation until relevant installation shop drawings have been appropriately reviewed by SEPTA. Installation shall comply with conformed shop drawings. If for any reason the material or component cannot be installed according to the approved shop drawing and the installation instructions provided by the manufacturer/fabricator, the Contractor is to alert SEPTA immediately and not begin installation without concurrence from the SEPTA Project Manager.

F. Perform necessary and specified tests and document the results. Replace material that fails the tests at no cost to SEPTA.

G. Remove and replace material that is damaged in storage or in the performance of work unless specifically accepted in writing by SEPTA's Project Manager.

H. No work shall be performed at the job site if the Contractor's Superintendent or his authorized representative, as approved by SEPTA, is not present at the location where work is being performed.

I. Install field samples/mock-ups at the job site as required by individual Specification Sections for SEPTA approval.

J. Submit final reports and test(s) data to SEPTA as required by the Contract Documents.

1.08 Non-Conformance Reports

A. A Non-Conformance Report (NCR) shall be issued when any material or component does not meet the requirements of the Contract Documents in the opinion of the SEPTA Project Manager or other approved SEPTA personnel.

B. Once issued, the Contractor has ten (10) days to challenge the NCR in a written response to the SEPTA Project Manager.

C. Any NCR not withdrawn in writing by the SEPTA Project Manager or other approved SEPTA personnel, must be corrected in a timely manner.

D. The Contractor is obliged not to proceed with any work which would cover or reduce access to the non-conforming work.

1.09 Construction Inspection and Monitoring Program

A. The Contractor will be required to complete checklists, usually in the presence of a member of the SEPTA Project team, at specific critical points of the Project's execution to verify QA procedures. SEPTA reserves the right to provide these checklists and require their completion in a timely manner without prior notification.

1.10 Contents of an Inspection and Testing Plan

A. The Contractor's inspection and testing plan must be specific and not generic; tailored to the actual requirements of the Project. Most programs will include many of the following items:

1. Organization and Responsibilities:
    a. Provide an organizational chart showing who has responsibility for QC functions and how they interact with the rest of the Project team. The QA/QC team must report directly to upper management and not to the Project Manager overseeing day-to-day activities of the Project.
    b. Supply brief resumes of key personnel.
    c. Document how the QA/QC personnel will oversee the QA/QC activities of subcontractors and fabricators.
2. Procedures and Documentation:
    a. Samples of logs and checklists to be used in QA/QC activities.
    b. A schedule of tests, inspections and mock-ups required by the Contract Documents and governmental authorities.
    c. Procedures which guarantee that any material which must meet a specific test or other definition of quality is delivered to the job site accompanied by written verification that the material does meet these requirements. Included in this procedure is the process of gathering this information and retaining it by the Contractor.
    d. Procedures which ensure that handling, and storage instructions are obtained and followed for all material.
    e. Procedures that ensure that the contractor effectively controls documents at the job site. Included in this responsibility is a requirement that a copy of the most current construction documents is present at the job site at all times; including but not limited to drawings, specifications, addendum items, change orders and RFI's.
3. Inspection and Testing Activities:
    a. A list of inspection devices to be used by the Contractor or a subcontractor which must be calibrated, the proposed frequency of calibration and who will calibrate them.
    b. Procedures to ensure that testing, and inspections will be done in a timely manner and will not negatively impact the progress of the work.
    c. Procedures to ensure that mock-ups and pre-installation conferences are done in a timely manner and give the SEPTA Project Manager sufficient time to participate and review them without negatively impacting the schedule.
    d. Procedures that ensure that material which fail tests or inspections is identified and segregated.
4. Audit Activities:
    a. Define how and how often the QA/QC efforts for key construction activities will be audited and how the results of this audit will be presented to the job superintendent.
    b. Provide an outline of the contents of a typical audit.
    c. Provide list of types and a schedule for audits to be implemented.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

THIS PAGE NOT USED

SECTION 01420

TESTING AND INSPECTION SERVICES

PART 1 - GENERAL

1.01 Description

A. The Contractor shall employ a testing and inspection agency fully licensed and competent in the field of testing and inspecting specific elements of the Project. The Contractor shall submit all testing agencies and their qualifications for SEPTA's prior written approval before any testing begins.

B. The required testing and inspections shall include the tests commonly used in the construction industry including but not limited by those called for in the Division 16 Specification Sections pertaining to the traction power equipment and the following:

1. Section 16122.
2. Section 16230.
3. Section 16260.
4. Section 16273.
5. Section 16274.
6. Section 16290.
7. Section 16315.
8. Section 16344.
9. Section 16910.
10. Section 16920.
11. Section 16953.

C. The Contractor shall pay for all necessary testing and inspection services.

1.02 Related Sections

A. Agreement.

B. Section 01410 – Inspection and Test Plans

C. Section 01600 – Materials and Equipment

D. Section 16122 – DC Traction Power Cable

E. Section 16230 – Generator Assemblies

F. Section 16260 – Traction Power Rectifier

G. Section 16273 – Traction Power Rectifier Transformers

H. Section 16274 – Transformer and Rectifier Unit

I. Section 16290 – Protective Devices and Instrument Transformers

J. Section 16315 – Dead Break Junction Equipment

K. Section 16344 – DC Traction Power Switchgear Assemblies

L. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

M. Section 16920 – Stray Current Monitoring

N. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Prior to start of work, submit testing and inspection agency name, address, and telephone number, and names of full time specialists and/or Professional Engineer licensed in the Commonwealth of Pennsylvania and responsible officer.

B. Submit information on the testing and inspection agency's participation in accreditation program(s) such as those run by the Construction Materials Testing Laboratory Accreditation Program of the National Institute of Standards and Technology and AASHTO Materials Reference Laboratory in the AASHTO Accreditation Program (AAP) in construction materials engineering and testing. Non-participation in appropriate third party accreditation programs may result in rejection.

C. Provide schedule of testing and inspection agency's activities commitment with the Contractor's schedule and work to be provided.

D. Other information and qualifications to allow SEPTA to determine their appropriateness for the tasks involved.

1. After each inspection and test, the testing and inspection agency must promptly submit a copy of draft results directly to the SEPTA Project Manager without Contractor review.

2. Include:

a. Date issued.

b. Project title and number.

c. Name of inspector.

d. Date and time of sampling or inspection.

e. Identification of product and Specification Section.

f. Location in the Project.

g. Type of inspection or test.

h. Date of test or inspection.

i. Results of tests or inspection.

j. A statement of conformance or non-conformance with the Contract Documents.

E. When requested by SEPTA, provide a written clarification and interpretation of test/inspection results.

1.04 Quality Assurance

A. The testing and inspection agency shall be approved by SEPTA.

B. The laboratory shall comply with the requirements of the most current edition of ASTM E329, "Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection."

C. Laboratory:

1. Authorized to operate in the Commonwealth of Pennsylvania.

D. Laboratory Staff:

1. Maintain a full time Professional Engineer licensed in the Commonwealth of Pennsylvania on staff to review services.

E. Testing Equipment:

1. All equipment must be calibrated at reasonable intervals with devices of an accuracy traceable to either the National Bureau of Standards or accepted values of natural physical constants defined by industry standards.

F. All site testing and taking of the specimens and samples shall be performed in the presence of the Contractor's Superintendent and the SEPTA Project Manager unless the SEPTA Project Manager waives the right to be present, in writing.

G. No testing required by the Contract Documents or common industry practice may be waived or altered without the written permission of SEPTA's Assistant General Manager of Engineering, Maintenance, and Construction or SEPTA's Chief Engineer.

1.05 Product Handling

A. The Contractor shall comply with pertinent provisions of Section 01600.

B. The Contractor shall promptly process and submit required copies of test reports and related instructions to assure necessary retesting and replacement of materials without any possible delay in the progress of the work.

1.06 Contractor’s Responsibilities

A. Representatives of the testing and inspection agency shall have access to the work at all times and at all job sites and off site locations, including manufacturing and fabrication facilities. The Contractor shall provide whatever support is required to enable the testing and inspection agency to perform its functions properly.

B. By advance discussion with the testing and inspection agency, the Contractor shall determine the schedule required for the testing and inspection agency to perform its tests and inspections and to issue each of its findings. The Contractor is solely responsible for any delays caused by testing and inspection services.

C. The Contractor shall provide all required testing and inspection time within the approved construction schedule.

D. Deliver to testing and inspection agency at designated location, adequate samples of materials proposed to be used which require testing, along with proposed mix designs.

E. Provide Incidental Labor and Facilities:

1. To provide access to work to be tested or inspected.

2. To obtain and handle samples at the job site or a source of products to be tested.

3. To facilitate tests and inspections.

4. To provide storage and curing of test samples.

F. Notify the SEPTA Project Manager forty-eight (48) hours prior to expected time for operations requiring inspecting and testing services.

G. When initial tests indicate non-compliance with the Contract Documents, subsequent retesting occasioned by the non-compliance shall be performed by the same testing and inspection agency, at no additional cost to SEPTA.

H. Inspecting and testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01452

CONTRACTOR QUALITY CONTROL – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Traction power equipment required for the Contract is unique in terms of rating and will be supplied by multiple manufacturers. Quality Control (QC) by the Contractor is therefore of paramount importance.

B. SEPTA shall monitor the Contractor's QC of the traction power equipment during design, manufacturing, installation, and by conducting reviews of submittals, design review meetings, observing manufacturing process, inspecting installation, and witnessing tests at the factory and site.

C. In case of conflict with other Sections, provisions that are more stringent shall apply.

1.02 Related Sections

A. All Sections of Division 1.

B. Section 01300 – Submittals

C. Section 01380 – Construction Photographs

D. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

E. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

F. Section 01822 – Demonstration and Training – Traction Power Equipment

G. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

H. Section 05090 – Metal Fasteners, Joining and Welding

I. Section 09910 – Paints and Coatings

J. Section 16060 – Grounding and Bonding

K. Section 16075 – Electrical Identification

L. Section 16260 – Traction Power Rectifier

M. Section 16271 – Auxiliary Power Transformers

N. Section 16273 – Traction Power Rectifier Transformers

O. Section 16274 – Transformer and Rectifier Unit

P. Section 16290 – Protective Devices and Instrument Transformers

Q. Section 16335 – Surge Protection

R. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

S. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Design Documentation:

1. Studies and Reports:
   a. Submit studies and reports for each component design requiring calculations. This is specifically applicable for the components which have not been previously used on similar traction power equipment. As a minimum, include in each report the following sections:
      1) General description.
      2) Design parameters.
      3) Design procedures.
      4) Calculation procedures.
      5) References to standards and technical literature.
      6) Design of the equipment based on the calculations.
      7) Statement of compliance with the Contract Documents, specified standards and codes to which each item of equipment is designed.
      8) Conclusions.
      9) Seal and signature of a Professional Engineer licensed in the Commonwealth of Pennsylvania.

2. Product Data:
   a. Provide technical product data for all items of equipment used.
   b. Identify materials, dimensions, weights, manufacturing and fabrication procedures, factory and field tests, and installation procedures.
   c. Make use of standard equipment product data and specifications where practical and describe functional, design, electrical characteristics and performance requirements. Identify materials, fabrication procedures, factory tests, field tests and installation procedures.
   d. Modify the manufacturer's standard schematics, drawings, brochures, diagrams, details, procedures, instructions, schedules, illustrations, calculations and other descriptive data as follows:
      1) Delete information which is not applicable to this Contract.
      2) Highlight pertinent information related to this Contract.
      3) Show dimensions, clearances, performance characteristics, interfaces, wiring diagrams, inputs, outputs and controls, as appropriate.
   e. Submit certificates of compliance for those products for which no product samples or tests are specified. Demonstrate that the product meets the Contract Document requirements. The certificates of compliance shall be signed by an authorized representative of the product manufacturer.

3. Design and Shop Drawings:
   a. Submit detailed design drawings including control schematics and layouts for SEPTA review.
   b. Prepare all design and shop drawings using SEPTA approved border and title block. Include in the title block the drawing number, title, date, Contract number, reference to next higher assembly and signature of the Contractor's responsible engineer.
   c. All drawings shall be prepared to SEPTA AutoCAD standards as specified elsewhere.
   d. Reserve a blank area, 2 inches by 4 inches in the lower right corner just above the title block, for SEPTA's review stamp.

e. Include a complete list of materials and parts with the Contractor's part number. Provide room for including SEPTA's part number.

f. Fully dimension each assembly.

g. Provide weight of each assembly.

h. Identify commercial equivalent of components, where possible.

i. Changes in products for which drawings have been reviewed and approved will not be permitted, unless those changes have been submitted to and approved in writing by SEPTA.

j. Include seal and signature of a Professional Engineer licensed in the Commonwealth of Pennsylvania on all drawings.

4. Manufacturers Internal Quality Control Tests and Control Points:

a. Submit details of the internal factory tests that will be performed by the manufacturer as part of his quality control.

b. Submit list of control points where the manufacturer's internal quality department will perform a pass/fail check.

c. SEPTA may elect to witness any or all control point tests at the manufacturer's factory.

5. Bill of Materials:

a. Provide a complete list of all equipment and materials used.

b. For each item of equipment on the list include the following information:

1) Item identification.

2) Major characteristics.

3) Name and address of the manufacturer.

4) Catalog number.

5) Complete ordering data.

6) Alternate manufacturers.

B. Product Samples:

1. Submit product samples to SEPTA as specified in other Sections of this Specification.

2. Prepay all shipping charges to SEPTA's offices or construction site.

3. Provide samples and quantity to clearly illustrate full color, range, and functional characteristics of products and materials. Provide complete accessories or attachment devices. After review and written approval by SEPTA, samples may be used in construction, if not damaged and if allowed by SEPTA.

4. Changes in products for which samples have been approved will not be permitted, unless those changes have been reviewed and approved in writing by SEPTA.

C. Software Code and Documentation:

1. Provide all software source code and software documentation developed under the Contract to insure that should the need arise after expiration of the warranty and the Contractor is unable or unwilling to provide technical support, SEPTA or a software consultant, will have the capability to perform any needed software modifications. At this time, SEPTA has no plans to modify supplied software without the Contractor's knowledge and consent.

2. Include all application and diagnostic software and any software developed for embedded microprocessors that are integrated into the equipment modules.

3. Software documentation shall include the following:
    a. General description and operation.
    b. Software architecture and program functions.
    c. Data flow information.
    d. Annotated source code listing, with comments and descriptions pertaining to each module in sufficient detail to allow an experienced programmer to understand the program.
    e. Detailed memory map and listing.
    f. Input/output port map.
4. In addition to the software source code and documentation described above, submit the following:
    a. A licensed copy of all software tools such as debuggers, assemblers and compilers needed to convert the supplied source code into executable form used by the target processors.
    b. Hardware devices, such as EPROM programmers, with their accompanying software tools, necessary to transfer the executable programs onto the storage devices used by any embedded microprocessors.
    c. Documentation that describes the procedures necessary to convert the supplied source code into an executable format.

D. Photographs:

1. Refer to Section 01380 for photograph requirements.

E. Record Documents:

1. Maintain one (1) record copy of all design documents and change orders at the work site. The design documents shall be continuously annotated to indicate the following:
    a. All design changes in the field.
    b. Substitutions of items of equipment as changes occur.
    c. Additional details not provided on the original design documents.
    d. All other changes, as required, to show a complete "as-built" condition.
2. Periodically update the drawings electronically. Upon completion of the construction, when the design documents include all design and field changes, designate and stamp the documents as record documents.
3. At completion of all work ensure the record documents are sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania and submit to SEPTA. All record documents will become the property of SEPTA.
4. Retain all system design and record documents for a minimum of five (5) years from the final acceptance date of each element of work. The documents shall be accessible to SEPTA during this period.

1.04 Quality Assurance

A. Use the following standards for the preparation of drawings:

1. IEEE 91, Graphic Symbols for Logic Diagrams (Two-State Devices).
2. IEEE 315, IEEE Standard for Graphics Symbols for Electrical and Electronic Diagrams (Including Reference Designation Class Designation Letters).

3. IEEE 315A, Supplement to Graphic Symbols for Electrical and Electronics Diagrams.
4. ANSI Y14.38, Abbreviations and Acronyms for Use on Drawings and Related Documents.
5. SEPTA drawing standards.

PART 2 - PRODUCTS

2.01 SEPTA's Review

A. All submissions shall be subject to review and approval by SEPTA in accordance with Section 01300 or as amended herein. Approval does not relieve the Contractor of its obligation to meet the requirements of the Contract.

B. One (1) copy of each submittal will be returned to the Contractor. Submittals bearing exception and submittals not approved will indicate the review comments and instruction relative to correction of the resubmittal.

C. Review and approval of a separate item will not constitute approval of the assembly in which the item functions.

D. Allow twenty-one (21) calendar days for all SEPTA reviews for submittals relating to traction power equipment.

2.02 Design Review Meetings

A. Design review meetings shall be conducted to discuss and evaluate design progress, technical adequacy of the design and the compliance with the performance requirements of the Contract. Each review shall also evaluate compatibility of the functional interfaces between the system components and between other facilities.

B. Hold design review meetings monthly and at special design milestones as required by SEPTA. The special design milestones shall include, but not be limited to:

1. In-progress (60 Percent) design review meeting following the in-progress design submission.
2. Pre-final (90 Percent) design review meeting following the pre-final design submission.
3. Final design (100 Percent) review meeting following the final design submission.

C. The location of the review meetings shall be, at the option of SEPTA, either at the Contractor's offices or at SEPTA's office. Prepare written record of each meeting in the form of meeting minutes. The meeting minutes shall be included in the Project correspondence and shall be distributed to SEPTA.

D. SEPTA reserves the right to review any and all design drawings, design data, studies and analyses.

E. SEPTA reserves the right to audio tape all meetings with the knowledge of all participants.

2.03 Manufacture Observation and Construction Inspection

A. SEPTA and its representatives will visit the Contractor's facilities and the construction site from time to time to monitor manufacturing and construction progress.

B. For this purpose, provide SEPTA thirty-five (35) days' notice of upcoming control points in the manufacture of traction power equipment, and arrange for design staff, manufacturing personnel, and construction personnel to be available for formal meetings, shop floor discussions and site inspections.

2.04 Test Witnessing

A. SEPTA and its representatives will visit the construction sites from time to time and be present at important stages of equipment testing.

B. For this purpose, provide SEPTA fourteen (14) days' notice of all important installation events, such as delivery of major equipment, and arrange for required field staff to be available for meetings and discussions at site.

PART 3 - EXECUTION

3.01 Interface Coordination System

A. Setup a control system to track all areas requiring interface with the Contractor and the subcontractors. Use the control system for the following activities:

1. Tracking of all interface requirements.
2. Any potential conflicts with subcontractors.
3. Impact on the Contract construction schedule.

3.02 Design Submittals

A. Refer to Section 01300 for design submittal requirements.

3.03 Distribution of Approved Submittals

A. Refer to Section 01300 for distribution of approved submittal requirements.

3.04 Resubmission Requirements

A. Refer to Section 01300 for submittal resubmission requirements.

3.05 Notification

A. Provide advance notification to SEPTA prior to important design, manufacture, testing, and construction events, as shown in Table 01010-2.

B. Notify the SEPTA Project Manager of any delays, field activity or factory test cancellations both verbally and with written confirmation.

3.06 Submission Schedule

A. Provide submittals as shown in Table 01452-1.

Table 01452-1 Design Documentation Submission Schedule

Deliverable Item	Level of Submission	Submission Requirement
Studies and Reports	In-Progress	At least fifteen (15) days prior to preliminary design meeting
	Final	At least fifteen (15) days prior to in-progress design meeting
Product Data	In-Progress	At least fifteen (15) days prior to preliminary design meeting
	Final	At least fifteen (15) days prior to in-progress design meeting
Design and Shop Drawings	In-Progress	At least fifteen (15) days prior to in-progress design meeting
	Pre-Final	At least fifteen (15) days prior to pre-final design meeting
	Final	At least fifteen (15) days prior to final design meeting
Plans and Procedures	In-Progress	At least fifteen (15) days prior to preliminary design meeting
	Final	At least fifteen (15) days prior to in-progress design meeting
Test Documentation	Test Plan, In-Progress	At least fifteen (15) days prior to preliminary design meeting
	Test Plan, Final	At least fifteen (15) days prior to in-progress design meeting
	Test Procedures, In-Progress	At least fifteen (15) days prior to in-progress design meeting
	Test Procedures, Final	At least fifteen (15) days prior to pre-final design meeting
	Test Reports	Within thirty (30) days of test completion
Bill of Material	In-Progress	At least fifteen (15) days prior to pre-final design meeting
	Final	At least fifteen (15) days prior to final design meeting

Deliverable Item	Level of Submission	Submission Requirement
Spare Parts, Special Tools and Test Equipment	Pre-Final List	At least fifteen (15) days prior to pre-final design meeting
	Final List	At least fifteen (15) days prior to final design meeting
	Parts, Tools and Equipment	With delivery of the last item of equipment
	Catalogs	With delivery of the last item of equipment
Product Samples	Final	At least fifteen (15) days prior to in-progress design meeting
Software Code and Documentation	Final	Within thirty (30) days of final system acceptance
Photographs	Final	Within thirty (30) days of final system acceptance
Operations and Maintenance Manuals	Manuals, Pre-Final	Include in pre-final design submission
	Manuals, Final	With delivery of the last item of equipment
Training and Training Manuals	Personnel Resumes	At least one hundred and twenty (120) days prior to commencement of training
	Training Plan	At least one hundred and twenty (120) days prior to commencement of training
	Training Program	At least ninety (90) days prior to commencement of training
	Training Manuals, Final	At least thirty (30) days prior to commencement of training
	Training Materials	At least thirty (30) days prior to commencement of training
	Program Demonstration	At least thirty (30) days prior to commencement of training
Record Documents	Final	Within thirty (30) days of final system acceptance

END OF SECTION

SECTION 01500

CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS

PART 1 - GENERAL

1.01 Description

A. The Contractor shall provide temporary facilities and controls needed for the performance of its work; except otherwise noted; to provide for the safety of employees and the general public, and protect SEPTA property. This may include but not necessarily limited to:

1. Temporary utilities such as heat, water, electricity, and telephone.
2. Field office for the Contactor's personnel and a separate facility for use by SEPTA personnel.
3. Sanitary facilities.
4. Enclosures such as tarpaulins, barricades, and canopies.
5. First-aid facilities.
6. Temporary fencing and other safety devices for pedestrian and vehicular traffic as well as isolating the construction area.
7. Entry control.
8. Personnel identification.
9. SEPTA operations staff must have unrestricted access to any area that contains in-service equipment.

B. If space limitations preclude the establishment of a field office compound, the Contractor may negotiate the use of space within the substation with the Project Manager if space is available and will have no impact on SEPTA operations.

1.02 Related Sections

A. Agreement.

B. Section 01010 – Summary of Work

C. Section 01060 – Regulatory Requirements and Safety

D. Section 01300 – Submittals

E. Section 01580 – Project Identification Signs

F. Section 01590 – SEPTA Field Office

1.03 Submittals

A. The Contractor shall comply with the pertinent provisions of Section 01300.

B. If required by the SEPTA Project Manager, the Contractor shall provide shop drawings; including signed and sealed engineering drawings if requested; for any temporary facility.

1.04 Product Handling

A. The Contractor shall maintain and protect all temporary facilities and controls in proper and safe condition throughout progress of the work. For facilities visible to the general public, the Contractor shall maintain them in an acceptable appearance and repair any vandalism within twenty-four (24) hours or as requested by the SEPTA Project Manager.

1.05 Temporary Utilities and Services

A. Water:

1. The Contractor shall provide drinking water from an approved source, so piped or transported as to keep it safe and fresh and served from single service containers or satisfactory types of drinking stands or fountain. All such facilities and services shall be furnished in strict accordance with existing governing health regulations.

2. Refer to the Agreement, Paragraph VIII.D. The Contractor shall protect pipes from freezing during inclement weather and repair any vandalism.

B. Sanitary Facilities:

1. Refer to the Agreement, Paragraph VIII.D.

2. The Contractor is prohibited from using existing toilet facilities, either those intended for SEPTA personnel or those intended for the general public at large.

3. The Contractor shall furnish for the work force on this Project, the necessary toilets, secluded from general public observation. The toilets shall be kept in a clean, sanitary condition and shall comply with the requirements and regulations of the agencies having jurisdiction. The SEPTA Project Manager must approve all toilet locations and may demand increased maintenance if the SEPTA Project Manager finds the level of maintenance unacceptable.

C. Power and Lighting:

1. The Contractor shall provide, maintain, and pay for all costs of temporary electrical and lighting services required at the job site for the proper performance and inspection of work. The level of lighting shall not be less than the existing. Lighting shall also be provided to all temporary general public facilities at levels satisfactory to the SEPTA Project Manager. Remove services and lighting after completion of work and repair of all damages.

2. The Contractor shall provide area distribution boxes so located that the individual trades may furnish and use 100 feet maximum length extension cords to obtain power and lighting at points where needed for work, inspection and safety.

3. The Contractor shall provide all necessary items such as circuit breakers, transformers, panelboards and cable required for the service. The Contractor shall provide a complete distribution system expanded as required during the construction including wiring devices, outlets, distribution panels, transformers, cable, and other related work necessary to provide a temporary power system for use during construction.

4. The Contractor shall pay all costs associated with the utility tie-ins, physical plant, maintenance of system throughout construction, removal of same at Project completion and any other items necessary in providing temporary power and light.

5. The temporary power and lighting system shall at all times conform to the applicable codes and regulations of OSHA, NEMA, UL and the local municipality.

D. Telephones:

1. The Contractor shall make necessary arrangements and pay costs for installation, maintenance, and operation of direct line; non-pay type; telephone services in SEPTA's field office at the job site. Portable; cellular; may be provided to fulfill this requirement at the SEPTA Project Manager's discretion.

E. Heating:

1. The Contractor shall provide and maintain heat necessary for proper conduct of operations.

2. The Contractor shall provide electric power to the heaters in the control cabinets of the electrical power equipment; including traction power; to prevent condensation during storage.

F. The Contractor shall engage and employ an experienced exterminator to provide monthly treatment until the Project closeout to rid the job site; within the Contract limits; of rodents, insects, and other pests.

G. The Contractor shall remove any graffiti found within the Contract limits immediately upon discovery and/or notification from the SEPTA Project Manager or their designee.

1.06 Access, Storage and Parking Areas

A. The Contractor shall establish a construction compound in which the Contractor provided SEPTA office trailers will be located adjacent to the Contractor's office trailers. The physical location of the compound will require written approval of SEPTA's Project Manager.

B. The Contractor shall provide a minimum of three (3) parking spaces adjacent to the SEPTA trailers within the compound for SEPTA vehicles.

C. The Contractor shall provide all necessary security for this compound area. The Contractor shall provide all necessary keys to the SEPTA Project Manager so as to provide access to the compound at any time.

D. The Contractor shall submit to the SEPTA Project Manager a plan layout of the compound within ten (10) working days after Notice to Proceed (NTP).

E. The Contractor shall coordinate the provisions of utility services for all trailers and be responsible for all installation charges, removal costs at Project completion, and any periodic or other charges incidental to the provision of those utility services.

F. Upon final acceptance of the work, the Contractor shall clean up the work areas and leave them in a neat and orderly condition. The Contractor shall dismantle and remove all temporary fencing and barricades and other temporary items installed, unless otherwise directed by the SEPTA Project Manager. Repair damaged areas to their original condition.

1.07 Field Offices and Sheds

A. Contractor's Field Office:

1. The Contractor shall furnish and maintain a field office with a telephone at the job site during the entire period of construction. The Contractor's Superintendent shall be present at said office at all times while its work is in progress. Keep readily accessible, at the field office, copies of both the Contract Documents and the latest approved shop and working drawings.
2. Submit for SEPTA's written acceptance, working drawings showing proposed locations and size of offices and shops.

B. Field Office Security:

1. The Contractor shall guard against unauthorized or illegal entry and protect the field office against vandalism, theft and mischief. The Contractor shall be responsible for the replacement and/or compensation for any items owned by SEPTA or SEPTA employees, which are related to the subject work, which are removed or damaged as the result of vandalism, theft, mischief, or illegal entry to the field office.

C. Upon Protect completion, the Contractor shall assume ownership of and remove temporary field offices and appurtenances from the job site, except as otherwise noted.

1.08 Temporary Barricades, Enclosures and Fencing

A. The Contractor shall provide all temporary barricades required by the staging plans or otherwise necessary for the safe execution of the Project, including but not limited to temporary barricades for designated Contractor work areas, Contractor laydown areas, and general public access for areas that must remain open during a stage.

1. Where temporary barricades are required outside a designated work area for the exclusive use of the Contractor, the Contractor shall provide them.
2. SEPTA reserves the right to require the Contractor to provide all necessary temporary barricades to ensure the safety of SEPTA personnel and passengers as determined by the SEPTA Project Manager, whose decision shall be final.

B. The Contractor shall submit drawings of the proposed temporary barricades for SEPTA’s review. Do not install temporary barricades until the drawings for them have been reviewed by SEPTA. All temporary barricades in confined spaces, as determined by the SEPTA Project Manager, must be constructed to not contribute smoke to or support flame spread of a fire. To achieve this, such temporary barricades shall be built of metal studs and Wonderboard style cement board.

OR

C. The temporary barricades shall be of a design as shown on the drawings.

1. Temporary barricades shall enclose and prevent entry into the work area and shall be full height and dustproof.
2. Temporary barricades shall be constructed of materials suitable for the location.
    a. At open locations in unconfined spaces, wood construction shall conform to the AFPA “National Design Specification for Wood Construction”, the latest edition. As a minimum, the temporary barricades shall be constructed of 5/8 inch thick APA rated exterior grade plywood. Framing members shall be Spruce-Pine-Fir No.2 or better, a minimum of 2 inches by 4 inches and larger sizes as necessary, spaced at a maximum 16 inches on center to provide a rigid temporary structure to resist all applicable loads.

b. All temporary barricades in confined spaces, as determined by the SEPTA Project Manager, must be constructed to not contribute smoke to or support flame spread of a fire. To achieve this, such temporary barricades shall be built of metal studs and Wonderboard style cement board.

3. Temporary barricades shall be painted on all solid surfaces exposed to the general public view.

4. Traffic cones, tape, stakes, and ribbons or other insubstantial items shall not be used to differentiate construction areas in lieu of temporary barricades. At the SEPTA Project Manager's sole discretion, the SEPTA Project Manager may make exceptions for work of extremely short duration.

D. Temporary Doors:

1. The temporary barricades shall have a reasonable number of temporary hollow metal doors and frames, with locksets, at locations acceptable to SEPTA. The locksets on the temporary doors requiring SEPTA access for operational and safety reasons shall be keyed to SEPTA's Standard Lock System.

E. On a daily basis, the Contractor shall maintain the temporary barricades in a "like new" condition. The Contractor shall remove graffiti and restore surfaces on a continual maintenance basis. Maintenance shall continue until the temporary barricades are removed.

F. The Contractor is required to enclose areas required by SEPTA for access and maintenance. If these areas are in public areas, they shall be secured with temporary barricades and doors in accordance with Articles 1.08/C and 1.08/D in this Section. The Contractor shall take all means to alleviate any or all tripping and falling hazards both within the job site but also in public areas. Areas where the general public or passengers may fall shall be secured and covered.

1.09 Temporary Signage (Construction)

A. The Contractor must provide an adequate number of signs to direct the general public around the construction site, as determined by the SEPTA Project Manager. These signs must be professionally fabricated and maintained/replaced to keep an "like new" appearance.

B. The Contractor must install Project identification signs as defined in Section 01580. These signs must be professionally fabricated and maintained/replaced to keep an "like new" appearance.

1.10 Protection of New Work

A. The Contractor shall take all necessary precautions to protect new work, whether executed by the Contractor or others. All damage which does occur shall be repaired to the satisfaction of the SEPTA Project Manager at no cost to SEPTA.

B. The Contractor must avoid damaging all property and facilities not included in the Project scope. All damage which does occur shall be repaired to the satisfaction of the SEPTA Project Manager at no cost to SEPTA. If non-SEPTA property is damaged it must be repaired to the written satisfaction of the property owner and at no cost to SEPTA.

1.11 Dust Control

A. The Contractor shall take all necessary precautions to eliminate dust and dirt created during the construction process from entering non-Project areas and those areas not owned by SEPTA. The Contractor shall be responsible for cleaning affected areas and restoring them to their preconstruction condition to the satisfaction of the property owner and at no cost to SEPTA.

1.12 Security

A. The Contractor shall provide adequate security measures to protect material, equipment, and work from all incidental and intentional damage or theft at Project job site locations, staging areas, and fabrication yards.

B. The use of guard dogs and the possession of firearms on SEPTA property are prohibited.

C. The Contractor shall be responsible for supplying the following security measures:

   a. Exterior lighting of 20 to 30 lux within the yard areas.

   b. 8 foot high chain link fence enclosure with gate(s) so the yard areas may be fully secured during non-work periods. Chain link fence fabric to have openings no greater than 2 1/2 inches.

D. The Contractor shall submit to the SEPTA Project Manager a plan layout of the security measures within ten (10) working days after Notice to Proceed (NTP). This information may be included in the compound plan required by Article 1.06/D in the Section.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01505

MOBILIZATION AND DEMOBILIZATION

PART 1 - GENERAL

1.01 Description

A. This Section specifies the mobilization of the construction plant and equipment at the job site; for materials and supplies necessary for the prosecution of the work; but not to be incorporated in the work; for construction of temporary facilities; for work preparatory to commencing the work and for demobilization of the construction plant.

B. Access to the job site shall be arranged by the Contractor by coordination with SEPTA.

1.02 Related Sections

A. Section 01580 – Project Identification Signs

B. Section 01700 – Contract Closeout

C. Section 01710 – Final Cleaning

1.03 Submittals

A. Submit within sixty (60) days after the Notice to Proceed (NTP), a layout of the proposed construction site including fences, roads, buildings, trailers, and storage areas. If non-SEPTA property is to be utilized, submit a proposal, and obtain tentative approval for this arrangement before committing to any lease arrangements or other agreements for the use of this land.

PART 2 - PRODUCTS

2.01 Plant and Equipment

A. Construction plant and equipment shall be of the capacity, type, quality, function and in the quantity necessary for the timely prosecution of the work.

PART 3 - EXECUTION

3.01 General

A. Construction plant, equipment, materials, supplies, temporary buildings, facilities, and other items necessary for mobilization shall be available at the job site at the times they are to be built, used, installed, or operated.

B. Construction plant location shall be approved by SEPTA and shall be appropriately close to the portion of the work for which it will be used. The construction plant, including equipment and personnel, shall have sufficient capacity, in the opinion of the SEPTA Project Manager, to permit a rate of progress which will ensure completion of the work within the Contract time required by the Agreement and shall also have sufficient excess capacity for emergencies and overloading. The SEPTA Project Manager shall have the right to reject

construction plants and apparatus which, are in the SEPTA Project Manager's opinion, unsafe, improper, or inadequate. Rejected construction plants and apparatus shall be brought to acceptable condition or shall be removed from the job site by the Contractor.

3.02 Demobilization

A. Upon completion of the work, the Contractor shall remove construction plant, equipment, materials, supplies, temporary building, facilities, and other items that were necessary for mobilization. The Contractor shall return the area allocated for the construction plant to its condition prior to the start of the work.

END OF SECTION

SECTION 01510

MAINTENANCE, SUPPORT AND RESTORATION OF EXISTING UTILITY FACILITIES

PART 1 - GENERAL

1.01 Description

A. This Section specifies the coordination, maintenance, support, protection and restoration requirements of existing public and private utilities affected by construction.

B. Existing Utility Facilities:

1. Existing utility facilities include, but are not limited to the following:
   a. PECO medium voltage services.
   b. Water utility lines.
   c. Building drainage lines.
   d. Street catch basins and drainage lines.
   e. Communications utility lines.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01060 – Regulatory Requirements and Safety

C. Section 01100 – Special Project Procedures

D. Section 01300 – Submittals

E. Section 02070 – Selective Demolition

F. Section 02220 – Excavation, Backfill and Compaction

1.03 Submittals

A. Shop Drawings and Working Drawings:

1. The Contractor shall submit working and shop drawings indicating the Contractor's plan and schedule for performance of work to the appropriate utility company for review and approval. A copy of this submittal shall be furnished to SEPTA in accordance with the requirements of Section 01300, by the Contractor.

2. The Contractor’s work drawings shall detail the actual location of existing facilities, including aerial interference which these facilities present to new work, as well as proposed method of proceeding with actual construction and details of proposed support systems.

3. Do not commence work until written approval has been received from the affected utilities and the SEPTA Project Manager.

B. Documentation:

1. Notice of Commencement of Work:

a. The Contractor shall provide to the utility five (5) days' notice, or as otherwise required by the affected utilities, prior to date of intended commencement of operations to parties having surface, subsurface or overhead structures in the construction area.
b. The Contractor shall comply with the provisions of 73 P.S. 176 et seq., which sets forth PA's "One Call System".
c. Provide copies of notices to the SEPTA Project Manager.

1.04 Quality Assurance

A. Comply with the applicable codes, regulations, reference standards and specifications.

1.05 Delivery, Storage and Handling

A. Coordinate with the specified utility companies who are furnishing materials for the work to determine availability, locations and required methods of storage and care of materials prior to incorporation into the work.

B. Transport, store, and handle materials in accordance with the requirements of the utilities.

1.06 Job Conditions

A. Location of Facilities:

1. Prior to the start of any work, contact the PA One Call System in order to provide for locating and marking underground facilities.

2. Locations of existing facilities shown are plotted from available records; however, these locations are not guaranteed.

3. Verify locations of facilities by field investigation within and adjacent to limits of the Project which may be affected by construction operations. Avoid damage or disruption of facilities during operation.

4. Upon encountering an existing facility, which is not shown, or upon ascertaining that a facility differs from that shown, determine ownership, use, and disposition of such facility and proceed as follows:
   a. If the facility is abandoned or is to be abandoned, perform necessary work for either condition as shown or specified.
   b. If facility is to remain in service, perform support and restoration work in accordance with these Specifications.

B. Coordination with the affected utility owners.

C. Responsibilities of the Contractor:

1. Maintain and protect facilities.

2. Give notice of commencement of work as specified.

3. Notify the SEPTA Project Manager and the utility of damage to facilities caused by construction operations. Repair or reimbursement for repair of such damage is the responsibility of the Contractor. Damaged electrical cables will be repaired or replaced as determined by the utility with all costs borne by the Contractor.

4. Provide access for inspection of facilities and for emergencies involving utility services.

5. Permit free and clear access to utility personnel for purposes of inspection, maintenance, providing additional service and construction of new facilities, if required.
6. When approved working drawing or shop drawings show a temporary facility provided for the Contractor's benefit, the Contractor shall supply necessary materials and perform this work, at no cost to SEPTA.
7. The Contractor is responsible for direct payment to the utility for work accomplished by the utility at the request of the Contractor for the Contractor’s convenience or for preferred means and methods of the Contractor.

PART 2 - PRODUCTS

2.01 Material

A. Backfill in accordance with Section 02220.

PART 3 - EXECUTION

3.01 General

A. The Contractor shall maintain complete in-place continuity of all utility services and provide proper support and protect utility facilities in accordance with the specifications of the utility affected.

B. Support facilities so as not to expose them to undo vibrations. Support and maintenance of these facilities will be subject to inspection by the utility.

C. Repair or replace public utilities damaged during construction at no cost to SEPTA, to the satisfaction of the utility.

D. Assume the cost for repair or replacement of private utilities damaged during construction, which will be repaired or replaced, by the private utility.

E. Conform to the specifications and standard practices of the affected utility owners. Coordinate with utility owners, which work, shall be done by Contractor and which work shall be done by the utility owner.

F. Provide, install, and maintain all temporary facilities required to provide interim utility service when a utility facility is to be relocated and when a utility facility to be replaced is abandoned prior to replacement.

3.02 Excavation and Backfilling of Utility Trenches

A. Excavate and backfill utility trenches in accordance with Section 02220 and with the requirements of the affected utility.

B. Proceed with caution in areas of utility facilities; expose them by hand excavation or other methods acceptable to facility owner.

3.03 Pavement, Sidewalks, Curbs, Gutters and Other Features

A. Remove pavement, sidewalks, curbs, gutters and other existing features where necessitated by utility trenches and those which interfere with the successful completion of the required

work and may be directed to be removed by the SEPTA Project Manager in accordance with other Sections of these Specifications.

B. Replace pavements, sidewalks, curbs, gutters, and other existing features, required to be replaced or directed to be replaced by the SEPTA Project Manager in accordance with other Sections of these Specifications.

C. Place temporary pavement where necessitated by sequence of operation.

3.04 Unsafe and Unsuitable Utility Structures

A. General Requirements:

1. If, upon exposure, condition, or location of facility to be supported in place is found to be unsafe for maintenance or support, contact utility for repair or reconstruction procedures.

B. Electric, Communication and Similar Type Facilities:

1. If structures containing electrical, communication and similar types of cables shown to be maintained complete in place are found upon exposure to be incapable of being maintained in place because of condition, location, or both, contact utility for repair or reconstruction procedures.

2. When service box, manhole or conduit structure containing electrical or communication cables is broken away, contact utility for repair or replacement procedures.

3. Exercise care when working in vicinity of telephone structures containing coaxial cable or fiber optic cable which cannot withstand movement.

END OF SECTION

SECTION 01570

MAINTENANCE AND PROTECTION OF VEHICLES, PEDESTRIANS AND PASSENGERS

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of furnishing, installing, maintaining, and subsequently removing temporary traffic control devices, and temporary traffic striping and markings; furnishing flagmen and police protection, as required by the City of Philadelphia. If the work does require flagging and affects a state highway, the flagman must receive state training and approval. The work also includes controlling, warning, guiding, and protecting vehicles and pedestrian traffic on streets and sidewalks affected by construction of the Project, and adjacent to job site; maintenance and control of SEPTA passengers on, or adjacent to, the job site, ensuring unimpeded access to buildings and/or SEPTA facilities adjacent to the job site; and the closing of streets and sidewalks.

B. The Contractor shall prepare working drawings showing proposed traffic control devices and shall apply to the City of Philadelphia for any permits necessary to work in the public right of way. Any proposed changes to the indicated vehicle traffic control plan shall be shown on working drawings prepared by the Contractor and shall be submitted to the City of Philadelphia for approval. A copy of the revised and approved working drawings shall be transmitted to the SEPTA Project Manager.

C. The Contractor's passenger control plan can be submitted with the work plan; refer to Section 01010; and Site Specific Work Plan (SSWP), if applicable. Any proposed changes to passenger control plan shall be shown on working drawings prepared by the Contractor and shall be submitted to the SEPTA Project Manager for SEPTA’s review.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01060 – Regulatory Requirements and Safety

C. Section 01300 – Submittals

D. Section 01500 – Construction Facilities and Temporary Controls

1.03 Submittals

A. The Contractor shall submit a Traffic Control Plan (TCP) to PennDOT and the City of Philadelphia for approval; also provide a copy to the SEPTA Project Manager; before starting work. Submit an updated TCP every time it becomes necessary to modify traffic operation or undertake construction in accordance with the requirements of PennDOT Publication No. 203, "Work Zone Traffic Control". The TCP shall show and describe proposed locations and time durations of the following:

1. Pedestrian and public vehicular traffic routing.

2. Traffic blockage and lane reductions anticipated to be caused by construction operations.

3. Allowable on-street parking within immediate vicinity of job site.
4. Access to buildings immediately adjacent to job site.
5. Driveways which will, and those which will not, be blocked by construction operations.
6. Temporary traffic control devices required on streets and sidewalks affected by construction.
7. Temporary commercial and industrial loading and unloading zones.
8. Police Traffic Protection:
    a. Type, circumstances, and requirement are to be defined.

B. The Contractor shall submit a passenger or pedestrian control plan. All passenger control signage shall be submitted to SEPTA for review prior to fabrication.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Commonwealth of Pennsylvania, Department of Transportation, PennDOT Standard Specifications, Publication 211.
2. Commonwealth of Pennsylvania, Department of Transportation, PennDOT Standard Specifications, Publication 203, "Work Zone Traffic Control".
3. Commonwealth of Pennsylvania, Department of Transportation, PennDOT Standard Specifications, Publication 408.

B. A color proof of all graphics must be reviewed by SEPTA prior to fabrication and use.

1.05 Job Conditions

A. At various times during the construction period, as defined in Article 1.03/A/8 in this Section and/or as required by the day to day work; the Contractor shall be required to provide uniformed police officers to maintain traffic control within the construction area. The Contractor shall include the costs for all police traffic protection activities associated with the work in the price as bid for the work. No extra costs will be considered for police protection during the work of this Contract. The Contractor shall enter into an agreement with the City of Philadelphia to be directly reimbursed for furnishing the required police protection.

PART 2 - PRODUCTS

2.01 Temporary Traffic Control Devices

A. The Contractor shall conform to the latest Regulations for Official Traffic Control Devices, 67 PA Code, Chapter 203; 67 PA Code, Chapter 211; and, if required, as follows:

1. PennDOT Pub. 408, Section 627.2, Temporary Concrete Barrier.
2. PennDOT Pub. 408, Section 962.2, Painting Traffic Lines and Markings.

B. Warning Lights and Flares:

1. Capable of alerting approaching traffic to hazards, unsafe conditions, and variances to normal traffic patterns.

C. High Rise Warning Flag Unit:

1. Have three (3) flags mounted nine feet above the base.

2.02 Flagmen Sign

A. 24 inches, octagonal, and attached to a 5 foot handle. One side of sign shall be a stop sign, and the other side of the sign shall be a slow sign.

B. Stop sign shall have white reflectorized letters, not shorter than eight inches, spelling "STOP" on a reflectorized, red, octagonal background.

C. Slow sign shall have black letters, not shorter than 8 inches, spelling "SLOW" on a reflectorized, orange, diamond background. The area between diamond and edge of flagmen sign shall be black.

2.03 Station Control Devices

A. All signs shall be of commercial quality and shall conform to SEPTA's graphic design standards. Submit all signs for review by SEPTA at least ten (10) working days in advance of any work that will disrupt pedestrian movement, disrupt transit operations, or necessitate closing of stairways, entrances, etc. Do not perform the work until the signs are in place.

PART 3 - EXECUTION

3.01 Traffic Control Devices and Detours

A. The Contractor shall provide provide traffic control devices and street detours per the recommendations of the City of Philadelphia.

3.02 Flagmen/Police Protection

A. The Contractor shall provide flagmen and/or police protection as required for street detours or closings.

3.03 Controlling Vehicular, Pedestrian Access and Flow Adjacent to Job Site and/or Station

A. Fabricate and install passenger control signage and other devices according to the approved passenger control plan.

B. Maintain each sign throughout the Project in a "like new" condition, free of all unrelated signs, posters, painting, advertising, and defacement of any kind. Replace signs as necessary to maintain them in the "like new" conditions.

C. Remove all signs from the site and repair damages when the temporary condition no longer is necessary or within ten (10) days of notice from SEPTA.

3.04 Street Closings

A. The Contractor shall close streets based on the working drawings, only after the street closings have been approved by the City of Philadelphia.

3.05 Removal of Devices

A. The Contractor shall remove all traffic control devices at the completion of each stage of work and/or at the end of the Project.

END OF SECTION

SECTION 01580

PROJECT IDENTIFICATION SIGNS

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of furnishing and installing Project identification signs and temporary construction signs as described below and required by the Contract Documents.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01500 – Construction Facilities and Temporary Controls

C. Section 01570 – Maintenance and Protection of Vehicles, Pedestrians and Passengers

D. Attachment – SEPTA Starburst Sign

E. Attachment – COVID-19 Safety Sign

1.03 Submittals

A. In accordance with Section 01300, submit the following:

1. Shop drawings of each sign scheduled to be utilized during construction. Indicate materials, size, location, fonts, and colors proposed for use.

2. After consultation with the SEPTA Project Manager, submit the following sign information for review and approval by SEPTA:

   a. Sketch and narrative description identifying the location, orientation, and mounting height of each sign.

   b. Total quantity of each sign to be utilized.

   c. Name, address, telephone number and key contact person of the company responsible for the fabrication of the sign.

3. Hardware and mounting details for erection of each sign.

1.04 Job Conditions

A. Signs shall be commercial quality and proofs shall be approved by SEPTA prior to fabrication.

1. Install Project identification signs within forty-five (45) calendar days after the Notice to Proceed (NTP).

2. The "NO TRESPASSING" sign shall be installed within the Contractor's Project compound and other areas to be determined by the SEPTA Project Manager.

3. The "COVID-19" sign shall be installed in areas to be determined by the SEPTA Project Manager. SEPTA's graphics department will provide an electronic copy.

B. Non-Project Signs:

1. Non-Project signs, such as business advertisements or labor union notices may be permitted subject to review by the SEPTA Project Manager whose direction will be final.

PART 2 - PRODUCTS

2.01 Project Identification Sign Material

A. Sign Material:

1. Cut sign base from a single 4 foot by 8 foot by 3/4 inch thick, waterproof exterior, A-B grade plywood with a smooth, finished surface. Round edges to a 1/8 inch radius. Joints will not be permitted.

B. Mounting Material:

1. General:
   a. Provide mounting frames and hardware of such quality to be able to support the sign under all weather conditions for the duration of the Project.
      1) Unless surface mounted, support signs with frames constructed with painted pressure treated dimension lumber, or other approved non-conductive material, of sufficient size to brace against weather conditions.
      2) Secure surface mounted signs using anchoring devices approved by SEPTA.
2. Hardware:
   a. Galvanized screws or bolts with galvanized nuts and washers.
   b. Paint all hardware, visible in the finished assembly, to match the adjoining surface of the sign or mounting.
3. Posts:
   a. Pressure treated dimensional lumber or other non-conductive material acceptable to SEPTA.

C. Paint:

1. Paint sign surfaces, posts, and mounting frames with one (1) coat of primer sealer and two (2) coats of white semi-gloss enamel on all sides and edges.
2. Use paint manufactured for exterior use by a manufacturer acceptable to SEPTA.

D. Acceptable Fabricator:

1. A company specializing in and having documented experience in the fabrication of graphic signs. Submit the fabricator's credentials to the SEPTA Project Manager for approval before any fabrication.

E. SEPTA Project Sign:

1. Provide three (3) SEPTA Project signs. Sample SEPTA Project sign is shown on "Sketch # SEPTA-1" attached at the end of this Section.
2. Size to be 4 feet by 6 feet.
3. SEPTA will provide the Contractor with a proof copy of the information to be displayed on the SEPTA Project sign at the pre-construction meeting.
4. Obtain the services of a graphic sign company to transfer the information contained on the SEPTA provided computer disk onto 0.1 mm pressure sensitive vinyl with weather-

all fluorinated polyurethane coating or approved equal film. The vinyl shall be mounted onto the sign surface.

5. Do not include information on the SEPTA Project signs except that contained on the computer disk provided by SEPTA.

6. The Contractor is responsible for advising the SEPTA Project Manager of any problems that occur during the production of the SEPTA Project sign.

2.02 Temporary Signs

A. Temporary signs are considered to be any sign not included in Article 2.01 in this Section that are required to be erected during the construction stage of the Project and removed at the completion of the construction stage of the Project. These signs include, but are not limited to, pedestrian wayfinding signs, field office signs, and safety and instructional signs for workers and visitors. This Section does not include signs utilized and required for the purpose of identifying public street traffic closures and/or detours.

B. Pedestrian Wayfinding Signs:

1. Each sign not to exceed 750 square inches unless specifically required by the SEPTA Project Manager.

2. Signs shall be black Helvetica bold letters on white background with key information in red.

3. If vandalized, signs must be replaced at no cost to SEPTA.

4. All signs must meet accessibility guidelines.

5. Total sign count not to exceed five (5) signs per stage.

6. If in satisfactory condition, signs may be reused stage to stage with approval of the SEPTA Project Manager.

C. Field Office Signs:

1. Size to be 4 feet high by 5 feet wide.

2. Letter with black enamel paint using block letters at least 4 inches high, with the Contract name. Contract number and the words “CONTRACTOR’S FIELD OFFICE” or “SEPTA’S FIELD OFFICE” as appropriate with each word painted on a separate line.

D. Where the field offices to be identified are not readily visible from the job site entrance, paint a directional arrow on the sign and locate the sign near the entrance. In this case, provide additional signs of reduced size with the words “CONTRACTOR’S FIELD OFFICE” or “SEPTA’S FIELD OFFICE” as necessary to direct traffic to, and identify the field office location(s).No Trespassing Sign:

1. Sign base will be white baked enamel aluminum, 12 inches wide, 18 inches high and 0.062 inches thick. Additional prints of two (2) colors will be used; fire red and black. 1 inch border on the top and both sides and 1/2 inch border on the bottom.

2. Sign Information:

a. 1 inch down from the top is a 10 inch wide by 2.75 inch high fire red block with reversed out white copy at 1.5 inch Helvetica. Med. Acct. A. K. Rev. M to read “**WARNING”** centered in caps.

b. 5 inches down from the top is the baseline for 0.75 inch Helvetica Med. Acct. A. K. Rev. M, black copy to read "**NO TRESPASSING**" centered in caps.

c. 8.75 inches down from top is the center of a 6 inch fire red outlined circle 0.5 inches thick with a diagonal 45 degree slash from the upper left to the lower right of the circle. Behind the circle and slash is a 4.5 inch pictograph of a walking pedestrian.

d. 13 inches down from the top is the baseline for 0.75 inch Helvetica Med. Acct. A. K. Rev. M, in black copy to read "**AUTHORIZED"** centered in caps.

e. 14.125 inches down from the top is the baseline for 0.75 inch Helvetica Med. Acct. A. K. Rev. M, in black copy to read "**PERSONNEL ONLY"** centered in caps.

f. 16.5 inches down from the top is the baseline for 0.375 inch Helvetica Med. Acct. A. K. Rev. M, broken down in four (4) lines of black copy to read

"All Others Will Be Prosecuted In
Accordance with the Penalties Provided
In Section 3503 of the Pennsylvania
Crimes Code"

Centered with initial caps.

g. 17.5 inches down from the top, flush right, is the base line for 0.5 inch SEPTA logo in black.

3. Fasteners are not incorporated in the sign. The Contractor can drill holes in the signs to mount them on fencing, walls and barricades not to obstruct the message of the sign.

PART 3 - EXECUTION

3.01 Inspection

A. Prior to erection, examine all signs to verify that the size, material and wording is in accordance with the approved shop drawings.

B. Examine areas and conditions under which the signs are to be located. Prior to erection, notify the SEPTA Project Manager of any conditions that may differ from the information identified on the sign submission.

3.02 Installation

A. Install signs in accordance with approved shop drawings and as directed by the SEPTA Project Manager. Support all non-surface mounted signs on a minimum of two (2) posts, anchored into the ground at a depth sufficient to provide rigid support of the sign during all weather conditions.

B. Provide Project signs and SEPTA's field office signs at places designated by SEPTA.

C. No trespassing signs shall be posted on every side at 40 foot spacing on all temporary fences and walls, barricades and compound fencing.

D. Temporary Signs, if required:

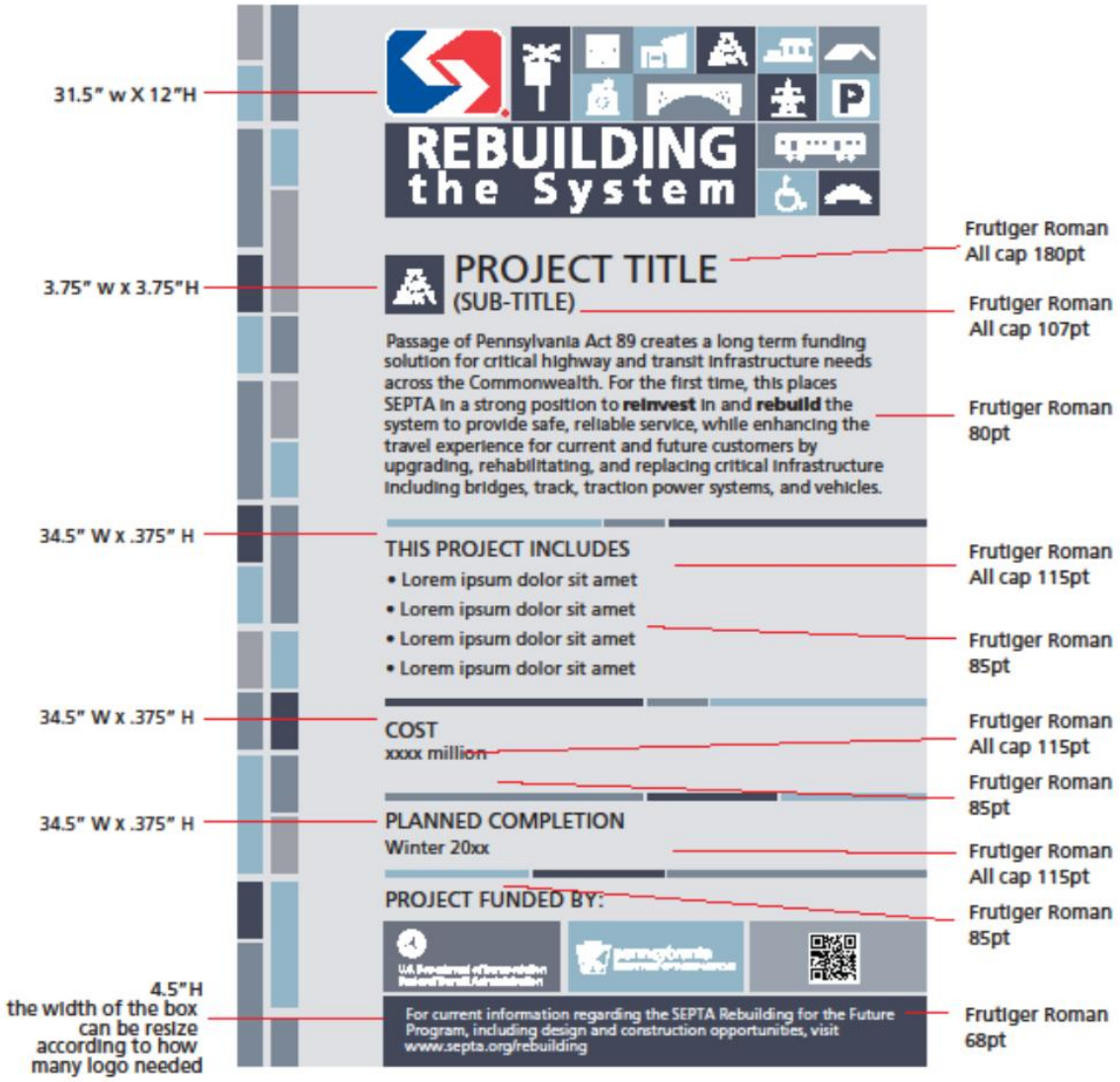
1. Field Office Signs:
   a. Provide one (1) sign for the Contractor's field office to indicate the Contractor's location.
2. Provide and install other temporary signs deemed necessary for the Project by SEPTA.

E. Sign Maintenance:

1. Maintain all signs throughout the course of construction from installation until Contract completion, keeping them clean, free from graffiti, in good repair and free of obstruction. Provide and maintain adequate protection against weather so as to preserve all work, materials, equipment, apparatus, and fixtures free from injury or damage. Maintain all signs free of all unrelated signs, posters, painting, advertising, and defacement of any kind. Within five (5) days of notice, the Contractor shall clean, repair, or replace signs as necessary to maintain them in a "like-new" condition.

F. Within five (5) days of final acceptance of the Project by SEPTA, remove and dispose of all Project identification and temporary signs. If any signs have disfigured a surface which is to become part of the final work, repair or replace the surface to the SEPTA Project Manager's satisfaction. All costs for the removal and disposal of signs shall be borne by the Contractor.

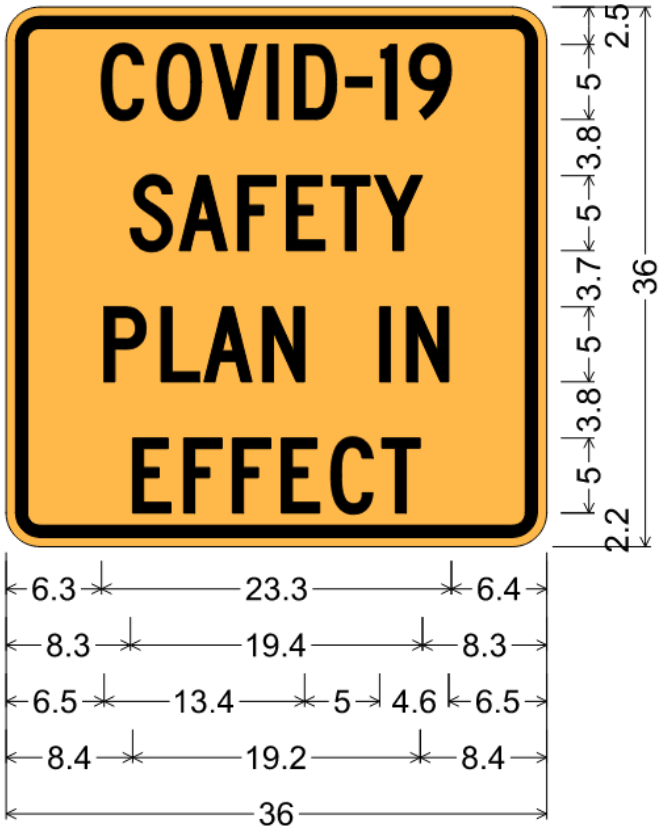
Sketch # SEPTA-1 SEPTA Starburst Sign



Spec Sheet for Rebuilding the System project

- Document is prepared in Adobe Illustrator and provided as a PDF file
- Fonts: Frutiger
- Colors: Logo - PMS 8605, PMS 8201, PMS 8180
  Background - PMS 8180 25% Opacity, Footer - PMS 8180 75% Opacity
  Graphic pattern - PMS 8605, PMS 8201, PMS 8180
  Text: black
- This document is prepared as 11% of the original size 48" x 72"
- All point sizes are specified at 48" x 72" scale

SKETCH # SEPTA-2 COVID-19 SAFETY SIGN



2.3" Radius, 0.8" Border, 0.6" Indent, Black on, Fluorescent orange;
"COVID-19", C 2K;
"SAFETY", C 2K; "PLAN", C 2K;
"IN", C 2K; "EFFECT", C 2K;
Table of widths and spaces

6.3	C 2.8	0.9	O 3.0	0.6	V 3.1	0.7	I 0.7	1.1	D 2.8	0.6	- 1.7	0.6	I 1.1	0.8	9 2.8	6.4

8.3	S 2.8	0.4	A 3.2	0.7	F 2.6	0.7	E 2.5	0.5	T 2.5	0.3	Y 3.2	8.3

6.5	P 2.8	1.0	L 2.6	0.3	A 3.2	0.7	N 2.8

5.0	I 0.7	1.1	N 2.8	6.5

8.4	E 2.6	0.8	F 2.6	0.7	F 2.5	0.7	E 2.6	0.7	C 2.8	0.6	T 2.6	8.4

SECTION 01590

SEPTA FIELD OFFICE

PART 1 - GENERAL

1.01 Description

A. At a location acceptable to the SEPTA Project Manager and within thirty (30) days after receipt of Notice to Proceed (NTP); the Contractor shall provide and maintain until completion of the work a temporary field office for the occupancy and use of SEPTA and its employees and equipped as specified in this Section. If space limitations preclude the establishment of a field office compound, the Contractor may negotiate the use of space within the substation with the Project Manager if space is available and will have no impact on SEPTA operations. At the completion of the work the Contractor shall provide for the removal of all office equipment located inside each TPSS.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01300 – Submittals

C. Section 01500 – Construction Facilities and Temporary Controls

1.03 Submittals

A. In accordance with Section 01300, submit within thirty (30) days after receipt of Notice to Proceed (NTP) a plan detailing SEPTA's office and associated appurtenances including a bill of materials of all required office equipment and supplies for the review of the SEPTA Project Manager.

PART 2 - PRODUCTS

2.01 Standard Equipment

A. Furnish the SEPTA field office with the following like new or new equipment and furniture as indicated below. Maintain this equipment in good operating condition until all punch list corrective work is completed and accepted by SEPTA.

B. Furniture:

1. One (1) double kneehole desk; one (1) 60 inches by 30 inches and one (1) 48 inches by 40 inches; with file drawer and three (3) drawers, all lockable, and with swivel 5-star base armchair for each desk.

2. One (1) new hanging storage rack on casters with 24 inch wide binders; total of thirty (30); similar to Bruning Superfile rolling stands with channel assemblies, catalog # 58-212-24001; Or Approved Equal.

3. One (1) drafting table; 60 inches by 36 inches; with drawer and stool.

4. Two (2) folding tables; 36 inches by 54 inches.

5. Ten (10) folding chairs.
6. One (1) file cabinet with four (4) drawers; legal size; lock and two (2) keys.
7. One (1) bookcase; 36 inches by 42 inches; with four (4) shelves.
8. One (1) white board with dry-erase markers.

C. Electronic Equipment:

1. One (1) new 19 inch laptop computer with the following minimum specifications:
   a. Intel Core 2 Duo T7300, 3.0 GHz processor or faster, Wi-Fi capability included; Wi-Fi ready that includes a wireless router and high speed modem, connected via a CAT5 Ethernet cable and a PC card installed in the laptop computer; 4 GB memory or more, 16 GB maximum memory capability, Microsoft Windows 10, 4 GB RAM, 128 MB video card, 500 GB minimum hard drive, complete with 8X HD DVD-R/DVD + RW/DVD-RAM/DVD + R DL, 800 MHz front side bus speed, nVidia GeForce 8600M GT video hardware, 512 MB dedicated, 767 MB total available video memory, lithium-ion battery, one (1) FireWire port, 19 in one media/smart card reader; or separate USB card reader; Microsoft Office 2010 Small Business, firewall, antivirus and internet security suite. Confirm specific configuration with SEPTA prior to purchase. Extended keyboard with extended keypad and mouse, speakers, 1 GB Ethernet LAN adapter, monitor stand for docking station. Add docking station and the ability to connect the laptop computer to multiple devices simultaneously using a single interface. The laptop computer must have a VGA port, HDMI port, parallel port, Serial port, PS/2(2) port, USB 2.0 (4 min.) port, RJ-11 port, and RJ-45 port. The laptop computer must be connected to the internet via 4G connectivity; minimum; or broadband internet service during all working hours via the 4G network card or other similar device. The Contractor shall pay all costs associated with the 4G connection service or other broadband internet service provider for the duration of the Project.
2. One (1) new color laser printer with minimum 600 by 1200 DPI resolution and twenty-seven (27) pages per minute and double sided printing capabilities, with network capabilities, scanning and additional 11 inch by 17 inch paper tray, 160 MB, 533 MHz processor.
3. One (1) new digital camera 13.0 megapixel resolution, 12x optical zoom, 5.7x digital zoom, 4 inch LCD, memory card xD card/micro xD card, minimum 1 GB. Second battery, charging adapter and case and USB connectivity.
4. One (1) new ten (10) cup automatic drip coffee machine with all necessary supplies.
5. One (1) new 10 cubic foot refrigerator.
6. One (1) new 2 cubic foot microwave.
7. One (1) new "smart" cell phone with AT&T; Or Approved Equal service. Device shall be able to make calls and send/receive emails and text messages. The Contractor to maintain and pay all costs associated with this item for the duration of the Project.

D. Office Supplies:

1. Continuous supply of 8.5 inch by 11 inch white paper.
2. Continuous supply of 11 inch by 17 inch white paper.
3. One box of blue, red, and black pens.
4. Ten (10) 8.5 inch by 11 inch ruled white tablets.

5. Ten (10) 8.5 inch by 11 inch graph paper tablets.
6. Two (2) boxes of hanging file folders.
7. Two (2) boxes of manila folders.
8. Ten (10) 2 inch, three (3) ring binders.
9. Two (2) staplers and tape dispensers; staples and tape.
10. One (1) heavy duty stapler with staples. Swingline Strongarm 113; Or Approved Equal.
11. One (1) electronically operated pencil sharpener.
12. One (1) three (3) hole punch.
13. One (1) two (2) hole punch.
14. Two (2) rolls of brown packing paper with heavy duty packing tape.
15. One (1) trash can.
16. One (1) recycling can.

E. Inspection supplies:

1. One (1) 12 inch hand level.
2. One (1) string level.
3. One (1) plumb bob with string and pouch.
4. One (1) box of keel; lumber crayons.
5. One (1) measuring wheel, as made by Rolatape; Or Approved Equal.
6. One (1) dry mil paint thickness gauge.
7. Two (2) concrete thermometers with portable data loggers, capable of taking and storing temperature readings for a period of two (2) weeks, LED on indicator, downloadable into computer via a Serial USB base station; LogTag, HoboproV2; Or Approved Equal.
8. Two (2) magnetic surface thermometers.
9. One (1) 100 foot fiberglass tape measure.
10. One (1) 25 foot tape measure.
11. Two (2) 5 foot folding stick rulers.
12. Macklanburg-Duncan #92379 24 inch SmartTool with module; Or Approved Equal.

F. Comfort Supplies:

1. One (1) paper cup dispenser and continuous supply of paper cups.
2. One (1) paper towel dispenser and continuous supply of paper towels.
3. Continuous supply of soap, hand sanitizer, and toilet paper.
4. One (1) water cooler unit with hot and cold spigots, refrigerated water. The Contractor to provide constant supply of water through the duration of the Project.

G. Safety Supplies:

1. Two (2) fire extinguishers, 5 pound ABC type.
2. Two (2) complete first aid kits.

H. All the above items shall be turned over to SEPTA permanently at the completion of the Project.

PART 3 - EXECUTION

3.01 Porta Potty

A. The Contractor shall provide a Porta Potty at each TPSS location.

3.02 Maintenance and Service

A. The Contractor shall provide continuous maintenance during the construction period including maintaining Porta Potty and provide toiletry supplies as necessary.

B. The Contractor shall repair or refinish damaged areas as required.

C. The Contractor shall provide supplies for the copying machine for an average usage of approximately five hundred (500) copies per month.

D. The Contractor shall repair or replace the copying machine, laser printer, and other related equipment within four-eight (48) hours of becoming inoperable or defective.

E. The Contractor shall keep the steps and walkways clear of snow and ice during all working hours of the Project.

3.03 Security

A. The Contractor shall guard against unauthorized or illegal entry and protect the Project site against vandalism, theft and mischief. The Contractor shall be responsible for the replacement and/or compensation for any item owned by SEPTA or its employees, which are related to the subject work, removed or damaged as the result of vandalism, theft, mischief or illegal entry to the Project site.

3.04 Removal

A. Upon Project completion the Contractor shall remove the equipment and furnishings from the job site at no additional cost to SEPTA.

END OF SECTION

SECTION 01600

MATERIALS AND EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Work of this Section includes:

1. Manufacturer's recommendations.
2. Fulfilling SEPTA sustainability goals and the reuse of materials.
3. Transportation and handling.
4. Storage and protection.
5. Repairs and replacements.
6. Product options.

B. Additional requirements for traction power equipment are included in Section 01612. In case of conflict the more stringent requirement shall prevail.

1.02 Related Sections

A. SEPTA Agreement.

B. Section 01010 – Summary of Work

C. Section 01060 – Regulatory Requirements and Safety

D. Section 01300 – Submittals

E. Section 01400 – Quality Requirements

F. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

1.03 Submittals

A. Refer to Section 01300 for submittal requirements.

1.04 Quality Assurance

A. The Contractor shall include in its Quality Assurance/Quality Control (QA/QC) program all procedures that are required to assure the proper handling, storage and installation of all materials and equipment.

B. The Contractor must identify the country of origin for all materials subject to source restrictions such as the "Buy America" requirements. Specifically stated relief, including acknowledgement of the country of origin, from these regulations must be obtained in writing before installation of any non-conforming material. Merely obtaining clearance for non-conforming material through the submittal process, even if the country of origin is stated, shall not be interpreted as providing this relief.

C. The Contractor shall turn over copies of all bills of lading, packing slips, labels, QA test results, and other information which establishes that materials delivered to the job site are

consistent with the requirements of the construction documents to the SPETA Project Manager.

D. The Contractor shall maintain on the job site a copy of storage and installation instructions and Safety Data Sheets (SDSs) for all materials being used in the Project.

1.05 Manufacturer's Recommendations

A. The Contractor shall comply with the manufacturer's recommendations on product handling, storage, and protection except as noted in the Contract Documents or otherwise approved by SEPTA.

B. If the Contract Documents deviate from any manufacturer's recommendations for material utilization and/or installation, the Contractor shall bring this to the attention of the SEPTA Project Manager and obtain clarification before proceeding.

1.06 Fulfilling SEPTA Sustainability Goals and the Reuse of Materials

A. For materials identified elsewhere as required to meet specific sustainability goals, the Contractor will keep all documentation necessary to establish that specific materials were used in a manner which meets these requirements.

B. The Contractor shall not reuse materials and equipment found on the existing premises, except as specifically called for by the Contract Documents or as approved through the change order process. If materials are called to be reused, their use shall be documented to the satisfaction of the SEPTA Project Manager and sufficient detail to fulfill all sustainability documentation requirements.

1.07 Transportation and Handling

A. The Contractor shall transport and handle products in accordance with the manufacturer's instructions. Excessive damage during transport and unloading, as judged by the SEPTA Project Manager, may be grounds for rejection of that material.

B. The Contractor shall promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.

C. The Contractor shall provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

D. The Contractor shall deliver and have delivered products to the job site in their manufacturer's original container, with labels intact and legible.

1. The Contractor shall maintain packaged materials with seals unbroken and labels intact until time of installation.

2. The Contractor shall promptly remove damaged material and unsuitable items from the job site, and promptly replace with materials meeting the specified requirements, at no additional cost to SEPTA.

E. SEPTA may reject, as non-complying, such material and products that do not bear satisfactory identification as to manufacturer, country of origin, grade, quality, and other pertinent information.

1.08 Storage and Protection

A. The Contractor shall store and protect products in accordance with the manufacturer's instructions, with seals and labels intact and legible.

B. The Contractor shall store sensitive products in weather tight, climate controlled enclosures.

1. Material subject to moisture damage as defined in the International Green Construction Code (IGCC) shall be inspected by an approved agency in conformance to the IGCC. Any material which has sustained damage per the IGCC will be repaired or replaced at the discretion of the SEPTA Project Manager at no cost to SEPTA.

C. For exterior storage of fabricated products which are intended for exterior installation; the Contractor shall provide above ground sloped supports as a minimum storage strategy. Components shall be appropriately protected from the weather. This storage is subject to the approval of the SEPTA Project Manager.

D. The availability of laydown areas may be limited. Unless otherwise directed by the Contract Documents, the Contractor shall make off site arrangements for storage, staging, and deliver material to the job site as required to not affect work progress of other contractors and/or create unsafe conditions.

E. The Contractor shall protect all finished surfaces and equipment.

F. The Contractor shall provide protection for finished floor surfaces prior to allowing equipment or materials to be moved over such surfaces.

G. The Contractor shall maintain finished surfaces and keep equipment clean, unmarred, and suitably protected until final acceptance by SEPTA.

1.09 Repairs and Replacement

A. In event of damage, the Contractor shall promptly make replacements and repairs at no additional cost to SEPTA. Do not install damaged material.

B. Additional time required to secure replacements and to make repairs will not be considered by SEPTA as justification for extension to Contract time.

1.10 Product Options and Substitutions

A. If a product becomes unavailable during the construction process, the Contractor must submit an alternative following the normal submittal review process in Section 01300. Under no circumstances may the Contractor install an alternate material from that which was submitted, no matter how closely the substitute resembles the original, without the written permission of the SEPTA Project Manager.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01612

DELIVERY, STORAGE AND HANDLING – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Deliver, store and handle of all equipment from manufacturing plants to the construction site or Contractor provided storage facility. Pack, load, transport and unload all equipment. Access to the sites is by public roads.

B. Accept the delivered equipment and immediately check for any damage that may have occurred during shipment before storing. Arrange inspection by the manufacturer where required. Replace any damaged equipment.

C. Pay all costs associated with equipment shipping including transportation costs, insurance and custom's fees. Obtain all relevant shipping approvals and permits prior to shipping.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control – Traction Power Equipment

C. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

D. Section 01822 – Demonstration and Training – Traction Power Equipment

E. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

F. Section 05090 – Metal Fasteners, Joining and Welding

G. Section 09910 – Paints and Coatings

H. Section 16050 – Basic Electrical Materials and Methods

I. Section 16060 – Grounding and Bonding

J. Section 16075 – Electrical Identification

K. Section 16260 – Traction Power Rectifier

L. Section 16271 – Auxiliary Power Transformers

M. Section 16273 – Traction Power Rectifier Transformers

N. Section 16274 – Transformer and Rectifier Unit

O. Section 16290 – Protective Devices and Instrument Transformers

P. Section 16335 – Surge Protection

Q. Section 16344 – DC Traction Power Switchgear Assemblies

R. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

S. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation

A. General:

1. Pack all equipment into crates or containers in accordance with the manufacturer's recommendations. Pack in a dry and clean area. Wrap all equipment in weatherproof coverings to protect the equipment from moisture and dust. Pad all equipment for protection against mechanical damage.
2. Provide adequate quantity of desiccants to keep the moisture out of the equipment crates and containers. Provide additional quantity of desiccants for travel over oceans and waterways and provide packing which shall prevent damage from water spray.
3. Brace all crates or containers to protect the equipment against damage due to vibration.
4. Provide tilt and shock indicators prior to shipping on the transformers, rectifiers, and DC switchgear assemblies. The indicators shall record tilts of more than 20 degrees and shocks of more than 0.5 g in any direction. The indicators shall not be removed until the equipment is in its permanent installed position.
5. SEPTA shall inspect the indicators before the equipment is unloaded from its carrier and again after it is in permanent installed position before the indicators are removed. Coordinate with SEPTA and provide all men and material for inspection.
6. Survey the route to verify no delivery conflicts. Ensure that all equipment can be delivered to site by road trailers.
7. Ship equipment only upon written approval from SEPTA after factory tests. Ship only equipment in mint condition. Inspect content of all packages prior to shipping and upon arrival.
8. Deliver all products to the site in the manufacturer's original packing. Upon arrival at site, verify that no damage has been caused in transit.
9. Provide sufficient notice to SEPTA before unloading the transformers, rectifiers, DC switchgear and DC circuit breakers and to enable witnessing the same.
10. In the event that components are missing, inform the equipment supplier immediately and request advice from SEPTA on how to proceed.
11. In the event of damage, inform the shipper, SEPTA, and the equipment supplier immediately and request advice on how to proceed. Take photographs of the damaged equipment and prepare a written report describing the detected damage and actions taken upon delivery.
12. Insure the test equipment against damage and loss in shipment or during use.

B. DC Switchgear:

1. Coordinate the delivery with SEPTA. Refer to Section 16344.

C. Rectifier Transformers:

1. Coordinate the place and time of delivery with SEPTA. Refer to Sections 16273 and 16274.

D. Rectifiers:

1. Coordinate the place and time of delivery with SEPTA. Refer to Sections 16260 and 16274.

3.02 Storage and Handling

A. Store all products in an environment recommended by the manufacturer of the product.

B. Immediately upon arrival at the site or the staging area, store the equipment in dry place protected from the elements. Provide temporary power supply to the DC switchgear and control cabinet anti-condensation space heaters to prevent damage from condensation.

C. Indoor Equipment:

1. Store all indoor equipment, such as DC switchgear, rectifiers, rectifier transformers, batteries and chargers, Supervisory Control and Data Acquisition (SCADA) remote terminal unit, indoors until the time when the Traction Power Substation (TPSS) building is ready to accept the equipment.

2. Store the equipment in weatherproof coverings in a dry and ventilated area in accordance with the manufacturer’s recommendations.

D. Outdoor Equipment:

1. Store all outdoor equipment duly protected from weather until the time the concrete pads and are installed and ready to accept the equipment.

2. Ensure that no condensation takes place in the cabinets of the equipment.

END OF SECTION

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SECTION 01700

CONTRACT CLOSEOUT

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for closing out the Contract and supplements requirements specified in Paragraph XII of the Agreement.

B. Contract closeout is the term used to describe collective requirements that are to be fulfilled at the end of the Contract term in preparation for final acceptance and occupancy of the work by SEPTA, as well as final payment to the Contractor and the completion of the Contract.

C. Prior to the completion of the entire Project and at the discretion of the SEPTA Project Manager, a certificate of substantial completion may be issued for portions of the work completed to the full satisfaction of SEPTA in accordance with Article 1.03 in this Section.

1.02 Related Sections

A. Agreement.

B. Section 01710 – Final Cleaning

C. Section 01720 – Project As-Built Documents

D. Section 01810 – Commissioning of Systems

E. Section 01820 – Demonstration and Training

F. Section 01822 – Demonstration and Training – Traction Power Equipment

G. Section 01830 – Operations and Maintenance Data

1.03 Prerequisites to Substantial Completion

A. General:

1. The Contractor shall complete the following before requesting the SEPTA Project Manager's inspection for certification of substantial completion for the work of the Contract. The Contractor shall list known exceptions in the request.

    a. In the progress payment request that coincides with or is the first request following the date substantial completion is claimed, activities should be either 100 percent complete for the portion of the work claimed as "substantially complete", or provide a list of incomplete items, the value of incomplete work, and reasons for the work being incomplete. Include supporting documentation for completion as indicated in the Contract Documents.

    b. Submit written certification to the SEPTA Project Manager that the Project, or designated portion thereof, is substantially complete.

    c. Submit the list of items to be completed or corrected and material delivery dates of major items, as applicable.

    d. Advise SEPTA of pending insurance change-over requirements.

e. All Contract record documents, maintenance manuals, warranties, and bonds shall be submitted as defined in the Agreement, Section 01720 and Section 01830.

f. Obtain and submit releases enabling SEPTA full, unrestricted use of the work and access to services and utilities. Where required, include occupancy permits, operating certificates and similar releases.

g. Deliver any access tools and material stock as required and further defined in Section 01830.

h. Change out locks, transmit keys, and transfer security provisions if required by the Specifications.

i. Start-up testing and demonstration of equipment and systems shall be completed as specified in Section 01810 and Section 01820.

j. Discontinue or change over and remove temporary facilities and services from the job site as directed by the SEPTA Project Manager along with construction tools and facilities, mock-ups, and similar elements.

k. Touch up and otherwise repair and restore marred exposed finishes.

l. All building operations, maintenance, and owner education instructions for the SEPTA personnel shall be completed as defined in Section 01820 and the International Green Construction Code (IGCC).

B. Inspection Procedures:

1. Upon receipt of the Contractor's request and submittal for inspection, the SEPTA Project Manager will either proceed with inspection or advise the Contractor of unresolved prerequisites.

a. Following the initial inspection, the SEPTA Project Manager will either prepare the certificate of substantial completion or will advise the Contractor of work which must be performed before the certificate will be issued. The SEPTA Project Manager will repeat the inspection when requested and when assured that the work has been completed.

b. SEPTA reserves the right to halt inspections at any time if, in the opinion of the SEPTA Project Manager, the incomplete items of work are either too numerous or too complex to qualify the Project as substantially complete.

c. Results of the completed inspection will form the initial "punch list" for final acceptance, but this list may be modified at the discretion of the SEPTA Project Manager.

d. The "punch list" shall include a reasonable time period to effectuate the work which is mutually agreed upon by all parties.

1.04 Prerequisites to Final Acceptance

A. General:

1. The Contractor shall complete the following before requesting the SEPTA Project Manager's final inspection for certification of final acceptance, and final payment as required by the Agreement, specifically sections regarding the Contractor and payment and completion. The Contractor shall list known exceptions, if any, in the request.

a. Submit the final payment request with final releases and supporting documentation not previously submitted and accepted. Include certificates of insurance for products and completed operations where required.

b. Submit an updated final statement to account for final additional changes to the Contract sum.

c. Submit a certified copy of the SEPTA Project Manager's final "punch list" which documents all work which has been completed.

d. Submit final meter readings for utilities, a measured record of stored fuel, and similar data as of the date of substantial completion or as of the date SEPTA took possession of and responsibility for corresponding elements of the work, if required.

e. Submit consent of surety, affidavit of payments of debts and claims, affidavit of release of liens, general release by trade contractor of SEPTA, guarantee against defects, any warranties and maintenance bonds, any special documentation such as copy of the Engineer or DER permits or certification of occupancy.

f. Submit evidence of final, continuing insurance coverage which complies with the insurance requirements.

g. Submit any remaining record documents and drawings, maintenance manuals, final Project photographs, damage or settlement survey, property survey, and similar final record information and as defined in the IGCC.

h. The Contractor shall issue final Project records in an electronic format. Electronic files shall be in a format approved by the SEPTA Project Manager for each specific item. Electronic files shall be organized and named per applicable section or naming protocol as provided by the SEPTA Project Manager.

i. The SEPTA Project Manager may elect progressive submissions of specific listed items during the course of work. Electronic files shall be created for the following items, note that the SEPTA Project Manager to edit list of desired information:

1) Submittals.
2) Construction permits.
3) Certificate of use and occupancy.
4) As-built drawings.
5) Manufacturer's OEM manuals.
6) Manufacturer's warranties.
7) Construction photographs.
8) Approved shop drawings.
9) Testing service results.
10) Concrete delivery forms.
11) Steel certifications.
12) UL inspections.
13) Survey log records.
14) Drilling log records.
15) All engineering, design, and calculations.
16) Documentation required by regulatory requirements.
17) Soil management documentation including but not limited to testing results, soil disposal documentation, chain of custody and permissions and disposal records.
18) Accident reports.

B. Re-Inspection Procedure:

1. The SEPTA Project Manager will re-inspect the work upon receipt of the Contractor's notice that the work, including "punch list" items resulting from earlier inspections, has been completed, except for those items whose completion has been delayed because of circumstances that are acceptable to the SEPTA Project Manager.

a. Upon completion of re-inspection, the SEPTA Project Manager will either prepare a certificate of final acceptance or will advise the Contractor of work that is incomplete or of obligations that have not been fulfilled, but which are required for final acceptance.
b. SEPTA reserves the right to halt inspections at any time if it becomes apparent that the incomplete items of work are either too numerous or too complex to qualify the Project as substantially complete.
c. If necessary, the re-inspection procedure will be repeated.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01710

FINAL CLEANING

PART 1 - GENERAL

1.01 Description

A. This Section details the work for preparing the site and/or facility for substantial completion.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01500 – Construction Facilities and Temporary Controls

1.03 Submittals

A. In accordance with Section 01300, provide information on the proposed cleaning materials and chemicals for the review of the SEPTA Project Manager including but not limited to Safety Data Sheets (SDSs).

1.04 Quality Assurance

A. In addition to the standards described in this Section, the Contractor shall comply with the pertinent requirements of governmental agencies having jurisdiction.

B. "Clean," for the purpose of this Article, and except as may be specifically provided otherwise, shall be interpreted as meaning the level of cleanliness generally provided by skilled cleaners using commercial quality building maintenance equipment and materials.

C. For any finishes, SEPTA may require a sample test area to be cleaned to ensure compatibility and to set a standard for final appearance.

PART 2 - PRODUCTS

2.01 Cleaning Material and Equipment

A. The Contractor shall provide required personnel, equipment and materials needed to achieve the specified standard of cleanliness.

2.02 Compatibility

A. The Contractor shall use only the cleaning materials and equipment which are compatible with the surface being cleaned, as recommended by the manufacturer of the material and acceptable to SEPTA.

B. The Contractor shall replace surfaces damaged from improper use of material and/or cleaning methods at no cost to SEPTA.

PART 3 - EXECUTION

3.01 Final Cleaning

A. The Contractor shall, prior to turning over the substantially completed area to SEPTA maintenance, remove from the area all tools, surplus materials, equipment, scrap, debris, and waste. If any of the Contractor's work continues in the substantially completed area, the Contractor shall continue the cleaning specified in Section 01500. Schedule a final cleaning date as approved by SEPTA with sufficient time for a post-cleaning inspection walk through with the SEPTA Project Manager and a Contractor's representative.

B. De-energize and ground active Traction Power Substation (TPSS) equipment per the Contractor and SEPTA safety regulations prior to attempting and cleaning of TPSS. Unqualified personnel may not enter TPSS areas or open electrical enclosures.

C. Job Site:

1. Unless otherwise specifically directed by SEPTA, the Contractor shall sweep grade areas within the Contract limit and paved areas adjacent to the job site.
2. The Contractor shall completely remove resultant debris.
3. The Contractor shall remove graffiti from all surfaces and restore surface to original condition.

D. Structures:

1. The Contractor shall visually inspect all existing and finished surfaces and remove all traces of soil, waste materials, smudges, graffiti, and other foreign matter.
2. The Contractor shall remove all traces of splashed materials from structure within Contract limit and from adjacent surfaces.
3. If necessary to achieve a uniform degree of cleanliness, the Contractor shall wash the exterior of the structure with high pressure detergent.
4. In the event of stubborn stains not removable with detergent, the Contractor shall utilize other cleaning methods; including light particle blasting if needed; subject to SEPTA's written approval and at no additional cost to SEPTA.
5. The Contractor shall remove paint droppings, spots, stains, and dirt from existing and finished surfaces.
6. The Contractor shall clean existing and new glass surfaces and frames, both inside and outside, before and after applying anti-vandal film to surfaces as called for in the Contract Documents.

E. Finished Surfaces:

1. The Contractor shall remove all labels and tags which are strictly used for the convenience of manufacturing, assembly, installation, and identifications. Remove all label residue.
2. The Contractor shall clean glass and glazing to a polished condition. Remove substances which are noticeable on surfaces. Replace any broken glass and damaged transparent materials.
3. The Contractor shall clean stainless steel surfaces; including screens; of all foreign material. Use cleaners as recommended by the manufacturer and approved by SEPTA.

4. The Contractor shall clean existing and new tile surfaces including the grout joints to a dirt and graffiti free condition.

F. Equipment and Lighting:

1. The Contractor shall wipe surfaces of all mechanical and electrical equipment including system components to a dirt-free condition. Touch up the painted surfaces to match with the overall finish of the equipment/system component.

2. Ensure that the equipment and system components are properly identified as required by the Contract Documents and applicable codes. Confirm that all cover plates are installed properly and locked if applicable. Missing or broken cover plates and those which do not fit, and lock properly must be replaced.

END OF SECTION

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SECTION 01720

PROJECT AS-BUILT DOCUMENTS

PART 1 - GENERAL

1.01 Description

A. The Contractor, throughout progress of the work, shall maintain an accurate record of changes to the Contract Drawings and Specifications.

B. The Contractor shall at the time of substantial completion, but prior to requesting release of retainage, transfer the changes to a set of final as-built documents, which shall include an as-built set of construction drawings and an annotated set of specifications.

C. The Contractor shall provide approved final as-built documents in an electronic format for SEPTA's future use. The format of these electronic files shall be approved by the SEPTA Project Manager prior to submission.

1.02 Related Sections

A. Documents affecting work of this Section include, but are not necessarily limited to, the Agreement and Division 1 of these Specifications.

B. Section 01300 – Submittals

C. Other requirements affecting Project as-built documents may appear in other pertinent Sections of these Specifications.

1.03 Submittals

A. The Contractor shall comply with the pertinent requirements of Section 01300.

1.04 Quality Assurance

A. Accuracy of Records:

1. The Contractor shall thoroughly coordinate changes within the as-built documents, making adequate and proper entries on each page of specifications and each sheet of drawings and other documents where such entry is required to show the change properly.

2. Accuracy of records shall be such that investigations to determine actual installed items may rely reasonably on information obtained from the approved final record documents.

B. The Contractor shall make entries on the as-built documents on a weekly basis to include all changes to the work performed during the last week to confirm they are an accurate representation of the as-built conditions.

C. The Contractor shall transfer "job set" information to a set of final as-built documents in a neat and professional manner.

1.05 Product Handling

A. The Contractor shall maintain the "job set" of record documents completely protected from deterioration and from loss and damage until completion of the work and transfer of all recorded data to the final as-built documents.

PART 2 - PRODUCTS

2.01 Record Documents

A. Job Set:

1. Following receipt of SEPTA's Notice to Proceed (NTP), the Contractor, shall secure from SEPTA one (1) complete set of all drawings and specifications comprising the Contract Documents. This "job set" will be maintained at the job site to record all as-built changes.

B. Final As-Built Documents:

1. The final as-built documents are to include:
   a. Updated as-builts of the original Contract Drawings.
   b. Additional as-built drawings as necessary, to describe changes during the Contract period that could not be included on the original Contract Drawings.
   c. Annotated specifications to include Contract Specifications with all changes made during the Contract period.
   d. "As installed" versions of same size drawings of all fabrication, detail, and installation drawings.

PART 3 - EXECUTION

3.01 Maintenance of Job Set

A. The Contractor shall, immediately upon receipt of the job set described in Article 2.01/A in this Section, identify each of the documents with the title "AS-BUILT DOCUMENTS - JOB SET."

B. Preservation:

1. The Contractor shall devise a suitable method for protecting the as-built job set; job set; in consideration of the Contract duration, the probable number of occasions upon which the job set must be taken out for new entries and for examination; the transfer of information on final as-build documents; and the conditions under which these activities will be performed.

2. The Contractor shall not use the job set for any purpose except entry of new data, for review by SEPTA and for the transfer of data to final as-built documents.

3. The Contractor shall maintain the job set at the job site of work.

C. Making Entries on Drawings:

1. The Contractor shall utilize an erasable colored pencil; not ink or inedible pencil; to clearly describe the change by graphic line and note as required.

2. The Contractor shall date all entries.
3. The Contractor shall call attention to the entry by a "cloud" drawn around the area or areas affected.
4. The Contractor shall in the event of overlapping changes, use different colors for the overlapping changes.

D. Revisions:

1. The Contractor shall transfer all changes to respective specifications and/or drawings set; if appropriate; immediately, as the change is approved.
2. The Contractor shall make appropriate entries in the drawings as soon as the change is incorporated in the field.

E. Conversion of Schematic Layouts:

1. The Contract Drawings may indicate arrangements of conduits, circuits, piping, ducts, and similar items shown schematically, and is not intended to portray precise physical layout.
2. Final physical arrangement is determined by the Contractor, subject to SEPTA's written approval. However, design of future modifications of the facility requires accurate information as to the final physical layout of items, which must be schematically shown on the final as-built drawings.
3. Show on the job set of as-built drawings dimensions accurate to within English Dimensioning Standards, the centerline of each run of items such as are described in Article 3.01/E/1 in this Section.
    a. The Contractor shall clearly identify the item by accurate note such as "cast iron drain", "galvanized conduit", and the like.
    b. The Contractor shall show, by symbol or note, the vertical location of the item "under slab", "in ceiling plenum", "exposed", and the like.
    c. The Contractor shall make all identification sufficiently descriptive that it may be related reliably to the Specifications.

3.02 Final Project Record Information

A. The purpose of the final Project as-built documents is to provide factual information regarding all aspects of the work, both concealed and visible, to enable future modifications of the work to proceed without lengthy and expensive site measurement, investigation and examination.

B. Accuracy of Record Data Prior to Transfer:

1. The Contractor is solely responsible for accurate transfer of all field changes and preparing additional reproducible drawings and specification pages.

C. Transfer of Data to Drawings:

1. The Contractor shall carefully transfer change data shown on the job set to the final as-built documents coordinating the changes as required.
2. The Contractor shall clearly indicate at each affected detail and master drawing a full description of changes made during construction, and the actual location of items.

3. The Contractor shall call attention to each entry by drawing a "cloud" around the areas affected.
4. The Contractor shall make changes neatly, consistently, and with the proper media to assure longevity and clear reproduction.
5. The Contractor shall prepare and submit ACAD and .PDF files of drawings in the same size as the original Contract Drawings which clearly depict any/all changes to details; including installation and fabrication drawings; incorporated in the construction that could not be corrected on the as-built drawings. These drawings shall be adequately identified and cross-referenced with pertinent drawing(s) to make it part of the final as-built documents.

D. Transfer of Data to Specifications:

1. The Contractor shall accurately and legibly transfer all information from job set to final annotated Project record specifications set.

E. Review and Submittal:

1. The Contractor shall submit the completed set of final as-built documents to SEPTA.
2. The Contractor shall participate in review meetings as required.
3. The Contractor shall make required changes and promptly deliver the final Project as-built documents to SEPTA.
4. The Contractor shall sign each sheet of the record drawings, certifying that they area an accurate representation of the as-built condition.
5. The final approved set of as-built documents shall be submitted via the SEPTA Project Management Information System (PMIS); e-Builder; in ACAD and .PDF type files utilizing the submittal process. SEPTA may request additional electronic; DVD or other electronic media; copies of the final as-built documents.

3.03 Changes Subsequent to Acceptance

A. The Contractor has no responsibility for recording changes in the work subsequent to final completion, except for changes resulting from work performed under warranty.

END OF SECTION

SECTION 01752

SPARE PARTS AND MAINTENANCE MATERIALS – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Furnish all spare parts required for operation and maintenance of the supplied equipment and systems for a period of two (2) years.

B. Furnish complete sets of special tools and test equipment required for maintenance and testing of the systems supplied including thermographic test equipment as specified below.

C. Set up inventory of all spare parts, special tools and test equipment in SEPTA's facility.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control – Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

D. Section 01822 – Demonstration and Training – Traction Power Equipment

E. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

F. Section 16060 – Grounding and Bonding

G. Section 16260 – Traction Power Rectifier

H. Section 16271 – Auxiliary Power Transformers

I. Section 16273 – Traction Power Rectifier Transformers

J. Section 16274 – Transformer and Rectifier Unit

K. Section 16290 – Protective Devices and Instrument Transformers

L. Section 16335 – Surge Protection

M. Section 16344 – DC Traction Power Switchgear Assemblies

N. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

O. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following documents for SEPTA's review and approval:

1. Preliminary and final list of all recommended spare parts, special tools and test equipment.
2. Spare parts, special tools and test equipment catalog including the following:
    a. Inventory of all spare parts, special tools and test equipment.
    b. Fixed unit price for all spare parts valid for two (2) years after Traction Power Substation (TPSS) acceptance by SEPTA.

c. Statement that guarantees availability of all spare parts, special tools and test equipment for a period of twenty (20) years after TPSS acceptance by SEPTA.

3. Inventory:
   a. Provide computer-based inventory for all spare parts, special tools and test equipment.

B. Submit the following documents in hard copy and CD ROM formats:

1. Manufacturer's descriptive literature.
2. Product specifications and performance data.
3. Calibration requirements and instructions.
4. List of recommended service centers for warranty administration and repair services.
5. Operation and maintenance manual.
6. Spare parts list.
7. All required software.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. NFPA 70E, Standard for Electrical Safety in the Workplace.

PART 2 - PRODUCTS

2.01 Spare Parts

A. Spare Parts for Warranty Repairs:

1. Spare parts ordered by SEPTA for support of revenue operations shall not be utilized by the Contractor for warranty repairs and warranty parts replacements.
2. Spare parts required for use by the Contractor to provide warranty support are the responsibility of the Contractor. SEPTA will not be responsible for receiving or storing any parts for warranty support.
3. At the end of the warranty period, SEPTA may, at its discretion, consider a negotiated price for purchase of all spare parts stocked, but not used, by the Contractor for warranty support.

2.02 Special Tools

A. Furnish special tools required for operation and maintenance of the equipment installed. Special tools include crimping tools, jigs, fixtures, equipment, hand tools, power tools, circuit-board testers and other tools and equipment necessary to maintain, repair, overhaul, assemble and disassemble the equipment, that are not commonly available from commercial tool suppliers.

B. Any tool that is not found in the catalog or showroom of the following companies is considered a special tool:

1. Sears.

2. AeroQuip.
3. Grainger.
4. Snap-On.
5. AMP.
6. MAC.
7. Williams.
8. Black & Decker.
9. Black Hawk.
10. Starrett.
11. ACE Hardware.
12. Hilti.
13. Home Depot.
14. Lowe's.

C. The Contractor shall provide fall protection suitable for use with the fall protection facilities provided on the TPSS installations. Tower systems manufactured by the following will be suitable:

1. Winsafe Corporation.
2. Or Approved Equal.

2.03 Test Equipment

A. Provide portable high-pot testers, meggers, relay test sets, transducer test and calibration sets, converter test and calibration sets, and printed circuit board testers to test all equipment supplied.

B. Furnish all equipment complete with all cables, connectors, probes and associated equipment to interface with the test points. Provide carrying case for each item of equipment.

C. Furnish self-contained, solid-state, programmable test and calibration equipment with LCD indicating analog and digital displays of appropriate variables, including, but not limited to, volts, amperes and phase angle degrees.

D. Supply test units to allow rapid identification of failures on individual assemblies to the Lowest Level Replaceable Unit (LLRU). Furnish test equipment using guided-probe technology to the maximum degree possible to test, troubleshoot and calibrate all electrical, electronic, mechanical and electro-mechanical components.

E. All test and calibration equipment shall be designed to generate accurate signals for testing of the connected equipment. Adjustment of signals shall be independent of each other.

F. Use hook-up multi-conductor cables with multi-pin connectors, as appropriate, to establish all connections required. No high-voltage connections to the test equipment are allowed.

G. Provide two (2) diagnostic laptop computers. The laptop computers shall be utilized for programming and testing of all the control system components (i.e. relays, Supervisory Control and Data Acquisition Remote Terminal Unit (SCADA RTU), etc.) and must be furnished with the latest version of MS Office Professional as well as all control system vendor programming and troubleshooting software. Provide all required connection cables to all control system equipment with each laptop computer.

1. Each laptop computer shall have the following minimum specifications.
    a. Be of rugged construction; proven test results and certified to military standards including drops up to 3 feet as well as an IP52 certification for protection from the ingress of duct and water.
    b. Intel® Core™ i7-6600U Processor (4M Cache, 2.60 GHz) with Security Bundle.
    c. Windows 10 Pro 64bit English, French, Spanish.
    d. 16 GB (1x16GB) 2133 MHz DDR4 N-ECC RAM.
    e. 500 GB Mobility Solid State Drive, Encrypted.
    f. AMD Radeon™ R7 M360 Video Card.
    g. 14.0" HD (1366x768) Display, Webcam with Privacy Shutter and Microphone, Non-touch.
    h. Sealed Internal RGB Backlit English Keyboard.
    i. Intel® Dual-Band Wireless-AC 8260 Wi-Fi + BT 4.2 Wireless Card.
    j. Include an internal mounted Tray load DVD+/- RW Drive.
    k. Carrying Case.
    l. Three (3) year full warranty.
2. Laptop computers must be submitted and approved by SEPTA.

H. All desktop test equipment shall operate on 120 VAC, 60 Hz. All portable test equipment shall operate on rechargeable batteries. Furnish rechargeable batteries, chargers and adaptors, as required.

2.04 Thermographic Test Instrument

A. General Requirements:

1. Provide a portable, handheld, thermal infrared imager of rugged, durable, compact and lightweight construction housed in a non-conductive and insulating enclosure.
2. Provide an instrument suitable for specific intended use within electrical preventative maintenance applications to determine electrical equipment hot spots from a safe visual distance away from the equipment and capable of providing images in compliance with NFPA 70E electrical arc-flash hazard access limitations.
3. Imaging procedure must be totally self-contained to a handheld unit, without the use of any additional umbilical connecting cords, battery packs or remote processing equipment. Provide simple operating controls and adjustments that do not take extensive field manipulations, tools, setups or pre-calibrations.
4. Fully test and calibrate the thermal imager equipment prior to delivery. Demonstrate calibration in the field.

B. Accessories:

1. Provide the instrument with full complement of accessories, including:

a. Rechargeable battery that can operate the instrument continuously for a minimum period of three (3) hours without recharge.
b. Removable battery pack capable of accepting standard and rechargeable type cell batteries.
c. Permanent charger station for docking and recharging the instrument when not in use, including:
    1) Battery charging indicator lights on the instrument and on the docking station to indicate charging in progress and charging complete.
    2) Standard 120 VAC, 60 Hz line cord.
d. USB 1.1 computer cable port connectors and associated cable, 5 feet minimum, for I/O exchange between the instrument and computer.
e. Impact-resistant, carrying, suitcase type protective hard case, capable of holding the instrument, all its accessories, and spare batteries. Provide the case with case handles, toggle latches and a padlock.
f. Protective covers to protect the lens, displays and connection ports when not in use
g. Vial of any special required lens cleaner that is not otherwise commercially available.
h. All supporting computer software and hardware that is fully compatible with Microsoft Windows operating system.
i. Provide the following additional accessories:
    1) RS-232 to USB 1.1 adapter.
    2) Wrist strap.
    3) Neck strap.

C. Supply thermographic test equipment and accessories as manufactured by one (1) of the following approved manufacturers:
    1. Raytek Corporation, Thermoview™ Ti30 Thermal Imager.
    2. Infrared Solutions, IR-Insight T Infrared Camera.
    3. Flir Systems ThermaCam 25 Infrared Camera.

PART 3 - EXECUTION

3.01 Inventory

A. Provide computer-based list for all recommended spare parts, special tools and test equipment. SEPTA will order the required spare parts and special tools.

B. Include manufacturer's catalog number, description, quantity recommended for being stocked as spares, quantity installed in the system, unit production price, subcontractor markup and price based on the recommended quantities.

3.02 Availability of Spare Parts, Special Tools and Test Equipment

A. Guarantee availability of all spare parts, special tools and test equipment for a period of twenty (20) years after TPSS acceptance by SEPTA.

B. Spare parts and specialty tools shall be provided prior to equipment being commissioned.

3.03 Quantities

A. General Spare Parts:

1. The Contractor to provide quantity of spare parts for the TPSS. Quantity of spare parts to be reviewed and approved by SEPTA.
2. Provide as a part of the equipment to be delivered adequate spare parts in sufficient quantities to enable system maintenance for a period of two (2) years after TPSS acceptance by SEPTA. The spare parts list to be provided by the Contractor which will be reviewed and approved by SEPTA. The spare parts list shall include, as a minimum, the following equipment:
   a. Rectifier transformers.
   b. Utility service 60Hz circuit breakers.
   c. DC circuit breakers.
   d. Protective relays and other components.
   e. Remote Terminal Unit (RTU) and associated equipment.
   f. Security and intrusion alarm systems.
   g. Disconnect switches.
   h. Battery chargers.
   i. Auxiliary transformers.
3. The following items shall be supplied, at a minimum, as the spare parts. The Contractor shall develop the list further based on the equipment selected and submit to SEPTA for approval in the final design phase.
   a. One (1) 60 Hz battery charger.
   b. One (1) set of each type of protection relays for each TPSS.
   c. Two (2) PCBs for adding additional status points to the RTU.
   d. One (1) of each type of voltage and current transducer for each TPSS.
   e. 1000 feet of control cable of each type.
   f. For each TPSS: One (1) complete 15KV AC circuit breaker, one (1) cathode and one (1) feeder DC circuit breaker.

END OF SECTION

SECTION 01810

COMMISSIONING OF SYSTEMS

PART 1 - GENERAL

1.01 Description

A. Start-up systems.

B. Testing, adjusting, and balancing.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Requirements

C. Section 13700 – Intrusion Alarm System

D. Section 13850 – Fire Alarm and Detection System

E. Section 15700 – Heating, Ventilating and Air Conditioning Equipment

F. Section 15935 – Building System Controls

G. Section 15950 – Testing, Adjusting and Balancing

H. Section 16230 – Generator Assemblies

I. Section 16240 – Battery Equipment

J. Section 16260 – Traction Power Rectifier

K. Section 16271 – Auxiliary Power Transformers

L. Section 16273 – Traction Power Rectifier Transformers

M. Section 16274 – Transformer and Rectifier Unit

N. Section 16340 – Medium Voltage Switchgear Assemblies (60 Hz)

O. Section 16344 – DC Traction Power Switchgear Assemblies

P. Section 16348 – Negative and Drainage Switchboard

Q. Section 16700 – Communications

R. Section 16772 – CCTV System

S. Section 16920 – Stray Current Monitoring

T. Section 16950 – Testing

U. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. In accordance with Section 01300, furnish for SEPTA's Project Manager review the following:

1. Schedule for all start-up testing.

2. Testing program.

1.04 Systems Start-up

A. The Contractor shall coordinate schedule for start-up of various equipment and systems.

B. The Contractor shall notify SEPTA fourteen (14) days prior to the start-up of each item.

C. The Contractor shall verify that each piece of equipment or system has been checked for proper control sequence or for other conditions which may cause damage.

D. The Contractor shall verify that tests, meter reading, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

E. The Contractor shall verify wiring and support components for equipment are complete and tested.

F. The Engineer of record and/or approved SEPTA personnel shall execute start-up with the participation of applicable manufacturer's representative and the Contractors' personnel in accordance with the manufacturer's instructions and the provisions of the International Green Construction Code (IGCC).

G. The Contractor shall require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or systems in operation.

1.05 Testing, Adjusting, and Balancing

A. The Contractor shall employ the services of an independent firm to perform testing, adjusting, and balancing under the direction of the Engineer of record and/or approved SEPTA personnel as part of the commissioning process.

B. An independent firm will perform services specified in Sections 13700, 13850, 15700, 15935, 15950, 16230, 16240, 16260, 16271, 16273, 16274, 16340, 16344, 16348, 16700, 16772, 16920, 16950 and 16953.

C. Reports will be submitted by the independent firm to SEPTA and the Contractor indicating observations and results of tests and indicating compliance or non-compliance with the requirements of the Contract Documents. The Contractor shall be responsible for submitting these reports to the SEPTA Project Manager.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01820

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.01 Description

A. Conduct formalized and documented demonstration of the installed equipment and systems to SEPTA staff and their representatives.

B. Provide training for SEPTA personnel to enable SEPTA staff to operate, service, and maintain the equipment and systems furnished. Commence training only at direction of SEPTA, after approval of training related submittals and delivery of sufficient amount of equipment spare parts and special tools. Training shall occur prior to the commissioning of the new equipment.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Requirements

C. Section 01830 – Operations and Maintenance Data

D. Section 13700 – Intrusion Alarm System

E. Section 13850 – Fire Alarm and Detection System

F. Section 15700 – Heating, Ventilating and Air Conditioning Equipment

G. Section 15935 – Building System Controls

H. Section 16240 – Battery Equipment

I. Section 16700 – Communications

1.03 Submittals

A. Submit the following documents for SEPTA’s review and approval:

1. Detailed resumes of all technical support and training personnel.
2. Training plan.
3. Training program.
4. Training manuals.
5. Training materials.

B. At the time of training provide one (1) set of handout materials to each student.

C. Submit one (1) record set after completion of training to the SEPTA Project Manager.

1.04 Demonstration and Instructions

A. The Contractor shall demonstrate operation and maintenance of equipment and/or systems to SEPTA's personnel four (4) weeks prior to date of final inspection.

B. The Contractor, for equipment or systems requiring seasonal operation, shall perform demonstration for other seasons within six (6) months after the initial demonstration and commissioning.

C. The Contractor shall utilize the manufacturer's operational and maintenance manuals as basis for instruction. The contents of manuals shall be reviewed with SEPTA in detail to explain all aspects of operation and maintenance.

PART 2 - PRODUCTS

2.01 Training Personnel

A. Provide experienced and competent training personnel who have direct and complete knowledge of the equipment and systems supplied and are capable of providing detailed explanations of the operation and maintenance of all equipment and systems at no additional cost to SEPTA.

B. Provide training personnel with minimum of ten (10) years of experience in the design, manufacture, installation and maintenance of the equipment.

C. All training personnel shall be fluent in oral and written English, with a complete understanding of the English language.

D. The training personnel shall be subject to approval by SEPTA. SEPTA reserves the right to request personnel replacement for any reason and have the technical support activity or training subject repeated at no additional cost to SEPTA.

E. Ensure that all instructors teaching the training courses are familiar with technical information and are able to utilize proper methods of instruction, training aids and audiovisual materials to insure effective presentations.

F. Coordinate with SEPTA to determine the student qualifications, number of students in the class, and the level of training required before preparing the training plan, program, manuals and materials.

G. Utilization of equipment supplier presenters is encouraged and supported by SEPTA. The Contractor is responsible for scheduling and all of the cost for training personnel and any required teaching materials, equipment and/or aids.

2.02 Training Plan

A. Develop a training plan that includes the following:

1. Training course outline, including:
    a. Program introduction and overview.
    b. Statement of overall program goals.
    c. Learning objectives specifically describing the desired knowledge to be gained.
2. Lesson schedule.
3. List of printed material, audio aids and visual aids to be used during lessons.
4. Schedule for written and practical tests.

B. As a minimum, include the following topics in the training plan:

1. Warranty program support.
2. Trouble shooting support.
3. Training and continuing education support.
4. Operation and maintenance activities in the field.
5. Developing alternative sources of spare parts and maintaining contact with spare part suppliers.
6. Safety.

C. The Contractor is responsible for providing any special equipment needed to make the presentations, such as audio-visual equipment, blackboards, wipe boards, flip charts, and overhead or slide projectors.

D. SEPTA will assist the Contractor in the set up and tear down of training aids and models used in presentations.

2.03 Training Program

A. Based on the training plan, develop a comprehensive training program for SEPTA's personnel to include both classroom and practical hands-on exercise sessions for equipment, systems and subsystems supplied under the Contract.

B. Arrange the training program in multiple classes of six (6) participants each. Each class would have personnel of similar technical background.

C. Design the course to cover all necessary details for performance of:

1. Equipment operations and its place in the overall system.
2. Preventive, corrective and overhaul maintenance.
3. Test procedures.
4. Equipment safety procedures.

D. Conduct the program at SEPTA provided facilities.

E. Demonstrate the training program to SEPTA's management.

F. Classes will be held on both first and third shifts. Develop class schedules in coordination with SEPTA.

G. Personnel attending each class will be designated by SEPTA and a list of attending individuals will be provided to the Contractor.

H. Design and give written and practical tests at suitable points of the course to determine the extent to which employees have learned and can apply the information presented. Submit attendance records and test scores to SEPTA.

I. Update lesson plans as required during the course to construction.

2.04 Training Manuals

A. Provide separate; individual; training manuals for operations and for maintenance personnel. SEPTA staff will use the manuals as text books for the training and for future reference.

B. Provide training manuals containing the following:

1. A discussion of staff prerequisites.
2. Program overview and goals.
3. Individual lessons, containing the following:
   a. Overview of each lesson and student learning objectives.
   b. Instructional methods and learning activities.
   c. Required equipment and resources.
   d. A fully developed content of each lesson.
   e. Illustrations, charts and graphics, as needed, to enhance content of the lessons.

C. As a minimum, include the following training topics:

1. Step-by-step introduction to each equipment and system function and operation, including terminology and identification of components.
2. Detailed theory of operation to explain theoretical background of operation of equipment being furnished.
3. Routine care including frequency of inspection, cleaning, lubrication, and adjustments to include manpower and time requirement.
4. Identification of problem symptoms, troubleshooting procedures and repair procedures and demonstration of taking out of service, repairing, maintaining, testing, and placing into service all components of the system.
5. Demonstration of shutdown and re-starting procedures.
6. Demonstration of disassembly and reassembly of systems and components.
7. Instruction in the use and maintenance of special tools and techniques to perform complex maintenance functions in the field and in the shop.
8. Safety instruction for operation and maintenance activities.
9. Emergency and permanent repair procedures.

D. Provide illustration with high resolution presentation suitable for producing high-quality images when projected on a typical classroom presentation screen.

E. Maintain, upgrade, and update the training manuals to include the latest data and information. Such maintenance of the training manuals may be performed remotely with notice to SEPTA. With each notice include a list of changes and the location of each change within the training manuals.

F. SEPTA reserves the right to record any or all training presentations and activities by the Contractor for its sole use without costs, obligation, or liability to SEPTA.

G. Prepare the training manuals in hard copies and electronic format as specified in Section 01830.

2.05 Training Materials

A. Provide all training aids, audiovisual equipment and visual aids for the courses.

B. Submit all training materials for approval. Provide one (1) set of training materials per student. The training materials shall include all materials for the students to interact in the learning situations.

C. Provide an adequate supply of high-quality, professionally prepared authoritative and up-to-date reference materials as well as other training aids necessary to impart the essential knowledge to SEPTA staff.

D. Work closely with SEPTA during development of training materials to ensure that the course organization, content and overall quality of training materials meet SEPTA expectations.

E. Use spare parts already supplied to SEPTA to facilitate hands-on training for educational purposes.

F. Restore all equipment utilized for training purposes to as new condition.

G. Illustrate operation of significant components using diagrams or cutaway views.

H. Demonstrate component locations by component cutaways, schematics and wiring diagrams.

I. All training materials shall become the property of SEPTA at the completion of the training program. SEPTA reserves the right to duplicate, at its expense, all films, slides, view graphs, tapes and handouts for its sole use.

J. Replace all training-damaged materials unless the damage resulted from neglect by SEPTA.

PART 3 - EXECUTION

3.01 Training Requirements

A. Provide minimum hours of training for each class for each major items of equipment as shown in Table 01820-1.

Table 01820-1 Training Requirements

Equipment	Length of Training
HVAC Equipment and Building Controls	Two (2) classes, four (4) hours each
Battery Equipment	Three (3) classes, four (4) hours each
Communications and Security Systems	Three (3) classes, eight (8) hours each
Fire Alarm System	Two (2) classes, four (4) hours each

END OF SECTION

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SECTION 01822

DEMONSTRATION AND TRAINING – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Conduct demonstration of the installed equipment and systems to SEPTA staff and their representatives.

B. Provide training for SEPTA personnel to enable SEPTA staff to operate, service, and maintain the equipment and systems furnished. Commence training only at direction of SEPTA, after approval of training related submittals and delivery of sufficient amount of equipment spare parts and special tools.

C. The training shall occur before commissioning of the new equipment at each Traction Power Substation (TPSS).

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01300 – Submittals

C. Section 01452 – Contractor Quality Control – Traction Power Equipment

D. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

E. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

F. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

G. Section 16060 – Grounding and Bonding

H. Section 16260 – Traction Power Rectifier

I. Section 16271 – Auxiliary Power Transformers

J. Section 16273 – Traction Power Rectifier Transformers

K. Section 16274 – Transformer and Rectifier Unit

L. Section 16290 – Protective Devices and Instrument Transformers

M. Section 16335 – Surge Protection

N. Section 16344 – DC Traction Power Switchgear Assemblies

O. Section 16348 – Negative and Drainage Switchboard

P. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

Q. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following documents for SEPTA's review and approval:

1. Detailed resumes of all technical support and training personnel.

2. Training plan.
3. Training program.
4. Training manuals.
5. Training materials.

B. At the time of training provide one (1) set of handout materials to each student.

C. Submit one (1) record set after completion of training to the SEPTA Project Manager.

1.04 Demonstration and Instructions

A. The Contractor shall demonstrate operation and maintenance of equipment and/or systems to SEPTA's personnel four (4) weeks prior to date of final inspection.

B. The Contractor, for equipment or systems requiring seasonal operation, shall perform demonstration for other seasons within six (6) months after the initial demonstration and commissioning.

C. The Contractor shall utilize the manufacturer's operational and maintenance manuals as basis for instruction. The contents of manuals shall be reviewed with SEPTA in detail to explain all aspects of operation and maintenance.

PART 2 - PRODUCTS

2.01 Technical Support and Training Personnel

A. Provide experienced and competent training personnel who have direct and complete knowledge of the equipment and systems supplied and are capable of providing detailed explanations of the operation and maintenance of all equipment and systems at no additional cost to SEPTA.

B. Provide training personnel with minimum of ten (10) years of experience in the design, manufacture, installation and maintenance of the equipment.

C. All training personnel shall be fluent in oral and written English, with a complete understanding of the English language.

D. The training personnel shall be subject to approval by SEPTA. SEPTA reserves the right to request personnel replacement for any reason and have any training subject repeated at no additional cost to SEPTA.

E. Ensure that all instructors teaching the training courses are familiar with all technical information and are able to utilize proper methods of instruction, training aids and audiovisual materials to insure effective presentations.

F. Coordinate with SEPTA to determine the student qualifications, number of students in the class and the level of training required before preparing the training plan, program, manuals and materials.

G. Utilization of equipment supplier presenters is encouraged and supported by SEPTA. The Contractor is responsible for scheduling and all of the cost for training personnel and any required teaching materials, equipment and/or aids.

2.02 Training Plan

A. Develop a training plan that includes the following:

1. Training course outline, including:
   a. Program introduction and overview.
   b. Statement of overall program goals.
   c. Learning objectives specifically describing the desired knowledge to be gained.
2. Lesson schedule.
3. List of printed materials, audio aids and visual aids to be used during lessons.
4. Schedule for written and practical tests.

B. As a minimum, include the following topics in the training plan:

1. Reliability program support.
2. Warranty program support.
3. Trouble shooting support.
4. Training and continuing education support.
5. Operation and maintenance activities in the field.
6. Developing alternative sources of spare parts and maintaining contact with spare part suppliers.
7. Safety.

C. The Contractor is responsible for providing any special equipment needed to make the presentations, such as audio visual equipment, blackboards, wipe boards, flip charts, and overhead or slide projectors.

D. SEPTA will assist the Contractor in the set up and tear down of training aids and models used in presentations.

2.03 Training Program

A. Based on the training plan, develop a comprehensive training program for SEPTA's personnel to include both classroom and practical hand-on exercise sessions for all equipment, systems and subsystems supplied under the Contract.

B. Arrange the training program in multiple classes of six (6) participants each. Each class would have personnel of similar technical background.

C. Design the course to cover all necessary details for performance of:

1. Equipment operations and its place in the system.
2. Preventive, corrective and overhaul maintenance.
3. Test procedures.
4. Equipment safety procedures.

D. Conduct the program at SEPTA-provided facilities.

E. Demonstrate the training program to SEPTA's management.

F. Classes will be held on both first and third shifts. Develop class schedules in coordination with SEPTA.

G. Personnel attending each class will be designated by SEPTA and a list of attending individuals will be provided to the Contractor.

H. Design and give written and practical tests at suitable points of the course to determine the extent to which employees have learned and can apply the information presented. All attendance records and test scores will be kept by SEPTA.

I. Update lesson plans as required during the course of design and construction.

2.04 Training Manuals

A. Provide separate; individual; training manuals for operations and for maintenance personnel. SEPTA staff will use the manuals as text books for the training and for future reference.

B. Provide training manuals containing the following:

1. A discussion of staff prerequisites.
2. Program overview and goals.
3. Individual lessons, containing the following:
    a. Overview of each lesson and student learning objectives.
    b. Instructional methods and learning activities.
    c. Required equipment and resources.
    d. A fully developed content of each lesson.
    e. Illustrations, charts and graphics, as needed, to enhance content of the lessons.

C. As a minimum, include the following training topics:

1. Step-by-step introduction to each equipment and system function and operation, including terminology and identification of components.
2. Detailed theory of operation. Explain theoretical background of operation of all equipment being furnished.
3. Routine care including frequency of inspection, cleaning, lubrication, and adjustments to include manpower and time requirement.
4. Identification of problem symptoms, troubleshooting procedures and repair procedures and demonstration of taking out of service, repairing, maintaining, testing, and placing into service all components of the system.
5. Demonstration of shutdown and re-starting procedures.
6. Demonstration of disassembly and reassembly of systems and components.
7. Instruction in the use and maintenance of all special tools and techniques to perform complex maintenance functions in the field and in the shop.
8. Safety instruction for all maintenance activities.
9. Emergency and permanent repair procedures.

D. Provide all illustrations with high resolution presentation suitable for producing high-quality images when projected on a typical classroom presentation screen.

E. Maintain, upgrade, and update the training manuals to include the latest data and information. Such maintenance of the training manuals may be performed remotely with notice to SEPTA. With each notice include a list of changes and the location of each change within the manuals.

F. SEPTA reserves the right to record any or all training presentations and activities by the Contractor for its sole use without costs, obligation, or liability to SEPTA.

G. Prepare the training manuals in hard copies and electronic format as specified in Section 01832.

2.05 Training Materials

A. Provide all training aids, audiovisual equipment and visual aids for the courses.

B. Submit all training materials for approval by SEPTA. Provide one (1) set of training materials per student. The training materials shall include all materials for the students to interact in the learning situations.

C. Provide an adequate supply of high quality, professionally prepared authoritative and up-to-date reference materials as well as other training aids necessary to impart the essential knowledge to SEPTA staff.

D. Work closely with SEPTA during development of training materials to ensure that the course organization, content and overall quality of all training materials meet SEPTA expectations.

E. Use spare parts already supplied to SEPTA to facilitate hands-on training for educational purposes.

F. Restore all equipment utilized for training purposes to as new condition.

G. Illustrate operation of significant components using diagrams or cutaway views.

H. Demonstrate component locations by component cutaways, schematics and wiring diagrams.

I. All training materials shall become the property of SEPTA at the completion of the training program. SEPTA reserves the right to duplicate, at its expense, all films, slides, view graphs, tapes and handouts for its sole use.

J. Replace all training damaged materials unless the damage resulted from neglect by SEPTA.

PART 3 - EXECUTION

3.01 Training Requirements

A. Provide minimum hours of training for each major item of equipment is shown in Table 01822-1. Split the duration between classroom training and hands-on demonstration in consultant with SEPTA.

B. The training may need to be provided in three (3) or more sessions depending upon the availability of SEPTA staff. Coordinate number of sessions needed with SEPTA.

Table 01822-1 Training Requirements

Equipment	Length of Training (Hours)
Rectifier Transformers and Rectifiers	Twenty-Four (24)
DC Switchgear Assembly	Seventy-Two (72)
Auxiliary Power Transformers	Sixty-Four (64)
Devices and Instrument Transformers	Twenty-Four (24)
Software for the System	Sixty Four (64)
Supervisory Control and Data Acquisition (SCADA) System	Twenty-Four (24)
Protective Relaying	Seventy-Two (72)
AC Switchgear Assembly	Seventy-Two (72)

END OF SECTION

SECTION 01830

OPERATIONS AND MAINTENANCE DATA

PART 1 - GENERAL

1.01 Description

A. The work of this Section specifies the requirements for preparation and submittal of operations and maintenance data. The data shall be complete and presented in an easily followed format, in accordance with the requirements of this Section.

B. Furnish SEPTA with comprehensive operations and maintenance manuals of all equipment and systems furnished.

C. Prepare manuals uniform in presentation showing all interfaces between equipment and subsystems in sufficient detail to present a complete and clear picture of the equipment and subsystems.

D. Ensure that the nomenclature, functional designations of components and their interconnections are consistent with the as-built drawings.

E. Provide all information needed for optimum and safe maintenance and repair of the equipment by SEPTA personnel.

F. Additional requirements for the traction power equipment operations and maintenance manuals are included in Section 01832.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Requirements

C. Section 01410 – Inspection and Test Plans

D. Section 01420 – Testing and Inspection Services

E. Section 01600 – Materials and Equipment

F. Section 01700 – Contract Closeout

G. Section 01720 – Project As-Built Documents

H. Section 01820 – Demonstration and Training

1.03 Submittals

A. Submit operations and maintenance manuals for each piece of machinery and equipment item as follows:

1. One (1) copy of sample format and outline of contents in draft form with the equipment shop drawings.

2. One (1) copy of complete manual in final form on the equipment delivery date, for review and comment by the SEPTA.

3. Five (5) copies of approved manual after the equipment is installed and ready to test.

4. In additional to paper copies required elsewhere in this Section, all documents, after final approval, will be submitted in an electronic format as approved by the SEPTA Project Manager.

B. Submit the following manuals for SEPTA's review and approval:

1. Operations manual.
2. Preventive maintenance manual.
3. Corrective maintenance manual.
4. Heavy repair manual.
5. Spare parts manual.
6. Special tools and test equipment manual.

1.04 Quality Assurance

A. Prepare instructions and data by personnel experienced in maintenance and operation of described products, equipment, and systems.

B. General Requirements for Manuals:

1. Prepare manuals written in clear grammatical English.
2. Manuals furnished may be the manufacturer's standard publications in regard to size and binding provided they comply with the specified requirements relative to quantity and quality of information and data.
3. Bind manuals within hard or flexible covers. Make illustrations clear, and printed matter, including dimensions and lettering on drawings, easily legible. If reduced drawings are incorporated into manuals, heavy-up original lines, and letters as necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to page size.

C. Prepare manuals using the following materials:

1. Loose leaf, 60 pound, three (3) hole punched paper.
2. Holes reinforced with plastic cloth.
3. Page size to be 8 1/2 inches by 11 inches.
4. Foldout diagrams and illustrations
5. Reproducible by dry-copy xerography method.
6. Oil, moisture, and wear-resistant plastic covers.

1.05 Format

A. The Contractor shall prepare data in the form of an instructional manual which conforms to the requirements of the International Green Construction Code (IGCC) and as outline below.

1. Clearly identify each manual through the front cover with at least the following information:
   a. (*Description of manual).
   b. (Description of equipment or systems).

c. SOUTHEASTERN PENNSYLVANIA TRANSPORTATION AUTHORITY CONTRACT (NAME & PO #).

d. (Name of Contractor).

e. Date: (#TBD).

B. The Contractor shall prepare a table of contents for each volume, with each product or system description identified, in three (3) parts as follows:

1. Part 1:

a. Directory listing names, addresses, and telephone numbers of the Architect/Engineer, the Contractor, subcontractors, and SEPTA personnel including Operations.

1) Title page including the name and function of the equipment and manufacturers.

2) Table of contents, in numerical order listing all section and subsection titles of included diagrams and drawings.

3) Index in alphabetical order.

4) Front piece for recognition illustration of the equipment described in the operations and maintenance manual.

2. Part 2:

a. Operations and maintenance instructions arranged by product or system and subdivided by Specification Section. For each category identify names, addresses, and telephone numbers of subcontractors and suppliers. Identify the following:

1) Significant design criteria.

2) List of equipment.

3) Parts list for each component. Information may include the following:

a) Manufacturer's literature describing each piece of equipment including major assemblies and subassemblies and providing the manufacturer's model number and drawing number.

b) Long lead time spare parts list for all spare parts not readily available on the open market or for which it is anticipated ordering and delivery time will exceed ten (10) days.

c) Complete list of parts and supplies, with current unit prices and sources of supply.

d) List of parts and supplies that are either normally furnished at no extra cost with the purchase of equipment or specified herein to be furnished as part of the Contract.

e) List of nearest local suppliers for all equipment parts.

4) Operating instruction, which may include the following information:

a) Operation instructions including step-by-step preparation for starting, operation, shutdown and draining, and emergency requirements.

b) Control diagrams as installed by the manufacturer.

c) Sequence of operation by the control manufacturer.

d) Wiring diagrams as installed by the manufacturer.

e) Diagrammatic location, functions, and tag numbers of each valve.

5) Maintenance instructions for equipment and systems may include the following information:

a) Maintenance instruction including step-by-step procedures for inspection, operation checks, cleaning, lubrication, adjustments, repair, overhaul, disassembly, and reassembly of the equipment for proper operation of the equipment. Include

list of special tools which are required for maintenance with the maintenance information.

b) Possible breakdowns and repairs.

c) Lubrication schedule indicating type and frequency of lubrication.

6) Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

3. Part 3:

a. Project documents and certificates including the following:

1) Shop drawings and product data.

2) Air and water balance reports.

3) Certificates.

4) Photocopies of warranties and bonds.

5) Appendix:

a) Include safety precautions, a glossary, and, if available at the time of submittal, copies of test reports and other relevant material not specified to be submitted.

1.06 Contents of Each Volume

A. Table of Contents:

1. Provide title of Project; names, addresses, and telephone numbers of Architect/Engineer, the Contractor, and subcontractors with name of responsible parties; schedule of products and systems indexed to content of the volume.

B. For Each Product or System:

1. List names, addresses, and telephone numbers of subcontractors and suppliers; including local source of supplies and replacement parts.

C. Product Data:

1. Mark each sheet to clearly identify specific products and component parts and data applicable to installation. Delete inapplicable information.

D. Drawings:

1. Supplement product data to illustrate relations of component parts of equipment and systems to show control and flow diagrams. Project as-built drawings shall not be used as maintenance drawings.

E. Typed Text:

1. As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating the manufacturer's instructions.

1.07 Manual for Materials and Finishes

A. Building Products, Applied Materials, and Finishes:

1. Include product data, with catalog number, size, composition, and color and texture designators. Provide information for reordering custom manufactured products.

B. Instructions for Care and Maintenance:

1. Include the manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture Protection and Weather Exposed Products:

1. Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional Requirements:

1. As specified in individual product Specification Sections.

E. Provide a listing in table of contents for design data with tabbed fly sheet and space for insertion of data.

1.08 Manual for Equipment and Systems

A. Each Item of Equipment and Each System:

1. Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

B. Panelboard Circuit Directories:

1. Provide electrical service characteristics, controls, and communications, by label machine.

C. Include color-coded wiring diagrams as installed.

D. Operating Procedures:

1. Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.

E. Maintenance Requirements:

1. Include routine procedures and guide for trouble-shooting, disassembly, repair, and reassembly instruction; and alignment, adjusting, balancing, and checking instructions.

F. Provide servicing and lubrication schedule and list of lubricants required.

G. Include the manufacturer's printed operation and maintenance instructions.

H. Include sequence of operation by the controls manufacturer.

I. Provide the original manufacturer's parts list, illustration, assembly drawings and diagrams required for maintenance.

J. Provide control diagrams by the controls manufacturer, as installed.

K. Provide the Contractor's coordination drawings with color-coded piping diagrams, as installed.

L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

M. Provide list of the original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

N. Include test and balancing reports.

O. Additional Requirements:

1. As specified in individual product Specification Sections.

P. Provide a listing in table of contents for design data with tabbed fly sheet and space for insertion of data.

1.09 Instruction of SEPTA Personnel

A. The Contractor is responsible for creating a building owner education manual in conformance with the IGCC.

B. Refer to Section 01820 for additional information on instruction of SEPTA personnel.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 01832

OPERATIONS AND MAINTENANCE MANUALS – TRACTION POWER EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. The work of this Section specifies the requirements for preparation and submittal of operations and maintenance manuals. The manuals shall be complete and presented in an easily followed format, in accordance with the requirements of this Section.

B. Furnish SEPTA with comprehensive operations and maintenance manuals of all equipment and systems furnished for each Traction Power Substation (TPSS) separately.

C. Prepare manuals written specifically for SEPTA operations and maintenance personnel. Each manual shall contain all information relevant to the TPSS.

D. Prepare manuals uniform in presentation showing all interfaces between equipment and subsystems in sufficient detail to present a complete and clear picture of the equipment and subsystems.

E. Ensure that the nomenclature, functional designations of components and their interconnections are consistent with the as-built drawings.

F. Provide all information needed for optimum and safe maintenance and repair of the equipment by SEPTA personnel.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Requirements

C. Section 01410 – Inspection and Test Plans

D. Section 01420 – Testing and Inspection Services

E. Section 01452 – Contractor Quality Control – Traction Power Equipment

F. Section 01600 – Materials and Equipment

G. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

H. Section 01700 – Contract Closeout

I. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

J. Section 01822 – Demonstration and Training - Traction Power Equipment

K. Section 01830 – Operations and Maintenance Data

L. Section 16060 – Grounding and Bonding

M. Section 16260 – Traction Power Rectifier

N. Section 16271 – Auxiliary Power Transformers

O. Section 16273 – Traction Power Rectifier Transformers

P. Section 16274 - Transformer and Rectifier Unit

Q. Section 16290 – Protective Devices and Instrument Transformers

R. Section 16335 – Surge Protection

S. Section 16344 – DC Traction Power Switchgear Assemblies

T. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

U. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Submit operations and maintenance manuals for each piece of machinery and equipment item as follows:

1. One (1) copy of sample format and outline of contents in draft form with the equipment shop drawings.
2. One (1) copy of complete manual in final form on the equipment delivery date for review and comment by the SEPTA.
3. Five (5) copies of approved manual after the equipment is installed and ready to test.
4. In addition to paper copies required elsewhere in this Section, all documents, after final approval, will be submitted in an electronic format as approved by the SEPTA Project Manager.

B. Submit the following manuals for SEPTA's review and approval:

1. Operations manual.
2. Preventive maintenance manual.
3. Corrective maintenance manual.
4. Heavy repair manual.
5. Spare parts manual.
6. Special tools and test equipment manual.

1.04 Quality Assurance

A. Prepare instructions and data by personnel experienced in maintenance and operation of described products, equipment, and systems.

B. General Requirements of Manuals:

1. Prepare manuals written in clear grammatical English.
2. Manuals furnished may be the manufacturer's standard publications in regard to size and binding provided they comply with specified requirements relative to quantity and quality of information and data.
3. Bind manuals within hard or flexible covers. Make illustrations clear, and printed matter, including dimensions and lettering on drawings, easily legible. If reduced drawings are incorporated into manuals, heavy-up original lines, and letters as necessary to retain their legibility after reduction. Larger drawings may be folded into manuals to page size.

C. Prepare manuals using the following materials:

1. Loose leaf, 60 pound, three (3) hole punched paper.
2. Holes reinforced with plastic cloth.
3. Page size to be 8 1/2 inches by 11 inches.
4. Foldout diagrams and illustrations.
5. Reproducible by dry-copy xerography method.
6. Oil, moisture, and wear-resistant plastic covers.

1.05 Format

A. Refer to Section 01830 for operations and maintenance data manual format requirements.

1.06 General Operations and Maintenance Manual Requirements

A. The manuals shall be written by professionals with the understanding of the TPSS. Manufacturer's catalogs and drawings shall be used to supplement the written information.

B. The manuals shall include annotated pictures to indicate location of all major equipment.

C. Provide a complete list of parts and supplies, with current unit prices and sources of supply.

D. Provie a list of parts and supplies that are either normally furnished at not extra cost with the purchase of equipment or specified herein to be furnished as part of the Contract.

E. Provide a list of nearest local suppliers for all equipment parts.

1.07 Operations Manual

A. Provide all information needed for the optimum and safe operation of the equipment, including:

1. Detail description of the TPSS, its systems, and their division into subsystems.
2. General systems familiarization material, such as location, function and operation of equipment, controls, meters, gauges, indicators, and switches. Use photos, sketches, and cut-section views for explanation.
3. Operation instructions including step-by-step preparation for starting, operation, shutdown and draining, and emergency requirements.
4. Control diagrams as installed by the manufacturer.
5. Sequence of operation by the control manufacturer.
6. Wiring diagrams as installed by the manufacturer.
7. Diagrammatic location, functions, and tag numbers of each valve.
8. Procedures to enable maintenance staff to operate the individual system components and the system as a whole in its normal and various contingency and emergency modes.
9. Safety precautions for working on or in the vicinity of each piece of equipment.
10. Explain, in detail, the operation of circuit breakers and DC switchgear from Supervisory Control and Data Acquisition (SCADA), local area network controller and via local

control. Explain various safety interlockings between DC switchgear and disconnect switches. Explain function of all protective relays in detail.

11. Include step-by-step instructions for equipment energization, operation, normal shutdown, and emergency shutdown. Emphasize the safety precautions to be observed during normal operation, inspection and before energization after a maintenance shutdown.

1.08 Preventive Maintenance Manual

A. Provide all information needed to enable maintenance staff to perform periodic inspection tasks to keep the system in satisfactory working order.

B. Include all information needed for preventive maintenance, adjustments, and on-line trouble diagnosis of each piece of equipment and system.

C. Maintenance instructions including step-by-step procedures for inspection, operation checks, cleaning, lubrication, adjustments, repair, overhaul, disassembly, and reassembly of the equipment for proper operation of the equipment.

D. Include maintenance standards, including specifications, wear limits, settings, and tolerances.

E. Provide recommended preventive maintenance schedule for all system components.

F. Provide procedures for equipment removal and re-installation.

G. Lubrication schedule indicating type and frequency of lubrication.

H. Possible breakdowns and repairs.

I. Maintenance instructions for finishes, including recommended cleaning methods and materials, and special precautions identifying detrimental agents.

1.09 Corrective Maintenance Manual

A. Provide all information needed to enable on-line and off-line troubleshooting. Include troubleshooting flow charts for diagnosis of breakdowns of all equipment and systems.

B. Include description of trouble symptoms, methods for diagnosing causes of trouble symptoms and corrective actions.

C. Provide all information needed to enable maintenance staff to troubleshoot, adjust and completely repair all equipment and systems.

D. Include detailed description and operation of each system, using block diagrams, flow diagrams, detailed schematics, and functional wiring diagrams.

E. Provide test and repair evaluation procedures.

F. Include safety precautions and procedures, glossary of terms and other relevant material.

1.10 Heavy Repair Manual

A. Provide all information needed to enable maintenance staff to service, maintain, repair, replace, disassemble, reassemble, rebuild, and overhaul the equipment and the system.

B. Include detailed description of procedures for long-term periodic maintenance requirements of all components. Include detailed description of mid-life rehabilitation or replacement of any component, as required.

1.11 Spare Parts Manual

A. Parts common to different assemblies, such as bolts and nuts, shall bear the same Contractor's number in all assemblies, with an index reference to the other assemblies in which they are found. Each part or subassembly shall be identified as part of a next higher assembly.

B. Commercially available items such as common fastenings, fuses, lamps, fittings and relays shall be identified in a separate list in the parts catalog by the Contractor’s part number and standard hardware nomenclature, sufficient for ordering these items commercially.

C. Provide complete list of spare parts and supplies, with current unit prices, sources of supply, and recommended quantities to be maintained in storage.

D. Provide a list of all functional components, with the manufacturer's model number and the manufacturer's part number.

E. Provide long lead time spare parts list for all spare parts not readily available on the open market or for which it is anticipated ordering and deliver time will exceed ten (10) days.

1.12 Special Tools and Test Equipment Manual

A. Include list of special tools and test equipment for general upkeep, inspection, and maintenance of the equipment.

B. Provide instructions and directions on how to use special tools and test equipment.

C. Include setup and testing procedures for all special tools and test equipment and procedures needed for periodic inspection and servicing requirements including lubrication, inspection, and adjustment of all apparatus.

1.13 Manual for Materials and Finishes

A. Building Products, Applied Materials, and Finishes:

1. Include product data, with catalog number, size, composition, and color and texture designators. Provide information for reordering custom manufactured products.

B. Instructions for Care and Maintenance:

1. Include the manufacturer's recommendations for cleaning agents and methods, precautions against detrimental agents and methods, and recommended schedule for cleaning and maintenance.

C. Moisture Protection and Weather Exposed Products:

1. Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.

D. Additional Requirements:

1. As specified in individual product Specification Sections.

E. Provide a listing in table of contents for design data with tabbed fly sheet and space for insertion of data.

1.14 Manuals for Equipment and Systems

A. Each Item of Equipment and Each System:

1. Include description of unit or system and component parts. Identify function, normal operating characteristics, and limiting conditions. Include performance curves, with engineering data and tests, and complete nomenclature and model number of replaceable parts.

B. Panelboard Circuit Directories:

1. Provide electrical service characteristics, controls, and communications, by label machine.

C. Include color-coded wiring diagrams as installed.

D. Operating Procedures:

1. Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shutdown, and emergency instructions. Include summer, winter, and any special operating instructions.

E. Maintenance Requirements:

1. Include routine procedures and guide for trouble-shooting, disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.

F. Provide servicing and lubrication schedule and list of lubricants required.

G. Include the manufacturer's printed operation and maintenance instructions.

H. Include sequence of operation by the controls manufacturer.

I. Provide the original manufacturer's parts list, illustration, assembly drawings, and diagrams required for maintenance.

J. Provide control diagrams by the controls manufacturer, as installed.

K. Provide the Contractor's coordination drawings with color-coded piping diagrams, as installed.

L. Provide charts of valve tag numbers, with location and function of each valve, keyed to flow and control diagrams.

M. Provide list of the original manufacturer's spare parts, current prices, and recommended quantities to be maintained in storage.

N. Include testing and balancing reports.

O. Additional Requirements:

1. As specified in individual product Specification Sections.

P. Provide a listing in table of contents for design data with tabbed fly sheet and space for insertion of data.

1.15 Instruction of SEPTA Personnel

A. The Contractor is responsible for creating a building owner education manual in conformance with the International Green Construction Code (IGCC).

B. Refer to Section 01822 for additional information on instruction of SEPTA personnel.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

THIS PAGE NOT USED

SECTION 02070

SELECTIVE DEMOLITION

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of demolition and removal of selected portions of Traction Power Substation (TPSS) within this Contract including the buildings and structures.

1.02 Related Sections

A. Division 1 or cutting and patching procedures.

B. Division 1 for general protection and work procedures for alteration projects.

C. Section 02080 – Hazardous Material Abatement

D. Section 02081 – Asbestos Abatement

E. Section 02082 – PCB Abatement

F. Section 02083 – Heavy Metals Abatement

G. Section 02084 – Petroleum Contaminated Material Abatement

H. Section 02085 – Lead Paint Abatement

I. All Division 16 Sections.

1.03 Submittals

A. Submit engineering survey of condition of building, electrical and mechanical equipment of the TPSS.

B. Submit proposed protection measures report; including Contract Drawings; that indicates the measures proposed for protecting individuals and property, for environmental protection, for dust control and for noise control. Indicate proposed locations and construction of barriers.

C. Schedule of selective demolition activities to indicate the following:

1. Detailed sequence of selective demolition and removal work, with starting and ending dates for each activity. Ensure SEPTA's on-site operations are uninterrupted. Note that some of the equipment has to be removed from the site promptly to make room for the new equipment.

2. Indicate how long, if at all, utility services will be interrupted.

3. Coordination for shutoff, capping and continuation of utility services.

4. Use of elevator and stairs. Note that some of the equipment is installed on building roofs with no stairways.

5. Coordination of SEPTA's continuing occupancy of portions of existing building and of SEPTA's partial occupancy of completed work.

D. Show pre-demolition photographs or video existing conditions of adjoining construction, including finish surfaces that might be misconstrued as damage caused by demolition operations. Meet the requirements of Division 1. Submit before work begins.

E. Documentation indicating that existing warranties are still in effect after completion of selective demolition.

F. Submit an inventory list of items that have been removed and salvaged.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASSE A10.6, Safety Requirements for Demolition Operations.

2. Environmental Protection Agency (EPA) regulations.

3. NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.

1.05 Definition

A. Remove: Detach items from existing construction and dispose of them off-site unless indicated to be salvaged or reinstalled.

B. Remove and Salvage: Detach items from existing construction, in a manner to prevent damage, and deliver to SEPTA ready for reuse.

C. Remove and Reinstall: Detach items from existing construction, in a manner to prevent damage, prepare for reuse and reinstall where indicated.

D. Existing to Remain: Leave existing items that are not to be removed and that are not otherwise indicated to be salvaged or reinstalled. Identify such items and obtain SEPTA approval.

E. Dismantle: To remove by disassembling or detaching an item from a surface, using gentle methods and equipment to prevent damage to the item and surfaces; disposing of items unless indicated to be salvaged or reinstalled.

1.06 Materials Ownership

A. Unless otherwise indicated, demolition waste becomes property of the Contractor. The Contractor shall remove demolition waste from the site.

B. Historic items, relics, antiques and similar objects including, but not limited to, cornerstones and their contents, commemorative plaques and tablets, and other items of interest or value to SEPTA that may be uncovered during demolition remain the property of SEPTA.

1. Carefully salvage in a manner to prevent damage and promptly return to SEPTA.

1.07 Pre-Demolition Meetings

A. Conduct pre-demolition conference at Project site.

1. Inspect and discuss condition of construction to be selectively demolished.

2. Review structural load limitations of existing structure.

3. Review and finalize selective demolition schedule and verify availability of materials, demolition personnel, equipment and facilities needed to make progress and avoid delays.
4. Review requirements of work performed by other trades that rely on substrates exposed by selective demolition operations.
5. Review areas where existing construction is to remain and requires protection, especially from the electrically energized parts.

1.08 Field Conditions

A. SEPTA will occupy portions of building immediately adjacent to selective demolition area. Conduct selective demolition so the SEPTA's operations will not be disrupted. Note that some demolition will require a power outage. Coordinate power outages with SEPTA.

B. Conditions existing at time of inspection for bidding purpose will be maintained by SEPTA as far as practical.

C. Notify SEPTA of discrepancies between existing conditions and Contract Drawings before proceeding with selective demolition.

D. Refer to Section 02080, Section 02081, Section 02082, Section 02083, Section 02084 and Section 02085 for hazardous materials abatement.

1. If suspected hazardous materials are encountered, do not disturb; immediately notify SEPTA.

E. Demolition and hauling equipment and other materials for historic areas shall be of sizes that clear surfaces within historic spaces, areas, rooms and openings, including temporary protection, by 12 inches or more.

F. Storage or sale of removed items or materials on-site is not permitted.

G. Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire protection facilities in service during selective demolition operations.

1.09 Warranty

A. Remove, replace, patch and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties. Notify the warrantor before proceeding.

B. Confirm the existence of any current warranties with SEPTA prior to selective demolition activities.

C. Notify the warrantor on completion of selective demolition, and obtain documentation verifying that existing system has been inspected and warranty remains in effect. Submit documentation at Contract closeout.

1.10 Coordination

A. Arrange selective demolition schedule so as not to interfere with SEPTA's operations.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Meet the governing EPA notification regulations before beginning selective demolition. Meet the hauling and disposal regulations of authorities having jurisdiction.

B. Meet the regulations of ASSE A10.6 and NFPA 241.

PART 3 - EXECUTION

3.01 Examination

A. Engage a Professional Engineer licensed in the Commonwealth of Pennsylvania to perform an engineering survey of condition of building to determine whether removing any element might result in structural deficiency or unplanned collapse of any portion of structure or adjacent structures during selective building demolition operations.

1. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

B. Engage a Professional Engineer licensed in the Commonwealth of Pennsylvania in electrical and mechanical disciplines to perform an engineering survey of the condition of the TPSS to determine the potential issues associated with the demolition of select electrical and mechanical equipment. The survey shall also identify the protective measures required for demolition.

1. Perform surveys as the work progresses to detect hazards resulting from selective demolition activities.

C. Verify that hazardous materials have been remediated before proceeding with building demolition operations.

D. Record existing conditions by use of measured drawings, preconstruction photographs or video and templates.

1. Meet the requirements specified in Division 1.

2. Inventory and record the condition of items to be removed and salvaged. Provide photographs or video of conditions that might be misconstrued as damage caused by salvage operations.

3. Before selective demolition or removal of existing building elements that will be reproduced or duplicated in final work, make permanent record of measurements, materials and construction details required to make exact reproduction.

3.02 Utility Services and Mechanical/Electrical Systems

A. Maintain services/systems indicated to remain and protect them against damage.

B. Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished that are existing services/systems to be removed, relocated or abandoned.

1. Arrange to shut off utilities with utility companies.

2. If services/systems are required to be removed, relocated or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of building.
3. Disconnect, demolish and remove fire-suppression systems, plumbing and HVAC systems, equipment and components indicated on the Contract Drawings to be removed.
    a. Remove portions of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.
    b. Drain piping to be abandoned in place and cap or plug piping with same or compatible piping material and leave in place.
    c. Disconnect and cap services for equipment to be removed and remove equipment.
    d. Disconnect and cap services for equipment to be removed and reinstalled and remove, clean, and store equipment; when appropriate, reinstall, reconnect and make equipment operational.
    e. Disconnect and cap services for equipment to be removed and salvaged and remove equipment and deliver to SEPTA.
    f. Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.
    g. Cap or plug ducts to be abandoned in place with same or compatible ductwork material and leave in place.

3.03 Protection

A. Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
    1. Provide protection to ensure safe passage of people around selective demolition area and to and from occupied and in-use portions of building.
    2. Provide temporary weather protection, during interval between selective demolition of existing construction on exterior surfaces and new construction, to prevent water leakage and damage to structure and interior areas.
    3. Protect walls, ceilings, floors and other existing finish work that are to remain or that are exposed during selective demolition operations.
    4. Cover and protect equipment which is in revenue service.
    5. Cover and protect furniture, furnishings and equipment that have not been removed.
B. Coordinate with SEPTA for removal of asbestos from indoor equipment before demolition.
C. Design, provide and maintain temporary shoring, bracing and structural supports as required to preserve stability and prevent movement, settlement or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
    1. Strengthen or add new supports when required during progress of selective demolition.
D. Remove temporary barricades and protections where hazards no longer exist.

3.04 Selective Demolition

A. Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the work within limitations of governing regulations and as follows:

1. Proceed with selective demolition systematically, from higher to lower level. Complete selective demolition operations above each floor or tier before disturbing supporting members on the next lower level.
2. Neatly cut openings and holes plumb, square and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
3. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
4. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
5. Maintain fire watch during and for at least four (4) hours after flame-cutting operations.
6. Maintain adequate ventilation when using cutting torches.
7. Remove decayed, vermin-infested or otherwise dangerous or unsuitable materials and promptly dispose of off-site.
8. Remove structural framing members and lower to ground by method suitable to avoid free fall and to prevent ground impact or dust generation.
9. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors or framing.
10. Dispose of demolished items and materials promptly.

B. Site access and temporary controls:

1. Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

C. Work in Historic Areas:

1. Selective demolition may be performed only in areas of the Contract that are not designated as historic.

D. Removed and Salvaged Items:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in a secure area until delivery to SEPTA.
4. Transport items to SEPTA's storage area designated by SEPTA.

5. Protect items from damage during transport and storage.

E. Removed and Reinstalled Items:

1. Clean and repair items to functional condition adequate for intended reuse.
2. Pack or crate items after cleaning and repairing. Identify contents of containers.
3. Protect items from damage during transport and storage.
4. Reinstall items in locations indicated. Meet the installation requirements for new materials and equipment. Provide connections, supports and miscellaneous materials necessary to make item functional for use indicated.

F. Protect construction indicated to remain against damage and soiling during selective demolition.

3.05 Selective Demolition Procedures for Specific Materials

A. Remove no more existing roofing than what can be covered in one (1) day by new roofing and so that building interior remains watertight and weather tight.

1. Remove existing roof membrane, flashings, copings and roof accessories.
2. Remove existing roofing system down to substrate

B. Concrete:

1. Demolish in small sections. Using power-driven saw, cut concrete to a depth of at least 3/4 inch at junctures with construction to remain. Dislodge concrete from reinforcement at perimeter of areas being demolished, cut reinforcement and then remove remainder of concrete. Neatly trim openings to dimensions indicated.

C. Masonry:

1. Demolish in small sections. Cut masonry at junctures with construction to remain, using power-driven saw and then remove masonry between saw cuts.

D. Saw-cut perimeter of area of concrete slabs-on-grade to be demolished, and then break up and remove.

3.06 Disposal of Demolished Materials

A. Remove demolition waste materials from Project site.

1. Do not allow demolished materials to accumulate on-site.
2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
3. Remove debris from elevated portions of building by chute, hoist or other device that will convey debris to grade level in a controlled descent.

B. Do not burn demolished materials.

3.07 Cleaning

A. Clean adjacent structures and improvements of dust, dirt and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION

SECTION 02080

HAZARDOUS MATERIAL ABATEMENT

PART 1 - GENERAL

1.01 Description

A. Building Materials:

1. The purpose of the work described in this Section is to abate regulated and hazardous building materials contained within the building structure per the scope of work. As part of the base scope of work, the Contractor shall be responsible for the removal, transport, and disposal or recycling of all designated items, unless otherwise stipulated, regardless of the actual quantities.

2. The Contractor shall furnish all labor, materials, equipment, and related items required to remove/abate all substances which are regulated under federal, state, and local statutes and land ban restrictions to the Contract limits as designated herein.

B. Decontamination (Cleaning):

1. This Section provides a description of methods to be used by the Contractor to clean and/or decontaminate various surfaces and structures as required by the scope of work for this Contract. The specific areas to be cleaned or decontaminated are described in this Project manual and related appendices.

2. The objective of this Specification is to establish general methods for the decontamination of building surfaces and infrastructures at the facility to provide for the environmental clearance of these materials. However, it is possible that the decontamination will not achieve the objective for clearance.

3. Where different options are described for decontaminating specific items, the Contractor may use discretion in determining the most appropriate methods, provided they are consistent with those included herein, and agreed to by SEPTA.

C. Cleaning of Building Surfaces:

1. The intent of this Section is to clean building surfaces to remove of oily accumulations and other residual impact from floor slabs, and to remove accumulations of dust, grime, dirt, ash, and other buildup from surfaces to reduce emissions during future demolition and/or minimize the potential for debris generated during demolition to be considered contaminated.

2. The Contractor shall furnish all labor, materials, equipment, and related items required to complete the work described herein in accordance with federal, state and local statutes.

3. For the purposes of this Specification, building surfaces to be cleaned include, but are not limited to:

   a. Staining, oily accumulations, non-liquid/tacky build-up, grease, dirt, grime, adhesives, wax, paint build-up, coal, ash, and loose paint on floors and shallow trenches, including under wood block and false floors.

b. Staining, grime, dust, grease, wax, adhesives, coal, ash, and other wastes present on walls, rafters, structural members, interior structures, platforms, mezzanines, equipment, equipment pads, and other horizontal and vertical surfaces.

c. PCB impact on electrical Traction Power Substation (TPSS) floors, if included as part of the scope of work (Section 2082).

D. Cleaning of Below-Grade Structures:

1. The intent of this work is to clean/decontaminate below-ground structures, including:

a. Underground process or building system piping and related drains, cleanouts, etc., including but not limited to industrial waste sewer piping, storm and sanitary sewer piping, and other process-related piping; and, pits, trenches, vaults, manholes, tunnels, sumps, basements, etc.

b. If required as part of the base scope of work, the Contractor shall furnish all labor, materials, equipment, and related items necessary to complete the work described herein in accordance with applicable federal, state and local regulations.

E. Demolition of TPSS Hazardous Materials:

1. The intent of this work is to remove, then recycle or dispose of materials from the TPSS sites materials that are known to contain or may contain hazardous materials content. Examples include, but are not limited to:

a. Cables and cable splices, including those with lead jackets (Section 02083).

b. Batteries (Section 02083).

c. Electrical and traction power equipment.

d. Transformers (Section 02082).

e. Tanks and drums.

f. Pipes and insulation (Section 02081).

g. Building materials (Section 02085).

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 02081 - Asbestos Abatement

C. Section 02082 - PCB Abatement

D. Section 02083 - Heavy Metals Abatement

E. Section 02084 - Petroleum Contaminated Material Abatement

F. Section 02085 - Lead Paint Abatement

1.03 Submittals

A. Provide all required submittals as identified in Section 01300.

B. Provide all required submittals as identified, including the Contractor’s method statements described herein.

C. All manifests shall be submitted to SEPTA no later than thirty (30) days after disposal.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Applicable Federal and State Occupational Safety and Health regulations and environmental statutes.
2. Applicable requirements of Federal, State and Local regulatory agencies.
3. Applicable State Regulations and Codes, and any Municipal requirements.
4. Title 29, Code of Federal Regulations, Part 1926.58, Asbestos Standards for Construction Industry.
5. Title 40, Code of Federal Regulations, Part 261, Identification and Listing of Hazardous Waste.
6. Title 40, Code of Federal Regulations, Part 262, Standards Applicable to Generators of Hazardous Waste.
7. Title 40, Code of Federal Regulations, Part 264, Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.
8. Title 40, Code of Federal Regulations, Part 265, Interim Status Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities.
9. Title 49, Code of Federal Regulations, Parts 100-199, Transportation of Hazardous Materials.
10. Title 40, Code of Federal Regulations, Part 268, Land Disposal Restrictions.
11. Title 40, Code of Federal Regulations, Part 761, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.

1.05 Scheduling

A. Provide the anticipated dates for decontamination activities described herein as part of the Contract schedule.

B. The work described herein may require some general demolition of building interiors which must be coordinated with SEPTA for clearance.

C. The Contractor must coordinate and sequence these activities with the other facility decommissioning efforts taking place during the work, especially utility cutting and capping work. In certain areas, the Contractor may not be allowed to conduct work until SEPTA has completed activities in the area.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Packaging and containerization materials and equipment including, but not limited to, the following:

1. Lab packing requirements as per the disposal or recycling facility.

2. Packing and shipping materials for medical wastes and radioactive materials in accordance with aforementioned regulations.
3. Fiberboard barrels.
4. Removable head drums, roll-off boxes, or equivalent, DOT approved.
5. Drum labels and other markings which meet 29 CFR 1926.58(K) and all other federal, state, or local codes and regulations.
6. Spill prevention countermeasure materials and control products, including plastic sheeting and absorbent materials consistent with the requirements of 49 CFR 173 and the Contractor's spill control plan.
7. Sampling equipment and containers which are consistent with standard USEPA sampling techniques or other appropriate containers.

PART 3 - EXECUTION

3.01 General

A. The Contractor shall be responsible for all worker health and safety procedures, including requirements by SEPTA and personal protection equipment and worker notification, during the removal, handling, and management of all hazardous and regulated materials.

3.02 Removal of Regulated Batteries

A. General:

1. Regulated batteries (lead-acid, nickel-cadmium, NiMH or dry type) may be present throughout the facility, typically in emergency light fixtures, equipment, backup systems, process equipment, control panels or in bulk. The Contractor shall be responsible for the removal and proper handling of all batteries within the Contract limits.
2. Many emergency light fixtures, battery backup systems and/or associated components may be suitable for recycling. The Contractor is encouraged to account for the recycling of such fixtures. Those fixtures which are not suitable for recycling shall be handled and disposed accordingly.

B. Removal Procedures:

1. The Contractor shall locate all regulated batteries throughout the facility and disconnect related electrical or communication feeds. All batteries should be removed from the associated devices. In the event that fixtures, or devices may be resold, the Contractor shall remove the entire unit and its components.
2. The Contractor shall properly collect, label and stage all batteries throughout the facility. Batteries must be sorted by type and place in separate collection containers, with the lead-acid battery containers labeled as a hazardous waste. Battery collection containers and storage areas should be well ventilated to eliminate any potential explosion dangers. All batteries shall be recycled or disposed appropriately.

3.03 Removal of Fluorescent and Other High Intensity Lamps

A. General:

1. Throughout the facility, fluorescent bulbs are present either in fixtures or stored in bulk. High-intensity mercury or halide vapor lamps are located throughout the interior and exterior of the buildings, and on light poles throughout the property.

2. Many light fixtures and/or associated components may be suitable for recycling or resale. The Contractor is encouraged to account for the recycling or resale of such fixtures in its bid. Those fixtures which are not suitable for recycling shall be removed and disposed appropriately.

B. Removal and Management Procedures:

1. The Contractor shall be responsible for the removal of all regulated lamps from the associated lighting fixtures. All lamps shall be carefully removed from the fixtures and placed in appropriately sized containers equipped with dividers to isolate bulbs.

2. The Contractor shall manage fluorescent bulbs using one (1) the following procedures:

a. Transport all bulbs to a SEPTA approved waste management company for recycling or disposal, or

b. Crush bulbs on-site using an appropriate and regulatory acceptable portable crushing unit. The crushing unit must be self-contained to prohibit emissions. A portable crusher may only be used if local or state regulations allow such use. The Contractor shall demonstrate that a portable crusher is acceptable prior to mobilization.

C. All bulb containers intended for off-site recycling shall be either shrink-wrapped or placed in a secure crate to avoid accidental breakage. All containers shall be labeled as hazardous waste in accordance with applicable DOT regulations, unless the waste is demonstrated as non-hazardous.

D. The Contractor must use appropriate precautions when handling lamps to avoid accidental breakage. Should accidental breakage of lamps occur, then the lamp debris shall be collected and placed in segregated reinforced drums or similar containers pending disposal.

3.04 Removal of Fluorescent and High Intensity Light Ballasts

A. General:

1. Throughout the facility, numerous fluorescent light ballasts and high intensity lamp ballasts are present either in fixtures or in bulk. The ballasts vary in size and may contain PCBs in excess of regulatory requirements. The Contractor shall be responsible for the removal, inspection, and management of all PCB-containing ballasts according to all federal, state and local requirements.

2. All ballasts shall be inspected for manufacturer indications of the presence or absence of PCBs. Those ballasts which are labeled as non-PCB containing shall be managed separately from those which are to be assumed to contain PCBs until verified with the manufacturer.

3. For ballasts with no obvious markings verifying that no PCBs are present, the Contractor is encouraged to further verify the presence of PCBs in ballasts by contacting the manufacturers to obtain records, if available, of the contents in the ballast models.

B. Removal and Handling of Ballasts:

1. The Contractor shall inspect each ballast within each light fixture in an effort to view the ballast labeling. If a label clearly indicates that the ballast is non-PCB (e.g., label reading "PCB Free" or "No PCBs"), the ballast may remain in the fixture (if the scope of work dictates the fixture is to remain). All other ballasts encountered, labeled or unlabeled, shall be removed from the lighting fixture. The Contractor shall use caution so as to not open or damage the ballasts during removal and handling.

2. The Contractor shall stage all removed ballasts on-site in reinforced containers with appropriate labeling according to 40 CFR 761. The Contractor shall employ adequate spill or leak prevention measures for each storage container. The Contractor shall follow the Contractor's spill control plan when handling all ballasts.

3. The assumed PCB-containing ballasts will be transported and disposed at a SEPTA approved waste management company licensed to accept PCB wastes.

3.05 Removal of Mercury Containing Devices

A. Mercury containing devices may be present within the Contract limits, primarily in thermostats, equipment switches (Mercoid controls, ignitron switches), duct thermometers, temperature switches and other devices. The Contractor shall be responsible for the removal of all mercury containing items within the Contract limits of the scope of work.

B. Each mercury containing device shall be removed from its related equipment and staged in a secured bucket or other approved container. When removing and handling the mercury items, the Contractor must employ all measures outlined in the Contractor's spill control plan to prevent possible leakage due to container damage.

C. The Contractor shall transport all mercury containing items according to all applicable DOT regulations for recycling or disposal.

3.06 Removal of Miscellaneous and Bulk Chemicals

A. General:

1. Small-volume (<5 gallons) and large-volume (>5 gallons) miscellaneous chemicals may be present throughout the facility. These containers may be labeled or unlabeled.

2. The Contractor shall be responsible for the identification, removal, characterization, transport and disposal of all miscellaneous chemicals within the Contract limits of the scope of work.

B. Identification and Classification of Miscellaneous Containers:

1. The Contractor shall set up an on-site staging area to organize and inspect all miscellaneous containers. The staging area must have adequate spill control measures and the Contractor's spill control plan. The Contractor shall segregate all miscellaneous chemicals into waste classifications, if possible, based on state regulations and requirements of SEPTA approved disposal or reclamation companies. If appropriate and allowable, the Contractor may use a bulking scheme for grouping similar types of chemicals.

2. The Contractor may consolidate non-hazardous oils or other products found in the containers with other non-hazardous equipment oils removed in bulk if the Contractor

can demonstrate safe practices, regulatory acceptance of such measures, and in doing so does not co-mingle hazardous wastes with non-hazardous wastes.

3. Upon completion of the staging and identification of chemical containers, the Contractor shall coordinate and/or characterize, if necessary, to facilitate disposal. All transportation and disposition of the miscellaneous containers shall be performed by the Contractor.

4. Lab-packing of many containers may be required. The Contractor shall coordinate with the transporter and/or disposal or recycling facility for specific lab-packing requirements.

3.07 Removal of Pressurized Gas Cylinders

A. Pressurized gas cylinders may be present that contain oxygen, nitrogen, helium, acetylene and other substances. The Contractor is responsible for removal of all pressurized gas cylinders present within the Contract limits. The Contractor shall properly collect, label and stage all gas cylinders throughout the facility. The cylinders shall be staged pending transport in a manner that will minimize the potential for discharge or damage. Management, transportation and recycling or disposal is the responsibility of the Contractor.

3.08 Removal of Surface Residues

A. The Contractor shall remove dust and oily residuals and other residues (where designated). Wash water and residuals generated during floor and surface cleaning efforts shall be collected and containerized in appropriate vessels. The Contractor shall stage, characterize, and dispose or treat wash water and residuals.

B. The handling of surface residues and wash water must be performed in accordance with the Contractor's spill control plan.

3.09 Removal of Non-Hazardous Equipment Oil

A. Oil-containing equipment associated with building control systems are present throughout the facility. In general, types of oil-containing equipment include, but are not limited to air compressors, HVAC compressors, chill water compressors, pumps, fans, motors, gear housings, hydraulic equipment and reservoirs, and elevator motors. The general locations for this equipment are provided in Environmental Investigation Report.

B. Certain equipment may contain oil impacted with PCBs. In these cases, oils shall be removed and managed separately from non-PCB containing oil. PCB containing oils may be managed and disposed by the Contractor (See Section 2082).

C. The Contractor shall drain free-flowing oil from any oil-filled item located on the property, providing it contains more than the minimal amount of fluid. All oil shall be drained into appropriate storage containers, consolidated if appropriate and allowed, and staged on-site with proper labeling pending transport to a SEPTA approved waste management company. Handling of oil must be performed in accordance with the Contractor's spill control plan.

3.10 Cleaning of Concrete Flooring

A. The Contractor shall be responsible for cleaning accumulations from building surfaces as described in Article 1.01/C in this Section prior to demolition.

B. Within each designated area, the Contractor shall first remove bulk accumulations. These materials shall be placed in an appropriate container pending future transport and disposal by the Contractor.

C. Upon removal of non-liquid accumulations, each resulting area shall be cleaned. An independent report will be provided. Slab locations with oily accumulations shall be cleaned until there are no further signs of free-flowing oil emanating from the concrete surface, or until it is determined that surface cleaning will not sufficiently decontaminate the concrete matrix. This determination shall be made in conjunction with SEPTA.

D. Areas with accumulations of grime, ash, dirt, wax, grease, dust, sludge, paint build-up, loose paint, coal, ash, etc. shall be cleaned to remove such materials prior to demolition. An independent report will provide further direction. Solid materials not appropriate for inclusions with wash water waste streams shall be managed separately.

E. The Contractor shall employ all residual collection, handling, and management procedures and precautions based on their approved spill control plan.

3.11 Cleaning of Walls and Elevated Building Surfaces

A. The Contractor shall clean grime, staining, dust, dirt, flaking paint, coal, ash, and other waste material from building walls and elevated building surfaces to remain. An independent report will provide further direction. Wash water shall be collected and managed by the Contractor.

B. If the structure(s) is/are to be demolished, or otherwise included as part of the scope of work, the Contractor shall clean elevated building surfaces to remove excess dust, dirt, grime, rust and other loose materials. If requested, the Contractor shall assist SEPTA with access to the overhead areas. Assistance may include provision of man lifts or other means to facilitate access.

C. The Contractor shall employ all residual collection, handling, and management procedures and precautions according to their approved spill control plan.

D. A final cleaning of the building floor shall be completed by the Contractor to achieve a "broom clean" state prior to demobilization.

3.12 PCB Impacted Concrete Surfaces

A. General:

1. PCB-impacted surfaces may be present in electrical TPSSs or other areas within the facility that are regulated under 40 CFR 761 (TSCA), as specified in the scope of work and/or appendices. The Contractor shall be responsible for decontaminating any such areas throughout the facility, if required by the scope of work (See Section 2082 for PCB abatement).

B. Decontamination of Concrete:

1. Within each designated area, the Contractor shall decontaminate the PCB-impacted concrete. Upon completion, the Contractor, in coordination with SEPTA, will confirm proper decontamination through collection and analysis of verification wipe, chip, or core samples, as directed.

2. In the event that the impacted surface(s) are to be removed as part of the overall Contract, the Contractor may remove the concrete slabs or surfaces in full and manage as PCB-impacted waste.

3. Unless otherwise specified, decontamination shall continue until verification samples indicate that PCB-impacted concrete is below the stipulated concentrations from wipe sampling or chip/core sampling. Verification sampling is not required if the slab or surface is removed in full. For waste characterization sampling, the Contractor is encouraged to contact waste companies to identify the method of characterization sampling (wipe vs. bulk) desired by the disposal facility.

4. The Contractor shall employ all collection, handling, and management procedures and precautions.

5. Any decontamination materials used shall be managed by the Contractor.

3.13 Cleaning of Sanitary and Storm Sewer Piping and Drains

A. General:

1. The Contractor shall clean all underground storm and sanitary sewer piping and collection points located on the facility. This shall include removal of any sediments or non-aqueous liquids (if present), followed by cleaning or flushing of the piping. It is the Contractor's responsibility to locate and access all piping.

B. Cleaning of Sewer Piping:

1. The Contractor shall clean residual materials from all sanitary and storm sewer piping, collection drains and manholes.

2. The Contractor shall clean all materials so that no residual solid materials from storm water catch basins will infiltrate the municipal sewer during the residual cleaning efforts.

3. Once the washing activities are completed, a record of cleaning is to be submitted for the sanitary and storm piping. Designated piping sections may then be capped and/or abandoned.

4. If required as part of the scope of work, storm and sanitary sewer piping and related manholes, sumps, drains and chambers shall be video scoped after cleaning. All piping greater than 4 inches inside diameter shall be video scoped.

5. The Contractor is responsible for the characterization, management, and disposal of any residual materials contained within the sewer systems that are not suitable for discharge to the municipal or plant-specific systems, either as-is or pre-treated by the Contractor.

3.14 Cleaning of Process Piping

A. General:

1. The Contractor shall clean/decontaminate all underground process piping (including, but not limited to, automotive fluid, hydraulic fluid, fuel oil, paint, industrial sewer, paint waste, solvent, and used oil piping) and related drains located on the property to the level necessary to facilitate disposal of the piping. This shall entail removal of any residual materials, including hazardous and non-hazardous solids or non-aqueous liquids (if present). It is the Contractor's responsibility to locate and access all piping.

B. Cleaning of Piping:

1. The Contractor shall remove any residual solids, liquids, or sludges within underground process piping using a method appropriate for the nature and use of the piping (i.e., turbo vacuum, flushing, compressed air, etc.).

2. Residual materials and decontamination wastes shall be collected in appropriate containers and staged in designated areas pending off-site transport. The Contractor is responsible for the characterization, management, and disposal of any residual materials contained within the process piping systems that are not suitable for discharge to the municipal system, including solids and fluids.

3. All spill prevention and control and countermeasures must be employed as per the Contractor's spill control plan.

4. Once the decontamination activities are completed, a record of cleaning for the specific segments of process piping shall be issued to SEPTA. Piping may then be removed or abandoned based on the scope of work.

3.15 Cleaning of Below-Ground Structures

A. General:

1. The Contractor shall clean all below-ground structures present within the Contract limits. These underground systems include pits, vaults, manholes, sumps, tunnels, basements and other structures associated with the process, utility and building control systems. This work shall include removal of residual materials and cleaning.

2. The Contractor shall be responsible for removal of all residual materials contained in the below-ground structures, regardless of volume or composition.

3. Sampling and analysis data for residuals from select pits may be included in the Reference Documents Environmental Investigation Report. If present, this data may be used by the Contractor to assist in disposal arrangements as needed; however, any and all additional sampling and analysis required to facilitate disposal acceptance shall be the responsibility of the Contractor.

B. Cleaning of Below-Ground Structures:

1. The Contractor shall initially remove any residual materials present within the designated below-ground structures. Removal may be conducted using a turbo vacuum, manual or equivalent method. The removed materials shall be staged on-site in lined and properly labeled drums, portable tanks or equivalent.

2. The Contractor shall be responsible for the disposition of all residual materials, solid or liquid.
3. Upon removal of residual materials, the Contractor shall clean below-ground structures. Cleaning shall continue until no loose materials, accumulations, residues or liquids remain.
4. After completion of the cleaning process, a visual inspection will be performed by SEPTA. Surfaces shall be accepted as clean when there are no observable loose solids, accumulations, residues or liquids. If such structures and surfaces do not meet these minimum requirements the Contractor shall repeat decontamination as directed by SEPTA at no additional cost to SEPTA unless otherwise stipulated.
5. Upon completion of decontamination of the below-ground structures, the Contractor shall furnish a record of cleaning to SEPTA.
6. The Contractor may abandon/backfill the below-ground structures only upon receiving formal clearance from SEPTA.
7. The Contractor shall employ all water collection, handling and management procedures according to their approved spill control plan.

END OF SECTION

THIS PAGE NOT USED

SECTION 02081

ASBESTOS ABATEMENT

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of the demolition, removal, and disposal of existing construction from the areas shown on the Contract Drawings; and, as required, to execute the work of this Contract including, but not necessarily limited to complete or partial demolition and removal of the following:

1. Removal of suspect asbestos containing materials.

B. Asbestos containing materials may be located in building areas not accessed during sampling. All materials listed in the USEPA's publication "Managing Asbestos in Place," in the Reference Documents, are suspect and shall require testing or special handling in accordance with this Section.

C. Removal of non-friable asbestos containing caulk and PACM roofing materials shall be performed in such a manner that the materials remain non-friable during the renovation. Roofing materials were not sampled and are presumed to be asbestos containing unless otherwise shown through laboratory testing. It is the Contractor's responsibility to ensure that the materials are removed without rendering the material friable.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01045 – Cutting and Patching

C. Section 01060 – Regulatory Requirements and Safety

D. Section 01300 – Submittals

E. Section 02070 – Selective Demolition

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:

1. Submit statements or drawings that indicate the means and methods that will be employed to remove the presumed roofing materials and other suspect materials. This should include the methods employed for adequately maintaining the non-friable conditions during the removal.

2. The Contractor shall submit a letter from a permitted hazardous waste facility, stating that the facility has agreed to accept the waste generated by the work; is authorized to accept the waste under laws of the state of residence; has the required capacity to treat and dispose of the materials; and will provide or ensure the ultimate disposal method indicated on uniform hazardous waste manifest.

3. Submit a copy of any and all testing and reporting to SEPTA.

1.04 Quality Assurance

A. During the bid period, it is recommended to inspect and examine the construction site and existing construction to be removed and determine the type of renovation or demolition required or dismantlement procedure, physical conditions, and any contingency that could be encountered during the renovation or demolition procedures.

B. Conduct building demolition so SEPTA's operations will not be disrupted.

1. Provide not less than seventy-two (72) hour notice to SEPTA of activities that will affect SEPTA's operations.

2. Not later than ten (10) working days prior to commencing work, submit required written notification to the Pennsylvania Department of Environmental Protection, Pennsylvania Department of Labor and Industry, U.S. Environmental Protection Agency and local authorities having Contract jurisdiction. Provide copies of such notifications to SEPTA.

3. Maintain access to existing walkways, exits, and other adjacent occupied or used facilities. Do not close or obstruct walkways, exits, or other occupied or used facilities without written permission from the SEPTA Project Manager.

C. Consider the safety of the work, safety of the people, and property on and adjacent to the work site when determining equipment movement and use of materials and equipment on the work site. Meet the safety requirements specified in Sections 01060. All work shall be undertaken in accordance with applicable federal, state and local regulations, standards, codes and guidelines.

1. Where the safety of persons is endangered within or adjacent to the area of renovation or demolition work, provide protection in accordance with requirements.

D. Arrange renovation or demolition schedule so as not to interfere with on-site operations. Do not unduly inconvenience SEPTA employees by demolition activities.

E. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

F. Storage or sale of removed items or materials on-site is not permitted.

G. Meet the applicable provisions of the most recent issues of the following references:

1. Codes and regulations of the jurisdictional authorities.

2. ANSI Standard Safety Code for Building Construction.

3. OSHA Standards as applicable.

4. United States Environmental Protection Agency, Managing Asbestos in Place.

5. NFPA 241, Standard for Safeguarding Construction, Alteration, and Demolition Operations.

6. City of Philadelphia, Department of Public Health. Removal of Friable or Rendered Friable Asbestos Containing Roof Materials, December 13, 1994.

7. City of Philadelphia, Department of Public Health. Asbestos Control Regulations, March 4, 1993.

8. National Emissions Standards for Hazardous Air Pollutants (NESHAP), Subpart M – National Emission Standard for Asbestos.
9. Commonwealth of Pennsylvania:
    a. Department of Labor and Industry, Asbestos Occupations Accreditation and Certification Act of 1990, No. 194 as amended by Act. No. 161 effective 2/20/99.
    b. Pennsylvania Department of Environmental Protection Title 25 Rules and Regulations, Chapter 124, National Emission Standards for Hazardous Air Pollutants.
    c. Department of Labor and Industry, Worker and Community Right-To-Know Act 1984-159.
    d. Pennsylvania Department of Environmental Protection, Act 97, the Solid Waste Management Act of July 7, 1980.
    e. Pennsylvania Department of Environmental Protection Title 25 Rules and Regulations, Chapter 109, Pennsylvania Safe Drinking Water Act.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 General Demolition

A. Demolish indicated portions of existing building completely in accordance with Section 02070. Use methods required to complete the work within limitations of governing regulations and as follows:
    1. Remove non-friable asbestos containing materials and presumed asbestos containing materials.

B. Control and prevent the spread of dust to occupied portions of the site and avoid creation of a nuisance in the surrounding area.
    1. Use water mist and other suitable methods to limit spread of dust and dirt. Meet the governing environmental protection regulations. Do not use water when it may damage adjacent construction or create hazardous or objectionable conditions, such as ice, flooding and pollution.

C. Remove trash and debris daily unless otherwise directed by the SEPTA Project Manager and do not allow construction debris and waste materials to accumulate.

D. Perimeter air monitoring shall be conducted to ensure the safety of SEPTA's employees and passengers during all removal activities. This shall be conducted through a licensed building inspector. Copies of the air monitoring data shall be posted on-site the next day after collection, and copies shall be sent to System Safety in-conjunction with sample analysis.

E. An Asbestos Supervisor is required to be on-site for the duration of the abatement work, including roof removal activities. The Contractor shall submit a copy of the Supervisor's current license with the bid documents.

F. All manifests shall be submitted to SEPTA no later than thirty (30) days after disposal.

3.02 Cleaning

A. Clean adjacent structures and improvements of dust, dirt, and debris caused by building renovation or demolition activities. Return adjacent areas to the condition existing prior to commencement of renovation or demolition activities.

END OF SECTION

SECTION 02082

PCB ABATEMENT

PART 1 - GENERAL

1.01 Description

A. This Section specifies the inventory and specific information on the quantities of Polychlorinated Biphenyl (PCB) containing materials at each location will be provided in Reference Documents.

1.02 Related Sections

A. Section 02080 - Hazardous Material Abatement

1.03 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Department of Transportation (DOT).
2. Title 40, Code of Federal Regulations, Part 761, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.
3. Toxic Substance Control Act (TSCA).

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Removal of PCB Containing Electric Equipment and Dielectric Fluids (Non-TSCA)

A. The Contractor shall remove and manage non-TSCA regulated PCB containing electrical devices in accordance with this section and 40 CFR 761 (TSCA) as appropriate. Any positive detection of PCBs, regardless of whether they are considered TSCA regulated, are considered PCB containing.

B. The Contractor shall drain and containerize free flowing oil from each transformer or capacitor into appropriate containers or vessels. The containers shall be properly labeled and staged in a secure area equipped with secondary containment in accordance with the Contractor’s spill control plan. Any oil which drains from these devices shall be containerized and stored on-site in DOT approved drums and appropriately labeled.

C. The recovered dielectric fluid shall be transported to an approved disposal or reclamation facility that is licensed to accept PCB wastes. Documentation that the specified facility has been informed of, and has acknowledged, the PCB contents must be provided prior to off-site transport. Final disposition of the PCB containing dielectric oil shall be the responsibility of the Contractor.

D. Upon completion of the draining and cleaning, SEPTA will authorize the Contractor to remove the transformer/capacitor carcasses for recycling or disposal.

3.02 Removal of PCB Containing Electrical Equipment and Dielectric Fluids (TSCA Regulated)

A. In the event that oil filled transformers, capacitors or other items are determined to contain PCBs above 50 ppm, the Contractor shall manage these devices under strict accordance with 40 CFR 761.60 (TSCA).

B. The Contractor shall drain and containerize free flowing oil from TSCA regulated equipment into appropriate container or vessel. The containers shall be properly labeled and staged in a secure area equipped with secondary containment in accordance with the Contractor's spill control plan. Any oil drained from these devices shall be containerized and stored on-site in DOT approved containers and labeled in accordance 40 CFR 761.

C. Upon draining all free flowing oil, the Contractor shall seal all transformer or capacitor openings and stage each empty carcass for subsequent off-site transport. The carcasses shall exhibit proper labeling indicating that they have been emptied.

D. All TSCA regulated PCB dielectric oil, equipment carcasses and related items shall be transported to a SEPTA approved waste facility that is licensed to accept PCB wastes under TSCA. On-site solvent washing of the carcasses is prohibited unless pre-approved by SEPTA.

E. The Contractor shall ensure that formal records of destruction are obtained from the disposal facility for each device and shall issue these records to SEPTA upon receipt.

F. All manifests shall be submitted to SEPTA no later than thirty (30) days after disposal.

3.03 Removal of PCB Containing Electrical Cable (Above Ground)

A. The Contractor shall be responsible for de-energizing electrical cable and providing access so the Contractor can obtain samples and characterize oil impregnated cable wrap. Analytical results shall be submitted to SEPTA for verification upon receipt.

B. The Contractor shall disconnect PCB containing cables at the terminal points and other strategic locations (providing there is no effect on electrical systems to remain), employing all appropriate spill control and prevention methods identified in the Contractor's spill control plan. Any oil which drains as a result of disconnection shall be containerized and stored on-site in DOT approved containers and labeled as "PCB containing electrical oil" or equivalent, unless otherwise stipulated.

C. All PCB containing cable and oil shall be staged on-site in a secured, spill controlled area as per the Contractor's spill control plan. Transport and disposal of the PCB containing cable and oil shall be the responsibility of the Contractor.

D. Electrical cable containing PCBs at concentrations below 50 ppm may be recycled, provided the recycler is notified in advance. The Contractor must demonstrate that the recycler has been notified and accepts this condition and receive authorization from SEPTA that recycling of such materials will be allowed.

E. Electrical cable containing PCBs at concentrations equal to or above 50 ppm shall be managed in accordance with applicable TSCA regulations. Under no circumstances shall any PCB containing cable insulation, sheathing, or other contents be stripped or metal removed onsite.

3.04 Removal of PCB Containing Electrical Cable (Below Ground)

A. The Contractor shall locate and protect underground electrical manholes and vaults prior to demolition, such that the structures are not damaged during site work and can be accessed after demolition.

B. If required as part of the scope of work, underground electrical cables shall then be cut and removed from manholes and, removed from the duct banks, including wiring, conduit, hangers, clamps, supports, etc. back to the Traction Power Substation (TPSS) feeders, mains and electrical buses. Electrical bus plugs shall be removed and turned over to SEPTA. The Contractor shall plug or cap penetrations through the floor slab to prevent debris or water from entering the duct bank system.

C. Care shall be taken to prevent the release of fluids from the cabling during removal. The Contractor shall collect any fluids released from the structures from which cabling was removed, including manholes, duct banks, vaults and other structures.

D. Electrical cable may include PCB containing insulation or asbestos wrapping. The Contractor shall be responsible for de-energizing cable and provide access so that the Contractor can sample and characterize oil impregnated cable wrap. Analytical results shall be submitted to SEPTA for verification upon receipt.

3.05 Removal of Other PCB Containing Building Materials

A. The Contractor shall be responsible for the verification, removal or other management of all PCB containing building materials referenced herein in accordance with all applicable federal, state and local requirements.

B. The Contractor is encouraged to further verify the presence of PCBs in the above referenced materials in an effort to reduce the volume of material to be disposed.

C. Building materials considered manufactured with PCBs (caulk, expansion joint material, paint, epoxy coatings, adhesives, and other similar materials) that contain PCBs >50 ppm shall be managed in accordance with 40 CFR 761 and amendments.

1. If such materials are removed prior to demolition, they may be subject to regulation as a PCB remediation waste under 40 CFR 761 and shall be disposed at a facility licensed to accept PCB remediation waste. Confirmation of this waste designation shall be made in conjunction with SEPTA.

2. If such materials are not removed prior to demolition, as directed by the scope of work, the demolition debris may be considered a bulk product waste, as defined by 40 CFR 761, and disposed at a solid waste landfill licensed to accept PCB containing materials. Characterization of in-place materials must be performed to demonstrate PCB content of debris generated during demolition. The Contractor must notify the designated landfill through waste disposal profiles or other formal documentation that PCBs are present in certain materials, and include all related data, including characterization results; demonstration of notification and acceptance by the disposal facility is required. Confirmation of this waste designation shall be made in conjunction with SEPTA.

D. Window caulk and expansion joint materials may also contain asbestos. The removal and management of such materials containing both asbestos and PCBs shall be conducted in a

manner that meets regulations governing the handling and management of both such materials.

3.06 Removal of PCB Containing Building Materials

A. The Contractor shall manage the other PCB containing building materials (>50 ppm) referenced herein in one (1) of the following manners:

1. If directed as part of the scope of work, the Contractor shall remove and dispose PCB impacted concrete, caulk, expansion joint materials, epoxy coatings, paints, and other like materials confirmed to contain PCBs using manual techniques prior to demolition. In areas where this work will occur, plastic sheeting or equivalent cover shall be placed on the underlying and/or adjacent surfaces to prevent uncontrolled accumulations of removed materials. The materials shall be removed separately from other demolition debris, carefully segregated, and staged pending disposal.

2. If directed as part of the scope of work, the Contractor may demolish the affected structures with the above referenced materials in place (with the exception of structural materials related to electrical TPSSs or other items that are impacted from TSCA regulated releases and/or considered "PCB Remediation Wastes" under TSCA) provided the work is done in a manner that does not result in uncontrolled disassociation of these materials from the building surfaces. Resulting debris shall be segregated and isolated from other wastes and general debris during demolition.

B. If required by the scope of work, structural materials adjacent to caulk/expansion materials (i.e., concrete, block, brick) and/or concrete slabs shall be saw cut at specified locations. Care shall be taken to prevent the uncontrolled release of dust and fragments during the saw cutting. All dust and fragments shall be removed in full and managed in the same manner as the removed materials. Water used during the saw cutting shall be controlled, containerized and managed accordingly.

C. Upon completion of removal efforts, the Contractor shall inspect the area of work for extraneous pieces of the PCB containing materials and remove as necessary.

D. The Contractor shall stage removed materials and related items on-site in reinforced containers with appropriate labeling according to 40 CFR 761.

END OF SECTION

SECTION 02083

HEAVY METALS ABATEMENT

PART 1 - GENERAL

1.01 Description

A. This Section describes to requirements for heavy metals abatement for the Traction Power Substation (TPSS) sites.

1.02 Related Sections

A. Section 02085 - Lead Paint Abatement

1.03 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Tile 29, Code of Federal Regulations, Part 1920, Procedures for Variations from Safety and Health Regulations under the Longshoremen's and Harbor Workers' Compensation Act.
2. Title 29, Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Removal of Bulk Lead-Containing Materials

A. The Contractor shall locate and remove the bulk lead-containing materials from the facility within the Contract limit in accordance with all applicable and appropriate worker health and safety measures under 29 CFR 1920 and 1926.

B. The Contractor shall properly stage all lead-containing bulk items in a manner that minimizes contact with other media, such as precipitation and unpaved areas. Staged containers shall be properly labeled and placed in a restricted area.

C. Lead-containing bulk materials shall be recycled or disposed by the Contractor.

3.02 Removal and Management of Process Wastes (Solid)

A. Solid process-related wastes may be present throughout the facility. The locations and estimated quantities for these and any other items have not been estimated.

B. Characterization of process wastes shall be performed by the Contractor. In the event that the waste materials are considered regulated upon characterization or other means, the materials must be managed appropriately by the Contractor and disposed of by a SEPTA

approved waste management or recycling company. The Contractor shall identify its procedures and logic for managing the process wastes in its waste management plan.

C. All manifests shall be submitted to SEPTA no later than thirty (30) days after disposal.

END OF SECTION

SECTION 02084

PETROLEUM CONTAMINATED MATERIAL ABATEMENT

PART 1 - GENERAL

1.01 Description

A. This Section describes the requirements for petroleum contaminated material abatement.

B. Meet the applicable provisions of the most recent issues of the following references:

1. Title 40, Code of Federal Regulations, Part 761, Polychlorinated Biphenyls (PCBs) Manufacturing, Processing, Distribution in Commerce, and Use Prohibitions.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 General

A. For the purposes of this Specification, "non-PCB" electrical equipment is defined as any transformer, capacitor, or other oil-filled equipment that is labeled as "non- PCB", "PCB free" or equivalent manufacturers markings, and where testing has shown no detectable concentrations of PCBs. Any positive detections of PCBs, regardless of whether they are TSCA regulated, are considered "PCB containing" for the purposes of this manual. This definition should not be confused with the definition of PCB containing included in 40 CFR 761.

B. Oil-filled transformers and capacitors are present in various Traction Power Substations (TPSSs) and related areas. A description of these units, including volume of oil and chemical content, is provided in the Environmental Investigation Report.

C. The Contractor shall be responsible for the removal and management of all transformers, capacitors, dielectric oil, and other oil-containing equipment within the Contract limits of the scope of work, in accordance with applicable regulations, waste management guidelines set forth herein, and the Contractor’s spill control plan.

D. Primary power cable containing oil-impregnated insulating material may be present throughout the property.

E. The Contractor shall be responsible for all applicable worker safety requirements and notification when managing electrical equipment. The Contractor shall be responsible for all aspects of the handling and disposition of non-PCB and PCB containing substances.

F. The Contractor shall be responsible for the cleanup of any and all dielectric oil released to the environment during these activities.

G. All manifests shall be submitted to SEPTA no later than thirty (30) days after disposal.

3.02 Removal of Non-PCB Electrical Equipment and Dielectric Fluids

A. The Contractor shall drain and containerize free-flowing oil from the non-PCB transformers designated for removal, and any other electrical items that may be accessed without destruction. The oil from these units shall be placed into reinforced drums or other approved containers. The Contractor may consolidate the dielectric oil with other non-hazardous equipment oils collected as described in this Section. Final disposition of the non-PCB transformer oil shall be performed by the Contractor.

B. The Contractor may clean or wash the interior of the non-PCB transformers as appropriate. Rinse liquids may be consolidated with the removed oil and shall be managed and disposed of by the Contractor.

C. Upon completion of the draining and cleaning, SEPTA will authorize the Contractor to remove the transformer/capacitor carcasses for disposition.

D. Oil-containing equipment is not to be transported off-site unless drained, or unless prior approval is provided by SEPTA.

END OF SECTION

SECTION 02085

LEAD PAINT ABATEMENT

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of the renovation, removal and disposal of existing construction from the areas shown on the Contract Drawings; and, as required, to execute the work of this Contract including, but not necessarily limited to complete or partial renovation and removal of the following:

1. All work which disturbs surfaces that are coated with lead based paint must be performed in accordance with the Occupational Safety and Health Administration (OSHA) 29 Code of Federal Regulation (CFR) Part 1926.62, Lead Exposure in Construction; EPA 40 CFR Part 745 Lead; PA Law 291, No. 44 Lead Certification Act; and City of Philadelphia Regulations. In addition, all other applicable federal, state and local codes, rules and regulations must be adhered to by the Contractor.

2. The Contractor shall be aware that Lead Based Paint (LBP) has been identified within the proposed renovation Project and must be familiar with the OSHA lead in construction standard and its requirements. In addition, all waste generated as part of the renovation Project should be tested in order to determine the classification of waste. The USEPA defines hazardous waste as waste containing the minimum concentration of a particular contaminant identified by the Toxicity Characteristic Leaching Procedure (TCLP). The USEPA regulatory level for lead (EPA Code: D008) is 5 parts per million (5 ppm).

B. The scope of work includes the testing and removal of lead based paint in each Contract that will be disturbed by the renovation and/or demolition.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01045 – Cutting and Patching

C. Section 01300 – Submittals

D. Section 02070 – Selective Demolition

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:

1. Submit statements or drawings that indicate the means and methods that will be employed to remove the Lead Based Paint (LBP). This should include the methods employed for adequately removing and disposing of the LBP.

2. The Contractor shall submit a letter from a permitted hazardous waste facility, stating that the facility has agreed to accept the waste generated by the work; is authorized to accept the waste under laws of the state of residence; has the required capacity to treat and dispose of the materials; and will provide or ensure the ultimate disposal method indicated on uniform hazardous waste manifest.

3. Submit a copy of any and all testing and reporting to SEPTA.

1.04 Quality Assurance

A. During the bid period, it is recommended to inspect and examine the construction site and existing construction to be removed and determine the type of renovation or demolition required or dismantlement procedure, physical conditions, and any contingency that could be encountered during the renovation or demolition procedures.

B. Conduct building renovations or demolition so SEPTA's operations will not be disrupted.

1. Provide not less than seventy-two (72) hour notice to SEPTA of activities that will affect SEPTA's operations.

2. Provide notification of the LBP removal as necessary. Provide copies of such notifications to SEPTA.

3. Maintain access to existing walkways, exits, and other adjacent occupied or used facilities. Do not close or obstruct walkways, exits, or other occupied or used facilities without written permission from the SEPTA Project Manager.

C. Consider the safety of the work, safety of the people, and property on and adjacent to the work site when determining equipment movement and use of materials and equipment on the work site. Meet the safety requirements. All work shall be undertaken in accordance with applicable federal, state and local regulations, standards, codes and guidelines.

1. Where the safety of persons is endangered within or adjacent to the area of renovation or demolition work, provide protection in accordance with requirements.

D. Do not unduly inconvenience SEPTA employees by renovations or demolition activities.

E. Storage or sale of removed items or materials on-site is not permitted.

F. Arrange renovation or demolition schedule so as not to interfere with on-site operations.

G. Protect against high and low temperatures and unfavorable environmental conditions in accordance with requirements of ACI 305R, 306R, and ACI 306.1.

H. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.

I. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 305R, Guide to Hot Weather Concreting.

2. ACI 306R, Guide to Cold Weather Concreting.

3. ACI 306.1, Standard Specification for Cold Weather Concreting.

4. EPA 40 CFR Part 745, Lead-Based Paint Poisoning Prevention in Certain Residential Structures.

5. OSHA Standards as applicable.

6. PA Law 291, No. 44 Lead Certification Act.

7. 35 Penn. Stat. § 5901 to 5916.

8. Codes and Regulations of the jurisdictional authorities.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 General Demolition

A. Demolish indicated portions of existing buildings completely in accordance with Section 02070. Use methods required to complete the work within limitations of governing regulations and as follows:

1. Remove and dispose of LBP. Additionally, wet, scrape, and stabilize loose and flaking paint.

2. No grinding, torching, saw cutting, dry scraping or sanding is permitted during the removal process.

B. Control and prevent the spread of dust to occupied portions of the site and avoid creation of a nuisance in the surrounding areas.

1. All surfaces shall be maintained free of accumulation of lead dust generated during renovation or demolition activities.

2. If applicable, separate and deposit all lead waste, including sealing tape, plastic sheeting, mop heads, sponge filters, and disposable clothing in double polyethylene bags of at least 6 mils thick and seal each bag separately.

3. No equipment, supplies or materials (except properly containerized waste materials) shall be removed from the Project work area unless such equipment, supplies, and/or materials have been cleaned free of lead debris.

4. Air monitoring by certified lead inspectors shall be conducted during the removal process to ensure no high levels of airborne lead containing dust are created.

C. Remove trash and debris daily unless otherwise directed by the SEPTA Project Manager and do not allow construction debris and waste materials to accumulate.

3.02 Work Area Cleanup and Clearance

A. Clean up procedures shall utilize HEPA filtered vacuum systems and/or wet methods, such as mopping, wet wiping, shoveling of wet debris, etc. No dry sweeping of dust, particulate matter or debris is allowed during any stage of the work affecting lead coated surfaces.

B. Conduct periodic inspections.

C. At the end of the demolition Contract, have a certified person conduct a clearance examination and provide appropriate documentation or statements of LBP compliance.

3.03 Disposal of Demolished Materials

A. The Contractor shall conduct the Mass Balance TCLP Testing for all waste generated during the renovation or demolition of the components coated with detectable levels of lead.

B. All waste shall be kept drummed, secured, labeled and stored in a designated secured storage space on-site until test results categorize all waste to be hazardous or non-hazardous.

C. The lead based waste media or other debris must be stored in a manner that does not allow entry of any hazardous material into the environment. Leak proof drums or portable bins are generally acceptable. The containers must be kept out of flood plains or areas where run off may occur. Weather resistant labels using indelible ink warning of the potential hazard associated with the material must be placed on the containers. The containers must be keyed to the samples taken.

D. All waste, after being evaluated in accordance with the TCLP test, shall be disposed of in accordance with all applicable local, federal, state, and/or county regulations.

3.04 Cleaning

A. Clean adjacent structures and improvements of dust, dirt and debris caused by building renovation or demolition activities. Return adjacent areas to the condition existing prior to commencement of renovation or demolition activities.

END OF SECTION

SECTION 02205

IMPACTED SOIL MANAGEMENT

PART 1 - GENERAL

1.01 Description

A. This Section describes the requirements for managing impact soil materials.

1.02 Submittals

A. Material Handling Plan for Non-Hazardous Contaminated Soils and Hazardous Soils:

1. Within forty-five (45) calendar days after award of Contract, the Contractor shall submit to the Engineer and SEPTA for review, a Material Handling Plan (MHP). The MHP must be approved by the Engineer and SEPTA, prior to the Contractor's commencement of work. The MHP shall, at a minimum, consist of:
    a. The Contractor's procedures for identifying non-hazardous contaminated soils and hazardous soils that will require excavation and management, including the use of real-time monitoring equipment to evaluate the nature of impacts in the field. Information on the specific model and manufacturer of organic vapor monitoring equipment and calibration procedures are to be provided. It should also include the training and experience of the personnel who will operate the equipment.
    b. The Contractor's procedures for safely handling non-hazardous contaminated soils, hazardous soils or soils which have not yet been tested but are believed to be potentially contaminated. The procedures must include personnel safety and health as well as environmental protection considerations.
    c. Name, address and telephone number of the proposed Pennsylvania accredited laboratory for analysis of representative soil samples.
    d. Identification of the Contractor's proposed waste transporter(s). This information shall include:
        1) Name and waste transporter permit number.
        2) Address.
        3) Name of responsible contact for the hauler.
        4) Telephone number for the contact.
        5) Any and all necessary permit authorizations for each type of waste transported.
        6) Previous experience in performing the type of work specified herein.
    e. All staging/stockpiling areas (if stockpiling areas are intended and available), or alternate procedures that will be used. Alternate procedures may include, but are not limited to, agreements from the intended disposal or treatment facilities to accept boring data and/or analytical data previously obtained during the site characterization so that materials may be directly loaded into vehicles for shipment to the disposal facility.
    f. A backup facility should the staging/stockpile areas become unavailable, insufficient in area or not be present by some other unforeseen difficulty.
    g. Identification of the Contractor's two (2) proposed Treatment Storage or Disposal (TSD) facilities for non-hazardous contaminated soils or hazardous soils (primary and back-up) for final disposal of the soils. The primary TSD shall be an approved soil recycling/treatment facility. The backup facility may be a recycling/treatment facility or a

Pennsylvania Department of Environmental Protection (PADEP) approved lined landfill or other facility approved by PADEP to accept this material.

h. The Contractor shall submit the following information prior to any transportation of soils regarding the temporary and final off-site TSD or facilities where it is proposing to take non-hazardous contaminated soils or hazardous soils.

1) Facility name, state identification number and EPA identification number.

2) Facility location.

3) Name of responsible contact for the facility.

4) Telephone number for contact.

5) Signed letter of agreement to accept waste as specified in this Contract.

6) Signed letter of agreement with a TSD for disposal of waste that may not be land-disposed.

7) Unit of measure utilized at facility for costing purposes.

8) A listing of all permits, licenses, letters of approval, and other authorizations to operate, which are currently held and valid for the proposed facility as they pertain to receipt and management of wastes derived from this Contract.

9) A listing of all permits, licenses, letters of approval, and other authorizations to operate which have been applied for by the proposed facility but not yet granted or issued.

10) The Contractor shall specify and describe the disposal/containment unit(s) that the proposed facility will use to manage the waste. The Contractor shall identify the capacity available in the units and the capacity reserved for the subject waste.

11) The Contractor shall provide the date of the proposed facility's last compliance inspection under RCRA.

12) A list of all active (unresolved) compliance orders (or agreements), enforcement notices or notices of violations issued to the proposed facility shall be provided. The source and nature of the cause of violation shall be stated, if known.

i. Description of all sampling and field/laboratory analyses that will be needed to obtain disposal facility approval.

B. Health and Safety Plan (HASP):

1. The Contractor shall submit, within forty-five (45) calendar days after the Contract award, a written HASP as specified herein, to the Engineer and SEPTA for review and comment. The Contractor shall make all necessary revisions required by the Engineer and SEPTA and resubmit the HASP to the Engineer and SEPTA for acceptance. Start-up work for the Contract will not be permitted until written acceptance has been issued by the Engineer and SEPTA.

2. Daily safety logs shall be maintained by the Contractor and shall be submitted to the Engineer and SEPTA either on request or on completion of the work. Training logs shall be maintained by the Contractor and submitted to the Engineer and SEPTA either on request or on completion of the work. Daily logs on air monitoring during excavation activities shall be prepared and maintained by the Contractor and submitted to the Engineer and SEPTA either on request or upon completion of the work.

3. A closeout report shall be submitted by the Contractor to the Engineer and SEPTA upon completion of the work within the defined exclusion zones. This report shall

summarize the daily safety and monitoring logs and provides an overview of the Contractor's performance regarding environmental and safety issues. The report shall carefully document all areas where contamination has been found including pictures, addresses of locations and potential sources.

4. The Contractor shall submit to the Engineer and SEPTA the name, office address and telephone number of the medical consultant utilized. Evidence of baseline medical examinations together with the evidence of the ability to wear National Institute for Occupational Safety and Health (NIOSH) approved respirators (as specified in ASSE/AIHA Z88.6) shall be provided to the Engineer and SEPTA for all construction personnel who are to enter the exclusion zones.

5. All accidents, spills, or other health and safety incidents shall be reported to the Engineer and SEPTA.

C. Water Handling Plan (WHP):

1. Within forty-five (45) calendar days after award of Contract, the Contractor shall submit to the Engineer and SEPTA for review, a Water Handling Plan (WHP) to address Removal, Treatment and Discharge/Disposal of Contaminated Water. The WHP must be approved by the Program Administration, ESS, prior to the Contractor's commencement of work. The minimum requirements for the WHP are specified in Article 3.04/B in this Section, for each type of disposal (disposal into the combined sanitary/storm sewer or off-site disposal). The Contractor shall maintain a complete, up to date copy of the WHP on the job site at all times.

1.03 Health and Safety

A. Description:

1. It is the Contractor's responsibility to stage and conduct his work in a safe manner. The Contractor shall implement a Health and Safety Plan (HASP) for contaminated/hazardous soil intrusive activities as set forth in 29 CFR 1910.120 and 29 CFR 1926.650-652. The Contractor shall ensure that all workers have at a minimum hazard awareness training. The Contractor shall segregate contaminated work area in secured exclusion zones. These zones shall limit access to the Contractor personnel specifically trained to enter the work area. The exclusion zone shall be set up to secure the area from the public and untrained personnel. The Project health and safety program shall apply to all construction personnel including persons entering the work area. In addition, the Contractor shall protect the public from on-site hazards, including subsurface contaminants associated with on-site activities. The HASP shall be signed off by a Certified Industrial Hygienist and reviewed by the Engineer and SEPTA.

2. Work shall include, but not be limited to:

a. Implementation of a baseline medical program.

b. Providing safety equipment and protective clothing for site personnel, including maintenance of equipment on a daily basis; replacement of disposable equipment as required; decontamination of clothing, equipment and personnel; and providing all other health and safety measures.

c. Providing, installing, operating and maintaining on-site emergency medical first aid equipment as specified in this Section for which payment is not provided under other pay items in this Contract.

d. Providing, installing, operating, maintaining and decommissioning all equipment and personnel decontamination facilities specified within this Section, including, but not limited to, the decontamination pad, decontamination water supply, decontamination water collection equipment and all other items and services required for the implementation of the health and safety requirements for which pay items are not provided elsewhere in this Contract.

e. Provide the minimum health and safety requirements for excavation activities within the limits of this Contract.

f. The HASP as presented in this Section is dynamic with provisions for change to reflect new information, new practices or procedures, changing site environmental conditions or other situations which may affect site workers and the public. The HASP will also address measures for community protection, accident prevention, personnel protection, emergency response/contingency planning, air monitoring, odor control and hazardous chemicals expected on site. Providing a Confined Space Entry Program as defined in 29 CFR 1910.146.

B. Environmental Consulting Services:

1. The Contractor shall retain an independent Environmental Consultant to obtain all permits and perform all field screening, air monitoring, community air monitoring, soil sampling, and health and safety services. The independent Environmental Consultant shall at a minimum provide documentation to the Engineer and SEPTA demonstrating the minimum requirements as set forth below:

a. The independent Environmental Consultant Project supervisor on site and other designated key personnel shall have a minimum of five (5) years of experience in the environmental field dealing with issues associated with contaminated soils. Such experience shall include oversight on environmental, specifically volatile organic compound and dust monitoring services as a routine part of its daily operations.

b. The independent Environmental Consultant must be experienced in work of this nature, size, and complexity and must have previous experience in working with the SEPTA.

c. The independent Environmental Consultant shall furnish a Project list identifying the location, nature of services provided, Owner, Owner's contact, contact's telephone number, Project duration and value for at least five (5) Projects.

d. The independent Environmental Consultant shall furnish to the Engineer and SEPTA a staffing plan which identifies the Environmental Consultant's key personnel and resume documenting their experience, training, licenses and education to justify their roles in the Project. A Health and Safety Officer must be designated.

e. The independent Environmental Consultant shall demonstrate that these key Project personnel have received an approved forty (40) hour OSHA Hazardous Waste Operations and Emergency Response (Hazwoper) Training including most recent eight (8) hour refresher training.

f. If conditions within the exclusion zone are deemed hazardous, then the Contractor and its independent Environmental Consultant shall ensure that all personnel working within identified exclusion zones and/or involved (direct contact) with the handling, storage or transport of hazardous and contaminated materials shall have completed a minimum of forty (40) hours of Health and Safety Training on Hazardous Waste Sites in accordance with 29 CFR 1910.120(e). The training program shall be conducted by a qualified safety

instructor. If conditions in the exclusion zone are deemed to be non-hazardous, the independent Environmental Consultant shall provide site specific training.

g. The Contractor shall ensure that on-site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations shall receive the training specified in above and at least eight (8) additional hours of specialized training on managing such operations at the time of job assignment.

C. The HASP shall meet 29 CFR 1910.120/1926.65. This document shall at a minimum contain the following:

1. Description of work to be performed.
2. Site description.
3. Key personnel.
4. Worker training procedures.
5. Work practices and segregation of work area.
6. Hazardous substance evaluation.
7. Hazard assessment.
8. Personal and community air monitoring procedures and action levels.
9. Personal protective equipment.
10. Decontamination procedures.
11. Safety rules.
12. Emergency procedures.
13. Spill control, dust control, vapor/odor suppression procedures.
14. Identification of the nearest hospital and route.
15. Confined space procedures.
16. Excavation safety procedures.

D. Measurement:

1. 25 percent of the lump sum price will be paid when the following items are implemented or mobilized:
   a. Medical surveillance program.
   b. Health and safety training.
   c. Health and safety plan.
   d. Environmental and personnel monitoring.
   e. Instrumentation.
   f. Spill control.
   g. Dust control.
   h. Personnel and equipment decontamination facilities.
   i. Personnel protective clothing.
   j. Communications.
   k. Mobilization.

2. 50 percent will be paid in proportional monthly amounts over the period of work.
3. 25 percent will be paid when the operation is demobilized and removed from the Project site.

E. Price to Cover:

1. The lump sum price bid for the health and safety requirements shall include all labor, materials, equipment and insurance necessary to complete the work in accordance with these Specifications. The price bid shall include, but not be limited to, the following:
   a. Providing training, safety personnel, air monitoring and medical examinations as specified.
   b. Providing safety equipment and protective clothing for site personnel, including maintenance of equipment on a daily basis; replacement of disposable equipment as required; decontamination of clothing, equipment and personnel; and all other health and safety activities or costs not paid for under other pay items in this Contract.
   c. Providing, installing, operating and maintaining on-site emergency medical and first aid equipment. This includes all furnishings, equipment, supplies and maintenance of all medical equipment, and all other health and safety items and services for which payment is not provided under other pay items in this Contract.
   d. Providing, installing, operating, maintaining, and decommissioning all personnel and equipment decontamination facilities, including decontamination pad, decontamination water supply, and all other items and services required for the implementation of the health and safety requirements for which pay items are not provided elsewhere in this Contract. Vehicle decontamination pads shall be included in the price of this item. Disposal of decontamination fluid shall be paid for under Article 3.04 in this Section.
   e. Spill Control:
      1) Payment shall account for furnishing, installing, and maintaining all spill control equipment and facilities. Payment will include equipment and personnel to perform emergency measures required to contain any spillage and to remove spilled materials and soils or liquids that become contaminated due to spillage during work within the exclusion zones and handling of excavated soils and liquids from these areas. This collected spill material will be properly disposed of.
      2) Payment under this item shall not include testing, handling, transportation or disposal of petroleum-contaminated/potentially hazardous soils excavated during construction. The price for this work will be paid for under Articles 3.01, 3.02 and 3.03 in this Section as appropriate.
   f. Dust Control:
      1) Payment shall account for furnishing, installing, and maintaining dust control equipment and facilities to be used whenever applicable dust levels are exceeded. Payment will include all necessary labor, equipment, clean water, foam and all other materials required by the Dust Control Plan. The DOH Community Air Monitoring Plan (CAMP) may be used as guidance.
   g. Vapor/Odor Suppression:
      1) Payment shall account for furnishing, installing and maintaining vapor/odor control equipment and facilities to be used whenever organic vapor monitoring or the presence of odors indicates that vapor suppression is required to protect workers or the public. Payment will include all necessary labor, equipment, clean water, foam and all other materials required by the Vapor/Odor Suppression Plan.

h. Mobilization/Demobilization:

1) Mobilization:

a) Payment shall include but not be limited to:

i. All work required to furnish, install and maintain all signs, fencing, support zone facilities, parking areas and all temporary utilities.

ii. All work required to furnish, install, and maintain an office space with phone and utilities for health and safety personnel.

iii. All work required for complete preparation of lay down area for roll-off containers, including sampling and any required fencing.

iv. All direct invoiced cost from bonding companies and government agencies for permits and costs of insurance.

v. All other items and services required for mobilization and site preparation.

2) Demobilization:

a) Payment shall include but not be limited to all work required to sample the area; remove from the site all equipment, temporary utilities and supporting facilities; performance of necessary decontamination and repairs; disposal of disposable equipment and protective gear and other items and services required for complete demobilization.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASSE/AIHA Z88.6, American National Standard for Respiratory Protection - Respirator Use - Physical Qualifications for Personnel.
2. Title 29, Code of Federal Regulations, Part 1910.120, Hazardous Waste Operations and Emergency Response.
3. Title 29, Code of Federal Regulations, Part 1910.146, Permit-Required Confined Spaces.
4. Title 29, Code of Federal Regulations, Part 1926.65, Hazardous Waste Operations and Emergency Response.
5. Title 29, Code of Federal Regulations, Parts 650-652, Excavations.
6. Title 40, Code of Federal Regulations, Part 261, Identification and Listing of Hazardous Waste.

PART 2 - PRODUCTS

2.01 Materials

A. Containers shall be as required in the United State Department of Transportation (USDOT) regulations.

B. Containers shall be watertight as required in the USDOT regulations and must meet all applicable regulations.

C. Polyethylene to be placed under (20 mil thickness minimum) and over (10 mil thickness minimum) soil piles. If soils are placed in drums, polyethylene must be placed over the drums.

D. The Contractor shall assure that the waste hauler's appropriate choice of vehicles and operating practices shall prevent spillage or leakage of contaminated material from occurring in route.

E. The Contractor shall provide, install and maintain any temporary loading facilities on site as required until completion of material handling activities. The location and design of any facilities shall be included in the MHP and be approved by the Engineer and SEPTA.

F. All vessels for temporary storage and transport to an off-site disposal facility shall be as required in USDOT regulations.

PART 3 - EXECUTION

3.01 Transporting and Disposal of Non-Hazardous Contaminated Soils

A. Description:

1. This work shall consist of the handling, transportation and disposal of non-hazardous contaminated soils. The materials covered by this Section are soils that are contaminated with petroleum or chemical products but cannot be classified as hazardous waste. For the purpose of this Specification, soil shall be defined as any material excavated below gravel or asphalt base material.

2. Non-hazardous contaminated soils are defined as soils exhibiting one (1) or more of the following characteristics:
   a. Elevated Photo-Ionization Detector (PID) readings, subsequently confirmed by lab analysis.
   b. Visual evidence of contamination.
   c. Petroleum and/or chemical odors.
   d. Soils that have been documented as contaminated in previous environmental reports.

3. Non-hazardous contaminated soils must be stockpiled at an off-site approved location or secured on-site by the Contractor, meeting all required federal, state and local stipulations. Contaminated soils determined to be non-hazardous shall be handled in accordance with this Section for soils determined to be hazardous shall be handled in accordance with the requirements for Article 3.03 in this Section.

4. The Contractor shall retain the services of an independent Environmental Consultant, as specified under Article 1.03 in this Section, to oversee the work required under this Item.

5. Non-hazardous soils shall be delivered to the disposal or treatment facility within thirty (30) calendar days after excavation.

6. The Contractor shall conduct sampling and analysis of the impacted soils as specified under Article 3.02 in this Section. The laboratory results shall be forwarded to the Engineer and SEPTA for review to determine if the soils will be handled and disposed of as contaminated regulated soils or hazardous waste. No other soils shall be sampled or tested without the Engineer's and SEPTA's approval or direction.

7. The Contractor shall ensure that all operations associated with the handling, sampling, loading, transportation, and disposal of non-hazardous contaminated soils are in compliance with all applicable federal, state, and city statutes and regulations.

8. The Contractor shall document the excavation, handling, transportation and disposal of non-hazardous contaminated soils. The Contractor shall supply all equipment, material and labor required to conduct the specified work of this Item.

B. Construction Details:

1. Material Handling:

a. Immediately after excavation of non-hazardous contaminated soil the Contractor shall:

1) Load material directly onto trucks/tankers/roll offs for disposal off site; or

2) If interim stockpiling is required, place on a minimum of 20 mil or equivalent plastic ground cloth and cover by minimum of 10 mil polyethylene sheeting or equivalent to protect against leaching or runoff of contaminants into groundwater or storm water. Weight or secure the sheeting by appropriate means and seal seams as approved by the DDC to prevent tearing or removal by weather. Grade surrounding surface to provide for positive drainage away from pile. Stockpile shall not exceed 100 cubic yards.

b. Institute appropriate procedures and security measures to ensure the protection of site personnel and the public from contaminated materials as described in the approved MHP and Article 1.03 in this Section.

c. Any soil encountered that appears to contain unknown contaminants (based on visual, odor, or other observation), or that vary substantially from the material originally identified must be segregated in stockpiles and the independent Environmental Consultant promptly notified. Construct stockpiles to the same requirements as stated in Article 3.01/A/1/b in this Section.

d. Provide any dewatering that is necessary to complete the work. Contaminated water shall be disposed of in accordance with Article 3.04 in this Section.

e. Provide and operate field organic vapor test equipment, a PID or a flame ionization detector (FID), to detect general organic vapor levels at intervals of approximately fifty (50) cubic yards of soil excavated, when visual or odor observations indicate the material may substantially differ from the soil previously excavated and/or as directed by the independent Environmental Consultant.

2. Off-Site Transportation to Disposal or Treatment Facility:

a. General:

1) The Contractor shall furnish all labor, equipment, supplies and incidental costs required to transport contaminated material from the work area to the off-site disposal or treatment facility, and any other items and services required for transporting contaminated material for disposal at an off-site facility.

2) The Contractor shall submit the name and location of the facility where an off-site scale is located. The Contractor shall also submit a plan to the Engineer and SEPTA for review outlining procedures on controlling trucks leaving the work site and on-route to the off-site scale. The Contractor shall be responsible for tracking all material/vehicles from the site to the off-site scale.

3) The Contractor shall provide to the Engineer and SEPTA certified tare and gross weight slips for each load received at the accepted facility which shall be attached to each returned manifest.

4) The Contractor shall coordinate the schedule for truck arrival and material deliveries at the job site to meet the approved Contract schedule.

5) The Contractor shall inspect all vehicles leaving the Project site to ensure that contaminated soils adhering to the wheels or undercarriage are removed prior to the vehicle leaving the site.

6) The Contractor shall obtain letters of commitment from the waste haulers and the treatment, disposal or recovery facility to haul and accept shipments. The letter shall indicate agreement to handle and accept the specified estimated quantities and types of material during the time period specified in the Contract schedule and any time extension as deemed necessary.

7) The Engineer and SEPTA shall review and approve waste profiles before transportation to the TSD facility.

b. Hauling:

1) The Contractor shall coordinate manifesting, placarding of shipments and vehicle decontamination. All quantities shall also be measured and recorded upon arrival at the disposal or treatment facility. If any deviation between the two (2) records occurs, the matter is to be reported immediately to the Engineer and SEPTA and to be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

2) The Contractor shall be held responsible, at its own cost for any and all actions necessary to remedy situations involving material spilled in transit or mud and dust tracked off-site.

3) The Contractor shall ensure that trucks are protected against contamination by properly covering and lining them with compatible material (such as polyethylene) or by decontaminating them prior to and between acceptances of loads.

4) The Contractor shall be responsible for inspecting the access routes for road conditions, overhead clearance and weight restrictions.

5) The Contractor shall only use the transporter(s) identified in the MHP for the performance of work. Any use of substitute or additional transporters must have previous written approval from the Engineer and SEPTA at no additional cost to SEPTA.

6) The Contractor shall develop, document and implement a policy for accident prevention.

7) The Contractor shall not combine contaminated materials from other Projects with material from this Contract.

8) No material shall be transported until approved by the Engineer and SEPTA.

c. Off-Site Disposal:

1) The Contractor shall use only the facilities identified in the MPH for the performance of the work. Substitutions or additions shall not be permitted without prior written approval from the Engineer and SEPTA, and if approved shall be at no extra cost to SEPTA.

2) The Contractor shall be responsible for acceptance of the materials at an approved facility, for ensuring that the facility is properly permitted to accept the stated materials, and that the facility provides the stated treatment and/or disposal services.

3) The Engineer and SEPTA reserves the right to contact and visit the disposal or treatment facility and regulatory agencies to verify the agreement to accept the stated materials and to verify any other information provided.

4) In the event that the identified and approved facility ceases to accept the stated materials or the facility ceases operations, it is the Contractor’s responsibility to locate an alternate approved and permitted facilities for accepting materials. The alternate facilities must be approved in writing by the Engineer, SEPTA and PADEP

in the same manner and with the same requirements as for the original facilities. This shall be done at no extra cost or delay to SEPTA.

5) The Contractor shall obtain manifest forms, and complete the shipment manifest records required by the appropriate regulatory agencies for verifying the material and quantity of each load in unit of volume and weight. Copies of each manifest shall be submitted to the Engineer and SEPTA within four (4) business days following shipment, and within three (3) business days after notification of receipt of the facility. Any manifest discrepancies shall be reported immediately to the Engineer and SEPTA and be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

d. Equipment and Vehicle Decontamination:

1) The Contractor shall design and construct a portable decontamination station to be used to decontaminate equipment and vehicles exiting from the exclusion zone. The cost for this work will be paid under Article 1.03 in this Section.

2) Water generated during the decontamination process shall be disposed of in accordance with Article 3.04 in this Section.

C. Method of Measurement:

1. Quantities for non-hazardous contaminated soils shall be measured in tons. The tonnage will be determined by off-site truck scales, per Article 3.01/B/2 in this Section, that are capable of generating load tickets.

D. Price to Cover:

1. The unit bid price bid per ton shall include the cost of furnishing all labor, materials, plant, equipment, and insurance for excavation, handling, transportation, disposal, documentation, fees, permits, loading, stockpiling, hauling, and any other incidentals necessary to complete all the work as specified herein for handling, transporting and disposal of non-hazardous contaminated soil.

2. Final disposal of hazardous soil shall be paid for under Article 3.03 in this Section. Disposal of decontamination water shall be paid for under Article 3.04 in this Section.

3. Backfill will be paid for under its respective item as specified in the Contract Documents.

4. The independent Environmental Consultant shall be paid under Article 1.03 in this Section.

3.02 Sampling and Testing of Contaminated/Potentially Hazardous Soil for Disposal Parameters

A. Description:

1. The work shall consist of collecting and analyzing representative soil samples for parameters typically requested by the disposal facilities.

B. Sampling and Laboratory Analysis:

1. At least thirty (30) days prior to the commencement of work, the Contractor's independent Environmental Consultant must submit a Soil Sampling Plan/Field Sampling Plan (SSP/FSP) to the Engineer and SEPTA for review and approval. The plan shall include the name, address and telephone numbers of the proposed laboratory. The plan shall also include training and experience of the personnel who will collect the samples.

2. The Contractor shall sample and analyze representative samples of the contaminated/potentially hazardous soils. Sampling will be performed in accordance with PADEP Form U Parameters and methodology for disposal within Pennsylvania. If disposal is out of state, the Contractor will complete the appropriate sampling methodology and parameters to comply with the appropriate state regulations. The Contractor will provide the application and approval of the facility to the Engineer and SEPTA. The cost associated with additional sampling and testing shall be included in the bid price of this Item.
3. All sampling shall be conducted by a person trained in sampling protocols using standard accepted practices for obtaining representative samples.
4. The quality of the data from the sampling program is the Contractor's responsibility. The Contractor must furnish all qualified personnel, equipment and instruments necessary to carry out the sampling. Unless directed otherwise, all sampling procedures must follow the PADEP sampling guidelines and protocols.
5. All sample containers shall be marked and identified with legible sample labels which shall indicate the Project name, sample location and/or container, the sample number, the date and time of sampling, preservatives utilized and other information that may be useful in determining the character of the sample. Chain-of-custody shall be tracked from laboratory issuance of sample containers through laboratory receipt of the samples.
6. The Contractor shall maintain a bound sample logbook. The Contractor shall provide the Engineer and SEPTA access to it at all times and shall turn it over to the Engineer and SEPTA in good condition at the completion of the work. The following information, as a minimum shall be recorded to the log:
    a. Sample identification number.
    b. Sample location.
    c. Field observation.
    d. Sample type.
    e. Analyses.
    f. Date/time of collection.
    g. Collector's name.
    h. Sample procedures and equipment utilized.
    i. Date sent to laboratory and name of laboratory.
    j. SEPTA reserves the right to direct the Contractor to conduct alternative sampling in lieu of the parameters described in Article 3.02/B/2 in this Section, if the situation warrants. The substitute sampling parameters shall be of equal or lesser monetary value than those described in Article 3.02/B/2 in this Section, as determined by industry laboratory pricing standards.
    k. Only dedicated sampling equipment may be used to collect these samples. All equipment involved in field sampling must be decontaminated before being brought to the sampling location, and must be properly disposed after use.
    l. Soils exceeding any of the hazardous characteristic criteria meet the legal definition of hazardous soils (rather than non-hazardous contaminated soils) and shall be transported or disposed of under Article 3.03 in this Section. All analyses must be done by a

laboratory that has received Pennsylvania accreditation. The Contractor must specify the laboratory in the MHP.

C. Price to Cover:

1. The unit price bid shall include the cost of furnishing all labor, materials, plant, equipment, and insurance necessary for sampling, handling, transporting, testing, documentation, fees, permits and any other incidentals necessary to complete the work as specified herein for sampling and testing of contaminated/potentially hazardous soil.

3.03 Handling, Transporting and Disposal of Hazardous Soils

A. Description:

1. This work shall consist of the handling, transportation and disposal of soils or materials that are listed as hazardous wastes or exhibit any of the characteristics of a hazardous waste, namely ignitability, corrosivity, reactivity, and toxicity, as defined in 40 CFR 261. For the purpose of this Section, soils shall be defined as any materials excavated below gravel or pavement and base.

2. Contaminated soils determined to be hazardous under Article 3.02 in this Section shall be handled, transported and disposed of in accordance with the requirements herein.

3. The independent Environmental Consultant retained by the Contractor, as specified under Article 1.03 in this Section, shall conduct sampling and analysis of above soils to determine which soils are hazardous.

4. All work shall be performed under the direct supervision of the Contractor's Environmental Consultant, as approved by the Engineer and SEPTA.

5. The Contractor shall ensure that all operations associated with the handling, sampling, loading, transportation and disposal of hazardous materials are in compliance with the applicable federal, state and local statutes.

6. The Contractor shall document the excavation, handling, sampling, and testing, transportation and disposal of hazardous soils. SEPTA shall be listed in the disposal documents as the waste generator.

7. The Contractor shall supply all equipment, material and labor required to conduct the specified work of this Section.

8. The Contractor shall ensure that all operations associated with the handling, sampling, loading, transportation and disposal of hazardous soils are conducted in a manner to protect site personnel, the public and the environment, in accordance with all applicable federal, state, and local laws and regulations.

9. The Contractor shall decontaminate all equipment prior to its removal from the exclusion zone and/or following contact with hazardous materials, as detailed in Article 1.03 in this Section. Water generated during the decontamination process shall be disposed of under Article 3.04 in this Section.

B. Construction Details:

1. Material Handling:

a. The Contractor shall institute procedures to protect site personnel and the public from the non-hazardous and hazardous materials as described in Article 1.03 in this Section.

b. The Contractor shall handle hazardous soil as approved in the MHP.

c. Stockpiled materials at the temporary TSD facility shall be handled according to the facility requirements but at a minimum shall be drummed or placed on and covered with polyethylene to protect against erosion and leaching into surrounding soils, the stockpile area shall be graded for positive drainage away from the pile, and shall be labeled while being held for sampling prior to permanent disposal.

d. Provide any dewatering that is necessary to complete the work. Water shall be disposed of in accordance with Article 3.04 in this Section.

2. Off-Site Transportation and Disposal:

a. The Contractor shall furnish all labor, equipment and supplies required to transport hazardous materials from the work area to the off-site TSD facilities and to acquire any other items and services required for transporting hazardous materials for storage and/or disposal at an approved off-site facility.

b. Weight Measurement:

1) The Contractor shall submit the name and location of the facility where an off-site scale is located. The Contractor shall also submit a plan to the Engineer and SEPTA for review outlining procedures on controlling trucks leaving the work site and on-route to the off-site scale. The Contractor shall be responsible for tracking all materials/vehicles from the site to the off-site scale.

2) The Contractor shall provide to the Engineer and SEPTA certified tare and gross weight slips for each load received at the accepted facility which shall be attached to each returned manifest.

c. General:

1) The Contractor shall organize and maintain the material shipment records/manifests required by law.

2) The Contractor shall coordinate the schedule for truck arrival and material deliveries at the job site to meet the approved Contract schedule. The schedule shall be compatible with the availability of equipment and personnel for material handling at the Project site.

3) The Contractor shall inspect all vehicles leaving the Project site to ensure that hazardous soils adhering to the wheels or under carriage are removed prior to the vehicle leaving the site.

4) The Contractor shall obtain letters of commitment from the waste haulers and the TSD facility to haul and accept shipments. The letter shall indicate agreement to handle and accept the specified estimated quantities and types of material during the time period specified in the Contract schedule and any time extension as deemed as necessary.

d. Hauling:

1) The Contractor shall not deliver waste to any facility other than the TSD facilities listed on the shipping manifest.

2) The Contractor shall coordinate manifesting, placarding, of shipments, and vehicle decontamination. All quantities shall also be measured and recorded upon arrival at the TSD facility. If any deviation between the two (2) records occurs, the matter is

to be reported immediately to the Engineer and SEPTA and to be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

3) The Contractor shall be held responsible, at its own expense, for any and all actions necessary to remedy situations involving material spilled in transit or mud and dust tracked off-site.

4) The Contractor shall ensure that trucks are protected against contamination by properly covering and lining them with compatible material (such as polyethylene) or by decontaminating them prior to any use other than hauling hazardous materials.

5) The Contractor shall be responsible for inspecting the access routes for road conditions, overhead clearance and weight restrictions.

6) The Contractor shall only use the transporter(s) identified in the MHP for the performance of work. Only a transporter with waste transporter permit from Pennsylvania may transport this material. Any use of substitute or additional transporters must have previous written approval from the Engineer and SEPTA at no additional cost to SEPTA.

7) The Contractor shall develop, document and implement a policy for accident prevention.

8) The Contractor shall not combine hazardous materials from other Projects with material from this Contract.

9) The Contractor shall obtain for SEPTA an EPA hazardous waste generator identification number and a representative of SEPTA will review and sign the manifest as the generator.

10) No materials shall be transported until approved by the Engineer and SEPTA.

e. Off-Site Disposal:

1) The Contractor shall be responsible for acceptance of the materials at an approved TSD facility, for ensuring that the facility is properly permitted to accept the stated materials, and that the facility provides the stated storage and/or disposal services.

2) In the event that the identified and approved facility ceases to accept the stated materials or the facility ceases operations, it is the Contractor's responsibility to locate an alternate approved and permitted facilities for accepting materials. The Contractor is responsible for making the necessary arrangements to utilize the facilities, and the alternate facilities must be approved in writing by the Engineer and SEPTA in the same manner and with the same requirements as for the original facilities. This shall be done with no extra cost or delay to SEPTA.

3) The Contractor is responsible to pay all fees associated with the generation of all excavated hazardous waste.

f. Equipment and Vehicle Decontamination:

1) The Contractor shall design and construct a portable decontamination station to be used to decontaminate equipment and vehicles exiting from the exclusion zone. Disposal of decontamination liquids is described under Article 3.04 in this Section.

g. Record Keeping:

1) The Contractor shall obtain manifest forms, and complete the shipment manifest records required by the appropriate regulatory agencies for verifying the material and quantity of each load in unit of volume and weight. Copies of each manifest shall be submitted to the Engineer and SEPTA within four (4) business days following shipment, and within three (3) business days after notification of receipt of the facility. Any manifest discrepancies shall be reported immediately to the

Engineer and SEPTA and be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

2) All original manifests shall be submitted to SEPTA no later than thirty (30) days after disposal.

3. Method Measurement:

a. Quantities for hazardous soil shall be measured in tons satisfactorily delivered to the treatment, storage or disposal facility. The tonnage will be determined by off-site truck scales, per Article 3.03/B/2/b in this Section, that are capable of generating load tickets.

4. Price to Cover:

a. The unit price bid per ton shall include the cost of furnishing all labor, materials, plant, equipment, and insurance for excavation, handling, transportation, disposal, documentation, permits, fees, taxes, stockpiling, hauling, and any other incidentals necessary to complete the work as specified herein for handling, transporting and disposal of hazardous soils.

b. Final disposal of non-hazardous materials shall be paid for under Article 3.01 in this Section. Disposal of decontamination water shall be paid under Article 3.04 in this Section.

c. All backfill material shall comply with the requirements of the PADEP Management of Fill Policy. Backfill will be paid for under its respective item.

3.04 Removal, Treatment and Discharge/Disposal of Contaminated Water

A. General:

1. This work shall consist of the proper removal and disposal of all contaminated groundwater and decontamination water generated during construction operations. The Contractor shall be solely responsible for the proper disposal or discharge of all contaminated water generated at the job site. The Contractor will have the option of treating water on-site for discharge to the combined sanitary/storm sewer system or removing contaminated water for off-site disposal. The Contractor shall be responsible to choose a method compatible to the construction work and shall be compensated on a per day basis regardless of method employed. The Contractor will be compensated for only those days where the system is in full operation.

2. The Contractor shall retain a dewatering/water treatment Specialist (hereinafter the "Specialist") and laboratory as specified under Article 3.05 in this Section, to conduct any testing that may be required for disposal of impacted water.

3. The dewatering/water treatment Specialist is responsible to obtain all permits; perform all water sampling, testing; and provide ancillary services related to dewatering and water treatment. The Specialist shall at a minimum provide documentation to the Engineer and SEPTA demonstrating the minimum requirements as set forth below:

a. The Specialist shall demonstrate that it has, at a minimum, five (5) years corporate experience in the dewatering. The Specialist should demonstrate expertise dealing with issues associated with contaminated water. During that five (5) year period, the Specialist shall demonstrate that it provided dewatering and water treatment systems a routine part of its daily operations.

b. During the five (5) year period, the Specialist shall demonstrate that it has provided these services with an aggregate cost of $1,000,000 in each of the five (5) years.

c. The Specialist must be experienced in work of this nature, size and complexity.

d. The Specialist shall furnish a Project listing identifying the location, nature of services provided, Owner, Owner's contact, contact's telephone number, Project duration and value for at least five (5) Projects in the last five (5) years of a similar nature, size and complexity to this Contract.

e. The Specialist shall furnish to the Engineer and SEPTA a staffing plan which identifies the Specialist key personnel and resume documenting their experience, training, licenses and education to justify their roles in the Contract. A Health and Safety Officer must be designated.

f. If conditions within the exclusion zone are deemed hazardous, then the Contractor and its independent Environmental Consultant shall ensure that all personnel working within identified exclusion zones and/or involved (direct contact) with the handling, storage or transport of hazardous and contaminated material shall have completed a minimum of forty (40) hours of Health and Safety Training on Hazardous Waste Sites in accordance with 29 CFR 1910.120(e). The training program shall be conducted by a qualified safety instructor. If conditions in the exclusion zone are deemed to be non-hazardous, the Specialist shall be responsible to provide site-specific training to its employees and other affected personnel.

g. The Contractor shall ensure that on-site management and supervisors directly responsible for or who supervise employees engaged in hazardous waste operations shall receive the training specified in above and at least eight (8) additional hours of specialized training on managing such operations at the time of job assignment.

4. The Contractor shall document all operations associated with the handling, sampling and disposal of contaminated water, and ensure that they are in compliance with applicable federal, state, and local statutes and regulations.

5. The Contractor shall supply all labor, equipment, transport, plant, material, treatment and other incidentals required to conduct the specified work of this Section.

6. If water will be disposed of into the combined sanitary/storm sewer system, the Contractor shall ensure the Specialist treats the water to meet the appropriate federal, state and local regulations. The Contractor is responsible for providing settling or filtering tanks and any other apparatus required. Alternatively, the Contractor can provide a plan for transport and disposal at an off-site waste disposal facility.

B. Construction Details:

1. For each disposal method the Contractor proposes to utilize (disposal to combined sanitary/storm sewer or off-site disposal), the WHP shall include the information required in Article 3.04/B/1/a and b in this Section, as appropriate.

a. On-site treatment and discharge to combined sanitary/storm sewers.

1) The Contractor shall comply with all applicable regulations.

2) The Contractor is solely responsible to obtain all necessary and appropriate federal, state, and local permits and approvals. The Contractor will be responsible for performing all and any system pilot tests required for permit approval.

3) The Contractor shall meet PADEP State Pollutant Discharge Elimination System (NPDES) permits if necessary.

a) Identification and design of the Contractor's proposed treatment to assure that the water meets the PADEP sewer use guidelines prior to discharge to the sewer, including identification of all materials, procedures, settling or filtering tanks, filters and other appurtenances proposed for treatment and disposal of contaminated water.

b) The name, address and telephone number of the contact for the Contractor's proposed chemical laboratory, as well as the laboratory's certifications under federal, state or non-governmental bodies.

c) The name, address and telephone number of the contact for the Contractor's proposed independent Environmental Consultant.

d) Copies of all submitted permit applications and approved permits the Contractor have received.

4) Materials:

a) The Contractor shall supply all settling or filtering tanks, pumps, filters, treatment devices and other appurtenances for treatment, temporary storage and disposal of contaminated water. All equipment shall be suitable for the work described herein.

5) Execution:

a) The Contractor is solely responsible for disposal of all water, in accordance with all federal, state and local regulations.

b) The Contractor is solely responsible for any treatment required to assure that water discharged into the sewer is in compliance with all permits and federal, state, and local statutes and regulations.

c) The Contractor is solely responsible for the quality of the water disposed of into the sewers.

d) The Contractor is responsible for sampling and testing of water for the DEP Sanitary/Combined and Storm sewer Effluent Limit concentrations. The quality of the data is the Contractor's responsibility. Any sampling and testing shall be conducted and paid in accordance with Article 3.05 in this Section.

e) The Contractor shall be responsible to maintain the discharge rate to the sewer such that all permit requirements are met, the capacity of the sewer is not exceeded and no surcharging occurs downstream due to the Contractor's actions.

f) Disposal of Treatment Media:

i. The Contractor shall be responsible for disposal or recycling of treatment media in accordance with all federal, state and local regulations.

ii. The Contractor shall provide the Engineer and SEPTA with all relevant documentation concerning the disposal of treatment media, including manifests, bills of lading, certificates of recycling or destruction and other applicable documentation.

iii. Disposal of treatment media shall not be considered as a separate pay item; instead it shall be considered as incidental work thereto and included in the unit price bid.

2. Off-Site Disposal:

a. The Contractor shall meet all applicable federal, state and local regulations pertaining to the transportation, storage and disposal of any hazardous and/or non-hazardous materials.

b. The following shall be submitted to the Engineer and SEPTA prior to initiating any off-site disposal:

1) Name and waste transporter permit number.
2) Address.
3) Name of responsible contact for the hauler.
4) Any and all necessary permit authorizations for each type of waste transported.
5) Previous experience in performing the type of work specified herein.

c. General information for each proposed treatment/disposal facility and at least one (1) backup treatment/disposal facility:
1) Facility name and EPA identification number.
2) Facility location.
3) Name of responsible contact for the facility.
4) Telephone number for contact.
5) Unit of measure utilized at facility for costing purposes.

d. A listing of all permits, licenses, letters of approval and other authorizations to operate, which are currently held and valid for the proposed facility as they pertain to receipt and management of the wastes derived from this Contract.

e. A listing of all permits, licenses, letters of approval and other authorizations to operate which have been applied for by the proposed facility but not yet granted or issued. Provide dates of application(s) submitted. Planned submittals shall also be noted.

f. The Contractor shall specify and describe the disposal/containment unit(s) that the proposed facility will use to manage the waste and provide dates of construction and beginning of use, if applicable. Drawings may be provided. The Contractor shall identify the capacity available in the units and the capacity reserved for the subject waste.

g. The Contractor shall provide the date of the proposed facility's last compliance inspection.

h. A list of all active (unresolved) compliance orders, agreements, enforcement notices or notices of violations issued to the proposed facility shall be submitted. The source and nature of the cause of violation shall be stated, if known. If groundwater contamination is noted, details of the facility's groundwater monitoring program shall be provided.

i. Description of all sampling and field/laboratory analyses that will be needed to obtain disposal facility approval.

j. Execution:
1) General:
a) The Contractor shall organize and maintain the material shipment records/manifests required by federal, state and local law. The Contractor shall include all bills of lading, certificates of destruction, recycling or treatment and other applicable documents.
b) The Contractor shall coordinate the schedule for truck arrival and material deliveries at the job site to meet the approved Contract schedule. The schedule shall be compatible with the availability of equipment and personnel for material handling at the job site.
c) The Contractor shall inspect all vehicles leaving the Project site to ensure that contaminated liquids are not spilling and are contained for transport.
d) The Contractor shall obtain letters of commitment from the waste haulers and the treatment, disposal or recovery facility to haul and accept shipment. The letter shall indicate agreement to handle and accept the specified estimated quantities and types of material during the time period specified in the Contract schedule and any time extension as deemed as necessary.

e) The Contractor shall verify the volume of each shipment of water from the site.

f) The Contractor is responsible for sampling and testing of water for off-site disposal. The quality of the data is the Contractor's responsibility. Any sampling and testing shall be conducted and paid in accordance with Article 3.05 in this Section.

g) The Contractor shall be responsible for any additional analyses required by the TSD facility, and for the acceptance of the water at an approved TSD facility.

2) Hauling:

a) The Contractor shall not deliver waste to any facility other than the TSD facilities listed on the shipping manifest.

b) The Contractor shall coordinate manifesting, placarding of shipments and vehicle decontamination. All quantities shall also be measured and recorded upon arrival at the TSD facility. If any deviation between the two (2) records occurs, the matter is to be reported immediately to the Engineer and SEPTA and shall be resolved by the Contractor to the satisfaction of the Engineer and SEPTA.

c) The Contractor shall be held responsible for any and all actions necessary to remedy situations involving material spilled in transit or mud and dust tracked off-site. This cleanup shall be accomplished at the Contractor's expense.

d) The Contractor shall be responsible for inspecting the access routes for road conditions, overhead clearance and weight restrictions.

e) The Contractor shall only use the transporter(s) identified in the WHP for the performance of work. Any use of substitute or additional transporters must have previous written approval from the Engineer and SEPTA at no additional cost.

f) The Contractor shall develop, document and implement a policy for accident prevention.

g) The Contractor shall not combine waste materials from other Projects with material from this Contract.

h) The Contractor shall obtain for SEPTA a hazardous waste generator identification number and will sign the manifest as the generator, if necessary.

i) No material shall be transported until approved by the Engineer and SEPTA.

3) Disposal Facilities:

a) The Contractor shall use only the TSD facilities identified in the WHP for the performance of the work. Substitutions or additions shall not be permitted without prior written approval from the Engineer and SEPTA, and, if approved, shall be at no extra cost to SEPTA.

b) The Contractor shall be responsible for acceptance of the material at an approved TSD facility, for ensuring that the facility is properly permitted to accept the stated material, and that the facility provides the stated storage and/or disposal services.

c) In the event that the identified and approved facility ceases to accept the stated materials or the facility ceases operations, it is the Contractor's responsibility to locate an alternate approved and permitted facilities for accepting materials. The Contractor is responsible for making the necessary arrangements to utilize the facilities, and the alternate facilities must be approved in writing by the Engineer and SEPTA in the same manner and with the same requirements as for the original facilities. This shall be done with no extra cost or delay to SEPTA.

3. Equipment and Vehicle Decontamination:
    a. The Contractor shall design and construct a portable decontamination station to be used to decontaminate equipment and vehicles exiting the exclusion zone. The cost for this work shall be paid under Article 1.03 in this Section.

C. Method of Measurement:

1. The quantity for on-site treatment and discharge or off-site disposal shall be on a per day basis.

D. Price to Cover:

1. The per day price bid shall include the cost of furnishing all labor, materials, plant, equipment, and insurance for handling, transportation, disposal, documentation, permits, hauling, mobilization and demobilization, and any other incidentals thereto to complete the work.

3.05 Sampling and Testing of Contaminated Water

A. Description:

1. The work shall consist of sampling and testing of potentially contaminated groundwater, surface runoff within the excavated area and all contaminated water generated during the decontamination process.

B. Sampling and Testing:

1. The Contractor is responsible, at a minimum, for sampling and testing of contaminated water for the Sanitary/Combined and Storm Sewer Effluent Limit concentrations. The quality of the data is the Contractor's responsibility. Any additional testing required by the federal, state and/or disposal facilities shall be included in the bid price of this item.

2. All sampling and testing shall be conducted by a person trained in sampling protocols using accepted standard practices and/or the PADEP sampling guidelines and protocols.

3. All sample containers shall be marked with legible sample labels which shall indicate the Project name, sample location and/or container, the sample number, the date and time of sampling, preservatives utilized, how the sample was chilled to 4°C, and other information that may be useful in determining the character of the sample.

4. Chain-of-custody shall be tracked from laboratory issuance of sample containers through receipt of the samples.

5. The Contractor shall maintain a bound sample log book. The Contractor shall provide the Engineer and SEPTA access to it at all times and shall turn it over to the Engineer, SEPTA and PADEP in good condition at the completion of the work. The following information, as a minimum, shall be recorded to the log:
    a. Sample identification number.
    b. Sample location.
    c. Field observation.
    d. Sample type.
    e. Analyses.

f. Date/time of collection.
g. Collector's name.
h. Sample procedures and equipment used.
i. Date sent to laboratory/name of laboratory.

6. Only dedicated sampling equipment may be used to collect these samples. All equipment involved in field sampling must be decontaminated before being brought to the site, and must be properly disposed of after use.
7. Samples shall be submitted to the Contractor's laboratory within the holding times for the parameters analyzed.
8. All analyses must be done by a Pennsylvania accredited laboratory. The Contractor must specify the laboratory in the WHP.
9. Analytical results for water discharged to the sewer and for off-site disposal must be submitted to the Engineer and SEPTA no later than five (5) days after sample collection.
10. SEPTA reserves the right to direct the Contractor to conduct alternative sampling in lieu of the parameters described above, if the situation warrants. The substitute sampling parameters shall be of equal or lesser monetary value than those described above, as determined by industry laboratory pricing standards.

C. Price to Cover:

1. The unit price bid per set shall include the cost of furnishing all labor, materials, plant, equipment, and insurance for handling, transport, sampling, testing, documentation, permits, other incidentals necessary to complete the work of sampling and testing of contaminated water. Any additional costs incurred by the Contractor for sampling and testing of contaminated water shall be included in the bid price of this item.

END OF SECTION

SECTION 02209

GEOTEXTILE FABRIC

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of furnishing all plant, labor, and equipment and performing all operations required for supplying, hauling and placing the geotextile fabric, complete, at locations shown on the Contract Drawings or as directed by SEPTA, and maintaining the filter fabric until placement of the stone material has been completed and accepted.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 02220 - Excavation, Backfill and Compaction

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:

1. Certificates of compliance of materials (SEPTA reserves the right to test materials for Specification compliance).

1.04 Quality Assurance

A. Meet the applicable provision of the most recent issues of the following references:

1. ASTM D 4491/D 4491M, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
2. ASTM D 4533/D 4533M, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
3. ASTM D 4632/D 4632M, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
4. ASTM D 4751, Standard Test Methods for Determining the Apparent Opening Size of a Geotextile.
5. ASTM D 6241, Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.
6. Commonwealth of Pennsylvania, Department of Transportation, Specifications Publication 408 (PennDOT Specs).

PART 2 - PRODUCTS

2.01 Materials

A. The filter fabric shall be non-woven polypropylene or polyester material meeting PennDOT Spec Section 735 Class 4. Refer to Table 02209-1 for geotextile fabric properties.

Table 02209-1 Geotextile Fabric Properties

Item	Minimum Average Requirement	Test
Grab Tensile Strength	290 Pounds	ASTM D 4632/D 4632M
Puncture Strength	775 Pounds	ASTM D 6241
Trapezoidal Tear	100 Pounds	ASTM D 4533/D 4533M
Apparent Opening Size	> #70 Standard Sieve	ASTM D 4751
Flow Rate	75 Gal./Min./SF.	ASTM D 4491/D 4491M

PART 3 - EXECUTION

3.01 Execution

A. The filter fabric shall be placed at the locations shown on the Contract Drawings or as directed by SEPTA. The surface to receive the fabric shall be prepared to a relatively smooth condition, free of obstructions, depressions, debris and soft or low density pockets of material. All holes, rips or flaws made in the fabric shall be repaired by placing a piece of fabric, which is 1 foot 6 inches larger than the hole in the fabric in all directions, directly over the hole before stone is placed on the fabric. The fabric shall be laid smooth and free of tension, stress, folds, wrinkles or creases. The fabric rolls shall be placed to provide a minimum width of 24 inches of overlap for each adjacent strip. When securing pins are necessary in the placement of the fabric, the pins shall be 3/16 inch diameter steel, pointed at one (1) end, and 22 inches long. All damage to the fabric during its installation or during placement of the stone shall be replaced or repaired by the Contractor at no cost to SEPTA. The fabric shall be protected from sunlight, ultra-violet light, high temperatures, dirt and debris at all times prior to installation.

B. Securing pins with washers shall be inserted through both strips of the 24 inches overlapped fabric at not greater than the intervals in Table 02209-2 along a line through the midpoint of the overlap.

Table 02209-2 Securing Pin and Washer Intervals

Pin Spacing	Slope
2 feet	Steeper than 3:1
3 feet	3:1 to 4:1
4 feet	Flatter than 4:1

C. Additional pins, regardless of location, shall be installed as necessary to prevent any slippage of the filter fabric.

D. Each securing pin shall be pushed through the fabric until the washer bears against the fabric and secures it firmly to the foundation.

E. The fabric shall be turned down and buried at all exterior limits.

F. The fabric shall be protected at all times during construction from contamination by surface runoff. All fabric so contaminated shall be removed and replaced with uncontaminated fabric.

G. Work shall be scheduled so that the fabric is exposed no more than five (5) days prior to the covering of the fabric with stone.

H. All damage to the fabric during the placement of stone shall be repaired or replaced by the Contractor.

I. Have geotextile inspected by the SEPTA Project Manager prior to backfilling.

END OF SECTION

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SECTION 02220

EXCAVATION, BACKFILL AND COMPACTION

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of construction of excavating and backfilling for embankment, structures, drainage and utility facilities; field quality control testing and analysis; and designing, furnishing, installing and removing support of excavation.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 02070 - Selective Demolition

E. Section 02205 - Impacted Soil Management

F. Section 16138 - Ductwork and Electrical Manholes and Handholes

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:

1. Certificates of compliance of materials for liquid limit, plasticity, and dry density. (The SEPTA Project Manager reserves the right to test materials for Specification compliance).

2. Three (3) copies of each field density, liquidity, plasticity and gradation test within twenty-four (24) hours after completion of testing.

3. Permits for disposal of excavated material:

   a. Obtain written permits and releases from the Owners of property where material will be deposited.

   b. Submit copies of each permit and release from each property Owner absolving the Owner and SEPTA from responsibility in connection with such disposal.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. AASHTO M43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction.

2. AASHTO M80, Standard Specification for Coarse Aggregate for Hydraulic Cement Concrete.

3. AASHTO M147, Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.

4. ASTM C 33/C 33M, Standard Specification for Concrete Aggregates.
5. ASTM D 698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3).
6. ASMT D 1556/D 1556M, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
7. ASTM D 2167, Standard Test Method for Density and Unit Weight of Soil in Place by the Rubber Balloon Method.
8. ASTM D 2216, Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
9. ASTM D 4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
10. ASTM D 6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
11. Commonwealth of Pennsylvania, Department of Transportation, Specifications Publication 408 (PennDOT Specs).
12. Commonwealth of Pennsylvania Department of Environmental Protection (PADEP).
13. 29 CFR 1926, Safety and Health Regulations for Construction.

1.05 Definitions:

A. Approved material is material which meets specified requirements for use as embankment, fill or backfill.

B. Authorized excavation is excavating to neat lines and limits shown and specified; excavating unsuitable material.

C. Backfill is the furnishing, placing and compacting specified materials to the lines and grades indicated and also including:

1. Testing density, liquid and plastic limits and gradation of compacted backfill.

D. Embankment is the proposed subgrade lines as shown on the Contract Drawings.

E. Excavation is the removing of all materials encountered within the indicated or specified limits, regardless of the nature of the material encountered and the method by which removed and also including:

1. Dewatering.
2. Legally disposing of waste materials and storing suitable excavated materials intended for reuse.

F. Excess excavation is material excavated beyond or below typical sections shown, as well as unavoidable over breakage in rock.

G. Grading consists of the following:

1. Excavation of earth and rock for grading.
2. Shaping of constructed embankments and fills.

H. Surcharge is temporary fill section of select material in order to provide soil compaction.

I. Unauthorized excavation is excavating materials which would otherwise be left in place but removal of which is required because the Contractor's operations have rendered them unstable; excavation which is not specified as authorized excavation, such as excavation beyond neat lines and bottom of footings and trenches as shown.

J. Unsuitable material is material which does not meet specified requirements for use in situ or as embankment, fill or backfill and is prohibited for use in the work.

PART 2 - PRODUCTS

2.01 Materials

A. Embankment, Fill or Backfill:

1. Common Fill and Backfill:
    a. Well graded soil aggregate mixture comprising stone, gravel, sand, silt, clay or combinations of such materials.
    b. Organic matter, debris, cinders and frozen material are prohibited materials.
    c. Particle size to be 4 inches maximum, but not exceeding 1 inch within 1 foot of finished grade.
    d. Liquid limit to be forty (40) maximum, determined in accordance with ASTM D 4318.
    e. Plasticity index to be ten (10) maximum, determined in accordance with ASTM D 4318.
    f. Maximum dry density to be not less than 100 pounds per cubic foot.
2. Backfill for Ground Grid:
    a. Mixture of common fill with limited sand and gravel.
    b. Soil resistivity shall not exceed 20 ohm-meters.
    c. Particle size less than 1 1/2 inches.
3. Open Graded Aggregate Backfill:
    a. Course aggregate meeting AASHTO M80, Class C or better; gradation size No. 67 in accordance with AASHTO M43.
4. Dense Graded Aggregate Backfill:
    a. Course aggregate meeting AASHTO M80, Class C or better; gradation size No. 8 in accordance with AASHTO M43, or meeting PENNDOT Specification Section 350, No. 2A.

2.02 Source of Materials

A. To the extent that it is available, obtain material from excavation operations. If sufficient suitable materials are not available to meet embankment, fill and backfill requirements, obtain material meeting specified requirements from borrow areas at no additional cost to SEPTA.

1. Earth excavation may contain excess moisture in its natural state or may take on excess moisture during handling and stockpiling. Manipulation to proper moisture content prior to compaction may be necessary. Earth excavation will not be considered as unacceptable backfill material by virtue of its moisture content only.

B. Use only material whose quality, source and zone of placement in the fill have been approved.

C. If borrow areas are provided by SEPTA within the right-of-way, dress and shape such areas to ensure positive drainage when borrow operations are completed.

PART 3 - EXECUTION

3.01 Preparation

A. Prior to any demolition, excavation or embankment activities, the Contractor must call PA One-Call Utility Locating Service.

B. Barricade open excavations and post with warning lights those excavations occurring on property adjacent to or within public access. Operate warning lights during hours from dusk to dawn each day and as otherwise required.

C. Protect structures, utilities, sidewalks, pavements and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation and backfill operations.

D. Indicated locations of known existing facilities and systems are approximate. Investigate and determine exact locations and natures of facilities and systems, and accept sole responsibility for damages thereto caused by construction activities. Before excavating in the vicinity of underground utilities, notify the appropriate jurisdiction. SEPTA does not guarantee that all facilities and systems, which may exist before the work begins, are indicated.

1. Preserve, protect and maintain existing operable drains and sewers during grading operations.

E. Keep excavations dry.

F. Before moving equipment across underground duct banks having less than 4 feet of cover, place decking on the path of that equipment. Extend decking outward from each side of the duct bank for a distance equal to the depth of the bottom of the duct bank, but not further than 4 feet. Decking shall consist of a 3 inch thick timber platform or 1 inch thick steel plate. If duct bank is exposed, do not place decking directly on duct bank.

G. Use of explosives is prohibited.

3.02 Installation, Application and Execution

A. The Contractor is responsible for setting and establishing finish elevations and lines.

B. Haul from site and legally dispose of any excavated materials, at SEPTA approved facilities, which are excess or are determined to be not suitable for filling or backfilling, at no additional cost to SEPTA. Copies of signed off manifests are required to be submitted to SEPTA as proof of offsite disposal before the Contractor shall be paid for the excavation.

C. Do not place, spread, roll or compact fill material that is frozen or thawing, or during unfavorable weather conditions. If interrupted by heavy rain or other unfavorable conditions, do not resume until ascertaining that the moisture content and density of the previously placed soil are as specified.

3.03 Rough Grading and Filling

A. Perform such soil, concrete, boulder and rock fragment removal or fill as may be required to facilitate the progress of the work. Grading shall be by blading.

B. Fill wells, test pits or holes which will not be completely removed by excavation, with lean concrete, crushed aggregate or clean select soil approved by SEPTA and compacted as specified herein, in layers not exceeding 6 inches after compaction.

C. Fill holes, swales and low points which will not otherwise be removed in the course of the work, to the indicated grades.

3.04 Pumping and Drainage

A. At all times during construction of the work and at its completion for final inspection, by SEPTA, provide and maintain ample means and suitable equipment, consistent with conditions encountered, to promptly remove and properly dispose of or discharge all water entering excavations or other parts of the work.

B. Control surface and subsurface water in excavations at all times until the structures to be built therein are completed and backfilled to approximately final grades.

C. Dispose of or discharge water in a suitable manner approved by SEPTA and in accordance with all applicable regulations so as to avoid damage to adjacent property, existing structures and all work under construction. Do not pump drainage water onto the streets without the written permission in advance from SEPTA. The Contractor is responsible for obtaining all required permits for discharging of water and for meeting all permit conditions throughout the life of the Contract.

D. Provide and maintain settling basins and sumps or settling tanks or other apparatus or equipment for catching and holding settleable matter necessary to meet permits and/or applicable regulations. These shall be frequently cleaned and maintained. All equipment or apparatus maintenance and operation is the responsibility of the Contractor. Wherever water containing mud, clay, sand or other material in suspension, is pumped from the excavations, make suitable provision to insure that the flow will be unobstructed. Take precautions to avoid pumping water through freshly placed concrete.

E. At no time shall the uplift pressure on any structure exceed 80 percent of the downward pressure produced by the weight of the structure and any backfill in place. The Contractor shall submit his proposed methods of controlling uplift pressure to SEPTA for approval prior to the start of excavation.

3.05 Excavation

A. General Requirements:

1. Excavate to the lines and grades indicated.

2. Where authorized by SEPTA, excavations may be cut back to a stable slope as follows:

   a. Where the sides of excavations are sloped, angle of slopes shall be as approved by SEPTA but shall not be steeper than allowed by the Title 29 Code of Federal Regulations, Part 1926, Safety and Health Regulations for Construction (OSHA).

   b. Maintain sides and slopes of excavations in safe condition until backfilling is completed.

c. Where the Contractor elects to slope the sides of excavations, backfill of the over excavated areas shall be made in the same manner specified for the adjacent excavated area. All additional backfill required shall be at no additional cost to SEPTA.

B. Trench Excavation:

1. Excavate trenches for utilities and drainage pipes by the open cut method.

2. Trench, from trench bottom to a point which will be either 2 feet above top of pipe or 1/2 pipe diameter whichever is greater, shall not be wider than that indicated.

3. Trench, from a point which will be either 2 feet above top of pipe or 1/2 pipe diameter whichever is greater, to top of trench, may be wider than widths indicated. Where the width is not indicated, excavate a trench width not less than 6 inches or more than 18 inches from each side of the pipe.

4. In paved areas, cut pavement on the neat lines at the width indicated for the trench. After compacting the backfill, restore pavement structure to a condition equivalent to or better than that of existing adjacent pavement. Restore pavement damaged outside the neat lines at no additional cost to SEPTA.

C. Ground Grid:

1. Excavate to 12 inches below ground grid elevation and compact subgrade to meet Specifications.

2. Over excavate and remove rock encountered which will project up to within 12 inches of ground grid.

3.06 Embankment, Fill and Backfill

A. Place initial layer of embankment, fill and backfill only on subgrade which has been inspected and accepted by SEPTA.

B. Place embankment, fill and backfill in 8 inch loose layers, unless otherwise shown, for entire width so that each layer can be uniformly and properly compacted. Compact each layer to the specified density for the entire width of the fill or embankment.

C. Avoid accumulation of large pieces of material at one (1) location. Fill voids and interstices with finer materials.

D. In confined areas, use approved power-activated compactors to achieve required density.

E. Prior to compaction, adjust moisture content of material within required limits by drying or watering either at material source or on fill.

F. Leave struts, braces, lagging and timber sheathing in place as long as needed to support excavation and adjacent facilities and structures.

G. Where utility facilities and structures are supported in place, use special equipment and techniques as required to achieve specified compaction under and around them.

H. When backfilling against structures, place material approximately simultaneously on both sides of structures to equalize opposing horizontal pressures.

I. When backfilling on tops of structures, place material in 6 inch lifts over full area.

J. Under concrete floor and other slabs on grade, place drainage material directly on prepared subgrade which meets density and elevation requirements.

K. Prior to placing embankment against slope greater than 1 vertical to 4 horizontal, cut benches into existing slopes. Height of bench not to exceed 2 feet unless otherwise approved.

L. Maintain embankment, fill and backfill in stable, well-drained condition.

M. Remove material which cannot be compacted to required density within specified tolerances, and replace with suitable material at no additional cost.

N. Where pipes, culverts or structures extend into embankments, construct embankment to at least 2 feet over and 10 feet on either side of the pipe, culvert or structure location prior to excavation of the trench.

O. Trench Backfill:

1. Except as may be otherwise specified for placement of bedding materials, place backfill around pipes as follows:
    a. Place backfill around bottom half of pipe, in layers not thicker than 4 inches, and in a manner which will ensure that pipe will be supported. Ram and tamp backfill placed under and around pipes with tools and equipment especially designed for that purpose.
    b. Deposit additional backfill to a point 12 inches above top of pipe but leave pipe joints exposed; compact backfill.
2. After pipe has been tested and accepted, place backfill as specified.

P. Ground Grid:

1. Backfill 12 inches below and 12 inches above ground grid conductors.
2. Backfill with material meeting requirements of Article 2.01/B/2 in this Section.
3. Compact according to the Specifications.
4. Test for resistivity in place. Use a minimum of four (4) tests. Backfill not meeting resistivity criteria shall be removed and new material installed at the Contractor's expense.

Q. Allowable Tolerances:

1. Construct finished subgrade to vary not more than 0.05 foot above or 0.10 foot below elevation shown.
2. Maintain moisture content of embankment, fill or backfill material within plus or minus 2 percent of optimum moisture content of material.
3. Compact each layer of embankment, fill or backfill material to 95 percent of maximum dry density as determined in accordance with ASTM D 698, Method D, at moisture content within tolerance specified, except as follows:
    a. From upper surface of fill or backfill to a plane 12 inches below bottom of subbase level of vehicular pavement, sidewalks and track beds, compact to 100 percent of maximum dry density at moisture content within tolerance specified.
    b. In areas of 95 percent compaction where utility facilities are located in fill and are not supported on concrete cradles, compact material for a depth of 1 foot directly below bottom of facility to 100 percent of maximum dry density at moisture within tolerance specified.

3.07 Compaction Adjacent to Structures

A. Compact embankment, fill or backfill materials within 6 feet of wing walls, retaining walls, abutments or other structures using plate compactors, power rammers, small rollers (5100 pounds max.), etc.

B. Do not overstress structures.

C. Backfilling against new structures without approval is prohibited.

3.08 Subgrade Preparation

A. Where the subgrade is on original ground or in cut or where embankment or fill is less than 1 foot, fulfill compaction requirement for 12 inches minimum below final subgrade.

B. If necessary, scarify original ground and adjust moisture content prior to compacting.

C. Remove rigid pavements and slabs which would be within 5 feet of finished grade. Rigid pavements and slabs which will be greater than 5 feet below finished grade may be left in-place only if broken into pieces not larger than 3 feet in greatest dimension.

D. For subgrade on which structures will be placed:

1. If structures are indicated to be founded on rock and that rock has been undercut to an elevation lower than that indicated, fill undercut space with concrete of same class as that used in structure.

2. If subgrade material is disturbed, either compact subgrade to 100 percent of maximum dry density when tested in accordance with ASTM D 698; or remove and replace material with pervious material and compact to 100 percent of maximum dry density, tested in accordance with ASTM D 698.

E. For Subgrade on Which Pipe and/or Conduit Will be placed:

1. Adjust trench bottom to line and grade by either scraping away soil or placing backfill material as specified.

2. Smooth bottom of trench; remove rock and unsuitable material which would be within 1 foot of pipe and conduit. Fill undercut space with backfill material and compact to bottom of pipe and conduit elevation.

3. Cut recess in bottom of trench for pipe bell in a manner which will ensure that pipe barrel will rest on trench bottom.

3.09 Field Quality Control

A. Test Method:

1. Determine the maximum dry density and the optimum moisture content in accordance with ASTM D 698, Method D.

B. Testing:

1. Test each source of material proposed to be used for embankment, fill and backfill and submit test results to the SEPTA Project Manager. Test material for moisture density relationship in accordance with ASTM D 698; for liquid limit in accordance with ASTM D 4318; for plastic limit in accordance with ASTM D 4318.

2. Embankments:
    a. Perform one (1) in-place compaction test for each 5,000 square feet of material placed in each horizontal layer in accordance with either of the following: ASTM D 1556/D 1556M, ASTM D 2167 or ASTM D 6938. Except perform not less than one (1) test for each layer.
    b. Perform one (1) maximum dry density test for every different fill material but not less than one (1) test for every ten (10) compaction tests.
3. Backfill at structures:
    a. Perform one (1) in-place compaction test for every 2500 square feet and every 2 feet of added height but not less than three (3) compaction tests in any day during which material is placed. Perform compaction test in accordance with either of the following: ASTM D 1556/D 1556M, ASTM D 2167 or ASTM D 6938.
4. Trench Backfill:
    a. Perform in-place compaction test every 100 linear feet for every 2 feet of added height, but not less than three (3) tests in any day during which material is placed. Perform compaction tests in accordance with either of the following: ASTM D 1556/D 1556M, ASTM D 2167 or ASTM D 6938.

3.10 Excess Excavated Material

A. The Intent of this Section is that all suitable materials excavated within the limits of the Project site shall be used in the formation of embankment and for backfilling. Where the quantity of excavation exceeds that required to make up embankments or fills to cross section as shown on the Contract Documents, the suitable surplus material shall be wasted on site as directed by SEPTA. If the excess excavated material cannot be disposed of on site, the material shall be removed and disposed of off-site according to Article 3.12 in this Section.

3.11 Unsuitable Material

A. The Contractor shall notify SEPTA upon discovery of any unsuitable material encountered during excavation. The area of unsuitable material shall be over excavated and the unsuitable material shall be replaced with suitable material meeting the requirements of this Section. Before proceeding, the Contractor and SEPTA shall agree upon the area to be over excavated. Unsuitable material shall be wasted on-site as directed by SEPTA. Excavation of unsuitable material shall be included in embankment for measurement and payment. If the unsuitable material cannot be disposed of on site, the material shall be removed and disposed of off-site according to Article 3.12 in this Section.

3.12 Removal and Disposal of Excess Material

A. The Contractor shall properly haul excess excavated materials or excess unsuitable material off-site for recycling or disposal.
    1. The Contractor shall prepare all necessary waste management notifications and submittals before, during and after the completion of the work. The following submittals and notifications are required:
        a. Health and Safety Plan (Submitted prior to any work being performed onsite).
        b. PA One Call (Completed prior to any work being performed on-site). Notify the SEPTA Project Manager when this is complete.

c. Provide copies of applicable licenses and permits to haul waste in the appropriate state prior to commencing disposal activities.

d. Written approval from the disposal facility accepting the impacted materials.

e. Record real time monitoring data and submit to the SEPTA Project Manager (During the work).

f. Provide one (1) copy of the laboratory analytical data package to SEPTA Project Manager (For disposal testing).

g. Provide copies of manifests and/or bills of lading documenting proper disposal (Associated with the shipment of residual waste).

h. Final report to include but not be limited to safety meeting summaries, air monitoring logs, field data sheets, field notes, all analytical laboratory data and disposal documentation. Prepare all federal, state and local permits that are required for the management and disposal of impacted soil and other wastes.

2. The Contractor shall prepare a soil management plan to manage soils according to PADEP Management of Fill Policy Document Number 258-2182-773 dated August 7, 2010. The soil management plan will include:

   a. Figure showing the location, horizontal and vertical dimensions of the areas that will be excavated and disposed off-site as a residual waste.

   b. Provide a plan for efficient stockpiling, loading and disposing of the materials deemed a residual waste. The plan should include specific details on the location the material will be stockpiled, loaded and the route to be taken off-site in order to transport the impacted materials to the approved landfill.

   c. Provide a schedule and plan for waste characterization sampling. To aid in waste characterization, analytical documents are provided separately to bidders.

3. Provide a post excavation sampling plan that will include a figure showing the extent of excavation areas and the proposed sampling locations in accordance with 25 PA. Code, 40 CFR, and applicable guidance. Submit sampling plan to SEPTA for review and approval before conducting any sampling and testing. Provide a Pennsylvania accredited laboratory for sample analysis to test soils per the Pennsylvania Management of Fill Policy.

4. Excavated materials determined by laboratory analysis to be above regulatory standards outlined in Tables FP-1a and FP-1b of the Pennsylvania Management of Fill Policy shall be disposed of offsite in accordance with applicable federal, state and local regulations. Refer to Section 02205.

5. Do not haul excavated material off-site until the following evidence has been submitted to the satisfaction of SEPTA and has issued written permission to haul the substances off-site.

   a. Laboratory analysis reports for samples collected for applications to recycle or dispose of wastes.

   b. The transportation firm provides proper licensing and permits for transport to the disposal facility and the disposal facility has provided documentation that they will accept the excavated materials and is authorized to transport the excavated materials from the site to the recycling or disposal facility.

   c. The recycling or disposal facility has accepted the excavated material and written acceptance by the facility has been provided to SEPTA.

6. The Contractor shall properly transport excavated materials off site to recycling or disposal sites and recycle or dispose of in accordance with the rules and regulations of the regulatory agencies having jurisdiction. Record transportation, recycling and disposal methods of excavated materials off site in log books, or on manifest forms with the following information recorded for each shipment:
   a. Generating Facility:
      1) Name and address of generating facility.
      2) Date of shipment.
      3) Signature of authorized agent of generating facility.
      4) Quantity of excavated materials.
      5) Description of excavated materials shipment.
   b. Transporter:
      1) Name and address of transporting company.
      2) Signature of driver of transporting vehicle.
      3) Vehicle identification number, registration number and state of registration.
   c. Recycling and Disposal Facility:
      1) Name and address of facility.
      2) Date of shipment received at facility.
      3) Signature of authorized agent of facility.
      4) Indication that excavated material was accepted by the facility.
      5) Quantity of excavated material accepted.
      6) Description of excavated materials accepted.
      7) Method for recycling or disposal of excavated materials.
7. Excavations will be replaced with Clean Fill (As defined in the Pennsylvania Management of Fill Policy) stone or structural backfill.

END OF SECTION

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SECTION 02230

SUBBASE

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of approved aggregate placed on the subgrade and in close conformity with the lines, grades, shown on the Contract Drawings or established by SEPTA.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 02520 - Bituminous Concrete Paving

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:

1. Submit certificates of compliance of materials for liquid limit, plasticity and dry density. (Note: SEPTA reserves the right to test materials for Specification compliance).

2. Submit three (3) copies of each field density, liquidity, plasticity, and gradation test within twenty-four (24) hours after completion of testing.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM D 1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft3 (2,700 kN-m/m3)).

2. ASTM D 4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.

3. PennDOT Specifications Section 350.

PART 2 - PRODUCTS

2.01 Materials

A. The aggregate Subbase shall be well graded material meeting the requirements of PennDOT Specifications Section 703.2, gradation 2A.

PART 3 - EXECUTION

3.01 Installation

A. The installation shall be in accordance with PennDOT Specifications Section 350.3. Subbase shall be compacted to not less than 98 percent of its dry weight density as determined by ASTM D 1557 or to 85 percent of its relative maximum density as determined by ASTM D 4253, whichever is higher.

END OF SECTION

SECTION 02270

EROSION AND SEDIMENTATION CONTROL

PART 1 - GENERAL

1.01 Description

A. This Section specifies the furnishing, placement, maintenance and removal of an erosion and sediment pollution control system consisting of soil stabilization and sediment barrier controls within the limits of construction as required during the Contract life.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 02209 - Geotextile Fabric

E. Section 02220 - Excavation, Backfill and Compaction

1.03 Submittals

A. In accordance with Section 01300, submit the following for approval:

1. Certificates of compliance of materials. The SEPTA Project Manager reserves the right to test materials for Specification compliance.

2. Submit three (3) copies of each gradation test within twenty-four (24) hours after completion of testing.

B. The Contractor shall submit to SEPTA a plan showing erosion and sedimentation controls before starting construction for approval. If the proposed limit of disturbance is equal to or greater than 5,000 square feet, the Contractor shall submit an Erosion and Sedimentation Control Plan sealed and signed by a Professional Engineer licensed in the Commonwealth of Pennsylvania to the Philadelphia Water Department (PWD) and obtain a determination of plan adequacy from the PWD.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Commonwealth of Pennsylvania, Department of Transportation, Specifications Publication 408 (PennDOT Specifications).

2. Commonwealth of Pennsylvania Department of Environmental Resources, Bureau of Soil and Water Conservation, Erosion and Sediment Pollution Control Manual, latest edition (DEP Standards).

PART 2 - PRODUCTS

2.01 Materials

A. Seeding to meet the material requirements of Section 804.2 of the PennDOT Specifications.

B. Mulching to meet the material requirements of Section 805.2 of the PennDOT Specifications.

C. Rolled erosion control product to meet the material requirements of Section 806.2 of the PennDOT Specifications.

D. Compost filter sock to meet the material requirements of Section 867.2 of the PennDOT Specifications.

PART 3 - EXECUTION

3.01 Installation

A. Seeding to be installed according to Section 804.3 of the PennDOT Specifications.

B. Mulch to be installed according to Section 805.3 of the PennDOT Specifications.

C. Rolled erosion control product to be installed according to Section 806.3 of the PennDOT Specifications.

D. Compost filter sock to be installed according to Section 867.3 of the PennDOT Specifications.

3.02 Field Quality Control

A. All erosion and sedimentation controls shall be inspected, maintained and repaired until the area served by the control is stabilized, as determined by SEPTA.

B. All erosion and sedimentation controls shall be inspected weekly and after every precipitation event and shall be cleaned or replaced as required to maintain function. Cleaning to meet Section 861 of the PennDOT Specifications, except that the sediment shall be removed when it has reached one half of the depth of the sediment control structure.

C. The Contractor shall remove and dispose of all temporary erosion and sedimentation control items after stabilization or as directed by SEPTA.

D. The Contractor shall keep plan(s) showing erosion and sedimentation controls on site and available for inspection by any governing authorities at all times.

END OF SECTION

SECTION 02520

BITUMINOUS CONCRETE PAVING

PART 1 - GENERAL

1.01 Description

A. This work shall consist of constructing a base (binder) course and a wearing (top) course of bituminous concrete pavement on a prepared subbase course in accordance with these Specifications, meeting the lines, grades, thicknesses and typical cross sections shown on the Contract Drawings.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 02220 - Excavation, Backfill and Compaction

E. Section 02230 - Subbase

1.03 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Provide either bituminous base course:
   a. PennDOT Specifications Section 309 SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, HMA BASE COURSE.

      or

   b. PennDOT Specifications Section 311 SUPERPAVE ASPHALT MIXTURE DESIGN, STANDARD CONSTRUCTION, WMA BASE COURSE.

2. Provide either bituminous wearing course:
   a. PennDOT Specifications Section 409 SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED HMA COURSES.

      or

   b. PennDOT Specifications Section 411 SUPERPAVE MIXTURE DESIGN, STANDARD AND RPS CONSTRUCTION OF PLANT-MIXED WMA COURSES

PART 2 - PRODUCTS

2.01 Materials

A. The wearing course shall be in accordance with Section 409.2 or Section 411.2 of PennDOT Specifications.

B. The base course shall be in accordance with Section 309.2 or Section 311.2 of PennDOT Specifications.

C. The subbase course shall meet the requirements of Section 02230.

PART 3 - EXECUTION

3.01 Installation

A. Construction of a bituminous base course and bituminous wearing course shall be in accordance with Sections 309.3, 311.3, 409.3, 411.3 of the Penn DOT Specifications to the depths and limits shown on the Contract Drawings.

B. Construction of a subbase course shall be in accordance with Section 02230.

END OF SECTION

SECTION 02533

CEMENT CONCRETE SIDEWALK AND DRIVEWAY APRON

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of furnishing and installing plain or reinforced cement concrete sidewalks as required and to reconstruct sidewalks damaged or removed during construction.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 02230 - Subbase

E. Section 03200 - Concrete Reinforcement

F. Section 03300 - Cast-In-Place Concrete

1.03 Submittals

A. In accordance with Section 01300, submit the following:

1. Working drawings indicating construction joint and expansion joint layout, and openings.

2. Mix design for each change of ingredients and ingredient sources, including admixtures.

3. Certificates of compliance to specifications of materials provided.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. PennDOT Specifications Section 676.

PART 2 - PRODUCTS

2.01 Materials

A. Steel forms to meet the requirements specified in Section 03300.

B. Reinforcement to be galvanized steel welded wire fabric as specified in Section 03200.

C. Concrete to be Class A cement concrete meeting Section 704 of the PennDOT Specifications.

D. Expansion joint filler meeting Section 705.1 of the PennDOT Specifications.

E. Use standard Portland cement and an air entraining admixture meeting Section 03300. The concrete shall contain not less than 5 percent or more than 7 percent entrained air at the time the concrete is deposited in the forms.

F. Base course material to meet Section 02230.

PART 3 - EXECUTION

3.01 Preparation

A. Prepare foundation according to PennDOT Spec 676.3(a). Compact subgrade of all sidewalks to be smooth and even. Loose material from the compacted subgrade surface shall be immediately removed before placing concrete.

3.02 Installation

A. Form Construction:

1. Set and brace forms to maintain straight and plumb lines on sides.
2. Set forms to the following grade and alignment tolerances:
    a. Grade to be plus or minus 1/8 inch.
    b. Alignment to be plus or minus 1/4 inch at any point and no more than 1/8 inch deviation from a 10 foot straightedge.

B. Concrete Reinforcement:

1. Install as indicated per the Contract Drawings.

C. Concrete Placement:

1. Place stone aggregate subbase prior to concrete placement.
2. Construct walkways to thickness shown on the Contract Drawings.
3. Moisten subgrade to provide a uniform dampened condition at the time concrete is placed. Do not place concrete around structures or frames until they have been brought to the required grade and alignment.
4. Place concrete in one (1) course monolithic construction for the full width and depth of walks. Support reinforcement in position while placing concrete.
5. Spread concrete as soon as it is deposited on the subgrade using methods which prevent segregation of the mix. Consolidate concrete along the face of the forms and adjacent to transverse joints. Use only square faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocation of joint materials.
6. Pour sidewalk concrete in alternate sections between expansion joints and allow setting and curing for a minimum of twenty-four (24) hours before pouring adjacent panels or sections.

D. Joints:

1. General:
    a. Construct expansion, isolation and contraction joints true-to-line with face perpendicular to surface of the walks.

b. Construct transverse joints at right angles to the pavement centerline.

c. When the walkway is abutting existing walks, place transverse joints to align with previously paved joints.

2. Contraction Joints:

a. Provide contraction joints to section the walkway into areas to match pattern and construction of existing joints.

3. Construction Joints:

a. Place construction joints at the end of pours and at locations where placement operations are stopped for a period of more than one-half (1/2) hour, except where such pours terminate at expansion joints.

b. Construct joints as shown on the Contract Drawings, or, if not shown, use standard metal keyway section forms.

4. Expansion and Isolation Joints:

a. Provide pre-molded joint filler for expansion joints and isolation joints abutting concrete paving and curbs, catch basins, manholes, inlets, structures, walks and other fixed objects.

b. Expansion joints shall be placed at intervals not more than 10 feet.

c. Extend joint filler full width and depth of the joint, and not less than 1/2 inch nor more than 1 inch below the finished pavement surface where joint sealer is indicated. If no joint sealer is shown on the Contract Drawings, place top of joint filler flush with finished concrete surface.

d. Use joint fillers in one (1) piece lengths for the full width being placed. Where more than one (1) length is required, lace or clip joint filler sections together.

e. Protect top edge of the joint filler during concrete placement with a metal cap or other temporary material. Remove protection after both sides of the joint are placed.

E. Concrete Finishing:

1. Perform concrete finishing using machine or hand methods as required.

2. After striking off and consolidating concrete, smooth the surface by screening and floating. Adjust the floating to compact the surface and produce a uniform texture.

3. After floating, test surface for trueness with a 10 foot straightedge. Distribute concrete as required to remove surface irregularities, and refloat repaired areas to provide a continuous, smooth finish.

4. Work edges of slabs and joints with 1/8 inch radius edging tools.

5. After completion of floating and when excess moisture or surface sheen has disappeared, complete surface finishing as follows:

a. Broom finish to match existing concrete walks by drawing a fine hair broom across the concrete surface. Repeat operation if required to provide a texture to match existing walks.

6. Leave forms in place for at least twenty-four (24) hours after concrete has been placed. After form removal, clean ends of joints and point up any minor honeycombed areas. Remove and replace areas or sections of major honeycombing.

F. Curing:

1. Protect and cure finished concrete walks in accordance with Section 3300.

G. Repair and Protection:

1. Repair or replace broken or defective walks (defects include graffiti).
2. Protect the walks from damage until acceptance of the work. Exclude pedestrians from walks for at least three (3) days after placement.
3. Sweep concrete walks and wash free of stains, discoloration, dirt and other foreign materials.
4. Provide necessary watchpersons to prevent vandalism to freshly poured concrete walks.

H. Testing

1. Perform required testing in accordance with applicable methods as specified in Section 03300.

END OF SECTION

SECTION 02724

MANHOLES

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of providing, installing and constructing manholes as indicated on the Contract Drawings.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 16138 - Ductwork and Electrical Manholes and Handholes

1.03 Submittals

A. Submit shop drawings and product data under provisions of Section 01300.

B. Submit certification that all materials used meet the Specifications.

1.04 Quality Assurance

A. Meet the application provisions of the most recent issues of the following references:

1. Commonwealth of Pennsylvania, Department of Transportation, Specifications, Publication 408 (PennDOT Specifications).

PART 2 - PRODUCTS

2.01 Material

A. Meet PennDOT Specifications Section 605.2, except as specified otherwise for electrical manholes and handholes.

PART 3 - EXECUTION

3.01 General

A. Installation shall be according to PennDOT standard plans except as indicated on the Contract Drawings.

3.02 Installation and Construction

A. In accordance with PennDOT Specifications Section 605.3.

END OF SECTION

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SECTION 02821

CHAIN LINK FENCES AND GATES

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of furnishing and installing woven wire fencing of the type and height specified and supporting metal posts and hardware as indicated on the Contract Drawings.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 03300 - Cast-in-Place Concrete

1.03 Submittals

A. In accordance with Section 01300 and as follows:

1. Shop drawings indicating details of fence height, cross dimensions and details of posts, post footings, rails, braces, fittings and accessories.

2. Working drawings including a layout drawing consistent with the Contract Drawings showing the spacing of posts; abrupt changes in grade; and all corner, anchor, end and pull posts and anchorage details.

3. Certifications that all materials used fully meet the Specifications.

4. Manufacturer's and installer's qualifications.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

2. AASHTO M181, Standard Specification for Chain-Link Fence.

3. American National Standards Institute (ANSI).

4. American Iron and Steel Institute (AISI).

5. Commonwealth of Pennsylvania, Department of Transportation, Specifications, Publication 408, latest edition (PennDOT Specifications) and Standards for Roadway Construction, Publication 72.

6. Manufacturers to have a minimum of two (2) years of experience in the manufacture and fabrication of commercial quality chain link fence.

7. Installers to have a minimum of two (2) years of experience in the installation of type of fencing provided as work of this Section.

PART 2 - PRODUCTS

2.01 Materials

A. General:

1. Unless otherwise specified, material shall meet the requirements of AASHTO M181.
2. All gauge measurements of finished wire shall be United States Steel Wire Gauge or equivalent.
3. Galvanizing shall meet ASTM A 123/A 123M.
4. Temporary construction fencing materials shall be identical to permanent fencing. In addition:
   a. Provide opaque screening material to be securely attached to the construction fence.
5. Provide products of the same manufacture, size, design and materials, and otherwise identical.

B. Non-structure mounted chain link fence to meet the requirements of PennDOT Specifications, Section 624.2, Section 1016.2 and Section 1110.01(a) and as follows:

   a. Provide fence fabric with a size of mesh of 1 inch, 9 gauge.
   b. Provide fabric tie wire per PennDOT Specifications, Pub 408, Section 1016.2 (a).2.
   c. Provide top and bottom rails, brace rails and fittings per PennDOT Specifications, Pub 408, Section 1016.2 (a).3.

PART 3 - EXECUTION

3.01 Preparation

A. Deliver materials clearly labeled with the manufacturer's original packaging with tags and labels intact and legible.

B. Store on skids to protect from direct contact with the ground.

3.02 Installation

A. Non-structure mounted chain link fence to meet the requirements of PennDOT Specifications, Pub. 408, Section 624.3 and as indicated on the Contract Drawings.

B. Temporary chain link fence to meet the requirements of PennDOT Specifications, Section 624.3 and as follows:

1. Provide a stable, self-supporting fence system. Alternatively, the Contractor may drive fence posts directly into ground outside of pavement areas, to a minimum depth of at least 3 feet to ensure fence is stable. Concrete foundations are not required.
2. Securely attach opaque screening material to the outside or construction side of the fence.

END OF SECTION

SECTION HIGH SECURITY ORNAMENTAL FENCES AND GATES

HIGH SECURITY ORNAMENTAL FENCES AND GATES

PART 1 - GENERAL

1.01 SUMMARY

A. Section Includes:

1. Decorative powder-coated-steel security fences.
2. Swing gates.

B. Related Requirements:

1. Section 03300 " Cast-in-Place Concrete" for concrete anchorage.
2. PREINSTALLATION MEETINGS

C. Pre-installation Conference: Conduct conference at project site.

1.02 SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For fencing and gates.

1. Include plans, elevations, sections, gate locations, post spacing, and mounting.

C. Samples: For each fence material and for each color specified.

1. Provide Samples 12 inches in length for linear materials.

1.03 WARRANTY

A. The contractor shall provide a twenty-year warranty on all finishes against finish failure, peeling and chipping.

1.04 QUALITY ASSURANCE AND CONTROL

A. All fencing posts and panels are to come from the same manufacturer, regardless of size or style.

PART 2 - PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Wind Loading:

1. Wind Exposure Category: B
2. Design Wind Speed: 90 mph

2.02 DECORATIVE POWDER-COATED-STEEL SECURITY FENCES

A. Acceptable Products and Manufacturers

1. Commercial Fencing:
   a. Montage Plus Commercial in 3-Rail as manufactured by Ameristar Fence Products
      1) Majestic – Smooth Top Rail (Typical SEPTA Standard)
      2) Classic Style – Pressed Top Picket
      3) Genesis – Flat Top Picket
   b. Maverick 3-Rail Commercial as manufactured by Iron World
      1) Aberdeen – Smooth Top Rail (Typical SEPTA Standard)
      2) Barcelona – Pressed Top Picket
   c. Westmoreland II in 3-Rail as manufactured by Northeast Fence and Iron Works
      1) Mayfair Style – Smooth Rail (Typical SEPTA Standard)
      2) Tacony Style – Pressed Top Picket
      3) Academy Style – Flat Top Picket
   d. Or Approved Equal
2. Intrusion Prevention Fencing:
   a. Montage Commercial 3-Rail with Invincible Style Pickets as manufactured by Ameristar Fence Products
   b. Guardian 3-Rail with Bent Pickets as manufactured by Iron World
   c. Frankford Bent Top/Press Point Top 3-Rail as manufactured by Northeast Fence and Iron Works
   d. Or Approved Equal

B. Posts:
1. Galvanized square steel tubular members, manufactured per ASTM A653 or A787, having 45,000 psi yield strength with a G90 zinc coating, .9oz/square ft, on interior and exterior of post.
   a. Posts for 8’-0” High Fencing:
      1) 3” Square minimum
      2) 12 Gauge minimum
   b. Posts for Gates, End Posts and Corner Posts:
      1) 6” Square minimum
      2) 3/16” Wall minimum

C. Post Caps:
1. Formed steel, weather tight, closure cap in style shown on drawing. Provide one for each post.

D. Rails:
1. Galvanized horizontal “U” channels, manufactured per ASTM A653, having a 50,000 psi yield strength with a G90 zinc coating, .9oz/square ft.
   a. Rail Size: 1 1/2" x 1 3/8"
   b. 14 Gauge minimum
   c. Rails to be mechanically punched to receive fasteners. Rails shall be attached to brackets using one-way stainless steel security fasteners.

E. Pickets:

1. Galvanized square steel tubular members, manufactured per ASTM A653 or A787, having 45,000 yield strength with a G90 zinc coating, .9oz/square ft.
    a. Picket Size: ¾" x ¾"
    b. 16 gauge minimum
    c. Spaced 3 15/16" maximum between pickets.
    d. Fencing shall have bent or curved intrusion prevention pickets.
    e. Pickets shall be inserted into pre-punched holes in the rails and shall be aligned to standard spacing using a calibrated alignment fixture. The aligned pickets and rails shall be joined at each picket-to-rail intersection by either a fusion welding process or industrial drive rivets painted to match fencing system.

F. Rail/Post Brackets:
    1. 14 Gauge minimum
    2. Flat Mount Brackets with 300 series stainless steel tamper resistant bolts, of sufficient length to attach items in a secure non-rattling position. Fasteners to have a minimum of 1,100 lbs holding power and a shear strength of 1,400 lbs. Fastener heads to be tamper resistant and painted to match panels.

G. Base plates:
    1. 6" square minimum, ½" thick galvanized steel plate with (4) predrilled holes, manufactured per ASTM A653, with a G90 zinc coating, .9oz/square ft.
        a. Attach Base Plates to substrate with (4) stainless steel threaded rods set into epoxy fixative as suggested by manufacturer.

H. The manufactured fence system shall be capable of meeting the vertical load, horizontal load, and infill performance requirements for Commercial weight fences under ASTM F2408.

I. Fasteners: Stainless-steel carriage bolts with tamperproof nuts.

J. Interior surface of tubes formed from uncoated steel sheet shall be hot-dip zinc coated same as exterior.

K. Galvanizing: For components indicated to be galvanized, hot-dip galvanize to comply with ASTM A123. For hardware items, hot-dip galvanize to comply with ASTM A153.

L. Finish: Powder coating

2.03 SWING GATES

A. Gates shall be as indicated on the contract drawing(s).
    1. Gate Configuration: Single leaf
    2. Gate Frame Height: Same as adjacent fencing.
    3. Gates shall be supplied with the same construction as the associated fencing panels.
    4. Gates shall have bent or curved intrusion prevision pickets.

B. Gate frames shall have a fully welded construction for a rigid frame.

C. Frame Corner Construction: Welded with 5/16-inch diameter, adjustable truss rods for panels 5 feet wide or wider.

D. Bracing: Provide diagonal adjustable length truss rods to prevent sagging as required.

E. Hardware: Latches permitting operation from both sides of gate, hinges, and keepers for each gate leaf more than 5 feet wide. Provide center gate stops and cane bolts for pairs of gates. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.

F. Hinges: BHMA A156.1, Grade 1, suitable for exterior use.

1. Function: 39 - Full surface, triple weight, antifriction bearing.

2. Material: Wrought steel, forged steel, cast steel, or malleable iron; galvanized.

G. Cane Bolts: Provide for inactive leaf of pairs of gates. Fabricated from 3/4-inch-diameter, round steel bars, hot-dip galvanized after fabrication. Finish to match gates. Provide galvanized-steel pipe strikes to receive cane bolts in both open and closed positions.

H. Finish exposed welds to comply with NOMMA Guideline 1, Finish #2 - completely sanded joint, some undercutting and pinholes okay.

I. Galvanizing: For items other than hardware that are indicated to be galvanized, hot-dip galvanize to comply with ASTM A123. For hardware items, hot-dip galvanize to comply with ASTM A153.

J. Finish: Powder coating

2.04 STEEL AND IRON

A. Plates, Shapes, and Bars: ASTM A36.

B. Tubing: ASTM A500, cold-formed steel tubing.

C. Galvanized-Steel Sheet: ASTM A653, structural quality, Grade 50, with G90 coating.

D. Castings: Either gray or malleable iron unless otherwise indicated.

1. Gray Iron: ASTM A48, Class 30.

2. Malleable Iron: ASTM A47/A47M.

2.05 MISCELLANEOUS MATERIALS

A. Non-shrink Grout: Factory-packaged, non-staining, noncorrosive, nongaseous grout complying with ASTM C1107/C1107M and specifically recommended by manufacturer for exterior applications.

PART 3 - EXECUTION

3.01 INSTALLATION BY SEPTA WORK FORCES

A. Or the following for Third Party Installation

3.02 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for site clearing, earthwork, pavement work, construction layout, and other conditions affecting performance of the Work.

B. Do not begin installation before final grading is completed unless otherwise permitted by SEPTA Project Manager.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.03 PREPARATION

A. Stake locations of fence lines, gates, and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, underground structures, benchmarks, and property monuments.

3.04 DECORATIVE SECURITY FENCE INSTALLATION

A. Install fences according to manufacturer's written instructions.

B. Space posts uniformly at 8 feet on center.

C. Post Mounting with Base Plates

1. Anchor base plates to concrete sidewalk or curbing with four stainless steel threaded rods set in Hilti RE-Hit Injection Epoxy system or approved equal.

2. Size rods appropriately to securely anchor fence posts and to support fence sections.

3. Provide stainless steel nuts and washers and install with Lock-Tight.

4. Install neoprene washer between base plate and stainless steel washer.

5. Install neoprene shim between concrete substrate and base plate.

6. Paint all hardware to match fencing.

3.05 GATE INSTALLATION

A. Install gates according to manufacturer's written instructions, level, plumb, and secure for full opening without interference. Attach hardware using tamper-resistant or concealed means. Install ground-set items in concrete for anchorage. Adjust hardware for smooth operation and lubricate where necessary.

3.06 ADJUSTING

A. Gates: Adjust gates to operate smoothly, easily, and quietly, free of binding, warp, excessive deflection, distortion, nonalignment, misplacement, disruption, or malfunction, throughout entire operational range. Confirm that latches and locks engage accurately and securely without forcing or binding.

B. Lubricate hardware**,** and other moving parts.

3.07 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain gates.

END OF SECTION

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SECTION 03100

CONCRETE FORMS

PART 1 - GENERAL

1.01 Description

A. This Section covers the concrete formwork for construction of all concrete structures set forth on the Contract Drawings and in these Specifications.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. Section 03200 – Concrete Reinforcement

E. Section 03300 – Cast-In-Place Concrete

1.03 Submittals

A. Submit manufacturer's descriptive form coating product data and current specification covering named product.

B. Submit manufacturer's descriptive form tie product data and current specification covering named product.

1.04 Quality Assurance

A. Provide formwork designed to ensure the tolerances indicated and to include factors pertinent to safety of personnel during construction.

1. Design formwork in accordance with ACI 347 and in accordance with the following:
    a. Design forms and falsework to include assumed values of live load, dead load, weight of moving equipment operated on formwork, temporary construction material, foundation pressures, stresses, lateral stability and such other factors pertinent to safety of structure during construction.
    b. Design formwork to be readily removable without impact, shock or damage to cast-in-place concrete surfaces and adjacent construction.

B. Set and maintain concrete forms within tolerance limits stated in ACI 347.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 347, Guide to Formwork for Concrete.
2. APA-The Engineered Wood Association, Panel Handbook & Grade Glossary.
3. Southern Pine Inspection Bureau (SPIB), Standard Grading Rules for Southern Pine Lumber.
4. U.S. Department of Commerce Product Standards PS-1-95, Construction and Industrial Plywood.

5. U.S. Department of Commerce Product Standards PS-20-94, American Softwood Lumber.
6. Western Lumber Grading Rules 98.

1.05 Delivery, Storage and Handling

A. Storage and Protection:

1. Protect formwork materials before, during and after erection to ensure acceptable finished concrete work. Also protect in-place materials and work of other trades in connection with concrete work.
2. In event of damage to erected forms, make necessary repairs or replacements prior to concrete pours. Perform such corrective work at no increase in Contract price.

PART 2 - PRODUCTS

2.01 Materials

A. Lumber:

1. Form framing, sheathing, struts, braces and shoring in conformance with WWPA Grading Rules or SPIB Grading Rules.
2. Provide rough structural and dimension lumber of allowable species, surfaced four (4) sides as applicable and grade stamped with the appropriate WWPA or SPIB stamp indicating product compliance with PS-20-94.
3. Use lumber free of material defects that would deform the finished concrete product.

B. Plywood:

1. Form sheathing and panels to not be less than 5/8 inch thick Exterior Type B-B Plywood Class I and II conforming to U.S. Product Standard PS-1-95.
2. Use Class II only on surfaces not exposed to view.

C. Steel:

1. Metal Forms of a pre-engineered standard design, conforming to the concrete sections indicated on the Contract Drawings, may be used in lieu of wood forms.

D. Form Ties:

1. Provide factory-fabricated, adjustable-length, removable or snap-off metal form ties meeting ACI 347.
2. Use snap-off metal ties with ends that break at least 1 1/2 inches from the face of the wall.
3. Do not use removable ties that leave holes larger than 1 inch.
4. Do not use wire ties, flat bands or form ties fabricated on the Project site.
5. Do not use wood spacers.

E. Provide commercial formulation form-coating compounds that will not bond with, stain, nor affect concrete surfaces, and will not impair subsequent treatment of concrete surfaces

requiring bond or adhesion, nor impede the wetting of surfaces to be cured with water or curing compounds.

PART 3 - EXECUTION

3.01 Inspection

A. Prior to placement of concrete, inspect forms for cleanliness and accuracy of alignment.

3.02 Preparation

A. Apply form coatings in accordance with the manufacturer's specifications.

B. Do not allow excess form coating material to accumulate in the forms.

C. Do not allow form coatings to come in contact with construction joints and reinforcing steel.

3.03 Erection

A. Construct forms in accordance with ACI 347 to required dimensions, plumb, straight, mortar tight and paste tight where appearance is important.

1. Securely brace and shore forms to prevent displacement, bowing and pillowing, and to safely support imposed concrete load.

2. Provide offsets, keyways, recesses, chamfers, blocking, screeds, bulkheads, anchorages and inserts, and such other features as required. Use selected materials to obtain above requirements.

3. Fabricate forms for easy removal without hammering or prying against concrete surfaces.

4. Form intersecting planes to provide true, clean-cut corners with edge grain of plywood not exposed to concrete.

5. Build into forms, or otherwise secure in forms, items such as inserts, anchors, miscellaneous metal items and such other embedded items as indicated on the Contract Drawings.

6. Wet forms sufficiently to prevent joints in wood forms from opening prior to concrete pour.

7. Do not use stay-in-place metal forms.

B. Provide temporary openings where interior area of formwork is inaccessible for cleanout, for inspection before concrete placement and for placement of concrete.

1. Securely brace temporary openings and set tightly to forms to prevent the loss of concrete mortar. Locate temporary openings on forms in as inconspicuous location as possible consistent with the requirements of the work.

2. Provide openings in concrete formwork of the correct size and in the proper location to accommodate other items and operations of construction work passing through forms. Accurately place and securely support items to be built into forms.

C. Earth forms are not permitted.

3.04 Construction

A. Form Removal:

1. Remove forms in accordance with ACI 347 without damage to concrete and in a manner to ensure complete safety and serviceability of the structure.
    a. Do not cut form ties back from the face of the concrete.
    b. Concrete surface shall not contain residual form coating that will interfere with other materials or coatings to be applied.
    c. Concrete containing slag ground granulated blast furnace slag tends to develop strength slower than a concrete containing 100 percent Portland cement.
2. Do not remove supporting forms or shoring until the members have acquired sufficient strength to safely support their weight and the anticipated construction loads without distortion or excessive deflection. SEPTA's consent to remove forms does not relieve the Contractor of the responsibility for the safety of the work.
3. When the atmospheric temperature at the site has been continuously above 50°F from the time of the pour, the forms shall be removed at the earliest practical time within the limits set forth in this paragraph and wet curing shall continue without delay.
    a. Forms for walls and other vertical faces may be carefully removed twenty-four (24) hours after the last portion of concrete in the section involved has been placed, provided the concrete has sufficiently hardened to preclude damage resulting from form removal and provided these members are not subjected to loads for a period of fourteen (14) days.
    b. Maintain horizontal forms in place for a minimum of fourteen (14) days or until the concrete, as determined by job-cured cylinders, has attained a compressive strength of 3,000 psi.
    c. When a water-reducing retarder is used in the concrete mix, the normal time periods for removing forms may need to be increased.
4. When the atmospheric temperature at the site drops below 50°F, leave all forms in place for at least five (5) days regardless of the temperature within the protective covering or enclosure. Upon removal of forms, notify SEPTA in order that a review of the newly stripped surfaces may be made before patching.

3.05 Re-Use of Forms

A. Forms for re-use shall meet new form requirements with respect to effect on poured concrete appearance and structural stability.

B. Do not delay or change the concrete pour schedule as a result of reusing forms compared to the schedule obtainable if all forms were new (in the case of wood forms) or if the total required forms were available (in the case of metal forms).

END OF SECTION

SECTION 03200

CONCRETE REINFORCEMENT

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of furnishing and installing reinforcement for concrete structures.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. Section 03100 – Concrete Forms

E. Section 03300 – Cast-In-Place Concrete

1.03 Submittals

A. Submit Shop Drawings and Product Data:

1. Prepare shop drawings of concrete reinforcement in accordance with ACI 315.
2. Provide drawings showing all fabrication dimensions and locations for placing reinforcement and bar supports; indicate bending diagrams, splicing and lap of rods, shapes, dimensions, and details of bar reinforcing and accessories.
3. Submit manufacturer's descriptive product data and current specification for each product specified herein, include installation instructions.

B. Submit Test Reports:

1. Submit copies of reports showing the results of tests conducted in accordance with the American Society for Testing and Materials (ASTM) Specifications.
2. Test requirements may be waived based upon certified copies of mill test reports.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 315, Details and Detailing of Concrete Reinforcement.
2. ACI 318, Building Code Requirements for Structural Concrete.
3. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
4. ASTM A 108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
5. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.

6. ASTM A 663/A 663M, Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
7. ASTM A 767/A 767M, Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement.
8. ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
9. Concrete Reinforcing Steel Institute, Manual of Standard Practice.

1.05 Delivery, Storage and Handling

A. Storage of Materials:

1. Store reinforcing materials in a manner to prevent excessive rusting and fouling with dirt, grease, and other bond-breaking coatings.
2. Identify bundles of reinforcing steel with tags wired to steel.

1.06 Project Conditions

A. Protect in-place reinforcement from excessive construction traffic and other work.

PART 2 - PRODUCTS

2.01 Materials

A. Reinforcing Steel:

1. Galvanized reinforcement bars to meet ASTM A 767/A 767M, Class 2, using ASTM A 615/A 615M, Grade 60, deformed steel.
2. Metal accessories to meet CRSI Manual of Standard Practice.

B. Joint Dowel Bars:

1. Reinforcement bars to meet ASTM A 615/A 615M, Grade 60, deformed steel.

C. Rebar Splicing Coupler:

1. A two (2) piece splicing system manufactured from ASTM A 615/A 615M, Grade 60 deformed rebar. A dowel bar splicer with integral nailing flange shall be threaded for a threaded dowel-in rebar such that the completed splice exceeds the tensile requirements of ACI 318.
2. Provide the coupler manufacturer’s plastic internal coupler protector where couplers are provided for anticipated future additions.
3. Plastic solid sleeve for placement over bar ends to protect threading from damage, contamination, and rust.
4. Use rebar splicing coupler only where shown on the Contract Drawings or where approved by SEPTA.
5. Manufacturers:
   a. Dayton Superior Corp.

b. Or Approved Equal.

D. Slab Joint Dowel Bar (for shear transfer):

1. Plain round bar conforming to requirements of ASTM A 663/A 663M, Grade 70, 75 or 80 which is not burred, roughened, or deformed out of round to slippage is not hindered.

2. Coat with curing compound to render surface bondless.

a. Refer to Section 03300 for curing compound.

E. Deformed Bar Anchors:

1. ASTM A 108 cold worked, deformed wire per ASTM A 1064/A 1064M with minimum yield strength of 70 ksi and minimum ultimate tensile strength of 80 ksi. Bar anchor shall be low carbon steel with the following properties C -0.23 max, Mn – 0.90 max, P – 0.040 max and S – 0.050 max.

2. Anchors shall be similar to Nelson, flux-filled deformed bar anchor by one (1) of the following manufacturers:

a. Type D2L, by Nelson Stud Welding.

b. Or Approved Equal.

F. Fibermesh:

1. First quality, 100 percent virgin polypropylene fibers containing no reprocessed olefin materials as manufactured by one (1) of the following manufacturers:

a. SI Concrete Systems.

b. Or Approved Equal.

2. Fibermesh material shall be mixed at rate of 1.5 pounds of fiber to 1 cubic yard of concrete.

3. Add fibrous reinforcement to concrete material at the time concrete is batched. Mix concrete in strict accordance with the fiber reinforcement manufacturer's instructions in order to achieve uniform three dimensional distribution.

2.02 Fabrication

A. Fabricate reinforcement to the dimensions indicated on the Contract Drawings and within the tolerances given in ACI 315. Perform bending of steel reinforcement by the cold bending method.

1. Do not use bars with kinks or bends not indicated on the Contract Drawings.

2. Perform bar shape fabrication in a manner that will not injure the material or lessen the member strength.

3. Use a designed bending machine, either hand- or power-operated.

4. Do not field bend bars partially embedded in concrete unless approved by SEPTA.

PART 3 - EXECUTION

3.01 Inspection

A. Notify SEPTA and Independent Testing Agency five (5) working days before placing concrete so the placement of metal reinforcement can be inspected.

3.02 Installation

A. Placing:

1. Place metal reinforcement accurately and securely brace against displacement within permitted tolerances and in accordance with ACI 318 through the use of reinforcing accessories.
2. Terminate reinforcement 2 inches from face of expansion joints.
3. Continue reinforcement across or through construction joints.
4. When obstructions interfere with the placement of reinforcement, pass such obstructions by placing reinforcing around it. Do not bend the reinforcing to clear the obstructions.
5. Install welded wire fabric as indicated, lapping joints eight inches, and wiring securely. Extend welded wire fabric to within two inches of sides and ends of slabs.
6. Do not lay metal reinforcement on formwork.
7. Place slab reinforcement supported from the ground on bar chairs made of plastic or steel.
8. Reinforcement supported from formwork for slabs, use bar chairs made of plastic or steel.
9. Place additional reinforcement around openings in slabs and walls as detailed on the Contract Drawings.
10. Deformed bar anchors shall be field welded to slab edge steel bent plate as shown on the Contract Drawings.

B. Splicing:

1. Splice metal reinforcement as indicated on the Contract Drawings and in accordance with ACI 318.
2. Welding of crossing bars (tack welding) is not permitted.
3. Secure metal reinforcement at intersections with not less than No. 16 gauge annealed wire or appropriate size clips. When bar spacing is less than 12 inches, tie alternate intersections.
4. Make mechanical butt splice in accordance with the rebar splicing coupler manufacturer’s installation instructions.

C. Slab Joint Dowel Bar Installation:

1. Install one-half the length of coated bar dowel into slab to be poured.

D. Cleaning:

1. Clean or otherwise protect metal reinforcement so that at the time concrete is placed, reinforcement is free from rust, scale or other coatings that will destroy or reduce bond.

E. Concrete Reinforcement Protection:

1. Provide protection for reinforcement during concrete pours in accordance with ACI 318, unless indicated otherwise on the Contract Drawings.

END OF SECTION

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SECTION 03300

CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 Description

A. The extent of concrete work is shown on Contract Drawings.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. Section 03100 – Concrete Forms

E. Section 03200 – Concrete Reinforcement

1.03 Submittals

A. Submit product data with application and installation instructions for proprietary materials and items, including reinforcement and forming accessories, admixtures, patching compounds, joint system, curing compounds, grouts and others as requested by SEPTA.

B. Submit shop drawings for fabrication, bending and placement of concrete reinforcement to SEPTA for approval before fabrication. Meet ACI 315 showing bar schedule, stirrup spacing, diagrams of bent bars and arrangement of concrete reinforcement. Include special reinforcement if required.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 301, Specifications for Structural Concrete for Buildings.
2. ACI 304, Measuring, Mixing, Transporting, and Placing Concrete.
3. ACI 305, Guide for Hot Weather Concreting.
4. ACI 306, Guide to Cold Weather Concreting.
5. ACI 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
6. ACI 318, Building Code Requirements for Reinforced Concrete.
7. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
8. ASTM A 706/A 706M, Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement.
9. ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

10. ASTM C 31/C 31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
11. ASTM C 33/C 33M, Standard Specification for Concrete Aggregates.
12. ASTM C 39/C 39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
13. ASTM C 42/C 42M, Standard Test Method for Obtaining and Testing Driller Cores and Sawed Beams of Concrete.
14. ASTM C 94/C 94M, Standard Specification for Ready-Mixed Concrete.
15. ASTM C 143/C 143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
16. ASTM C 150/C 150M, Standard Specification for Portland Cement.
17. ASTM C 172/C 172M, Standard Practice for Sampling Freshly Mixed Concrete.
18. ASTM C 173/C 173M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method.
19. ASTM C 231/ C 231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
20. ASTM C 260/C 260M, Standard Specification for Air-Entraining Admixtures for Concrete.
21. ASTM C 618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete
22. Concrete Reinforcing Steel Institute, Manual of Standard Practice.

B. Engage a testing laboratory acceptable to SEPTA to perform material evaluation tests and to design concrete mixes. Furnish test reports in triplicate for approval.

C. Materials and installed work may require testing and retesting, as directed by SEPTA, at any time during progress of work.

PART 2 - PRODUCTS

2.01 Form Materials

A. Refer to Section 03100.

2.02 Concrete Materials

A. Reinforcing Bars:

1. ASTM A 615/A 615M, grade 60, deformed.
2. Reinforcing bars to be welded to meet ASTM A 706/A 706M.

B. Welded wire fabric to meet ASTM A 1064/A 1064M.

C. Dowel bar anchors to meet ASTM A 1064/A 1064M.

D. Deformed welded wire fabric to meet ASTM A 1064/A 1064M.

E. Tie wires to meet ASTM A 1064/A 1064M.

F. Accessories:

1. Spacers, chairs, ties, mechanical splices and other devices necessary for proper assembly, placing and supporting reinforcement.
2. Provide plastic tipped or stainless accessory legs at surfaces exposed to view.
3. Provide plastic wire ties, slab bolsters and chairs.
4. Chairs shall be sized and spaced to prevent cover loss during construction operations.

G. Supports for Reinforcement:

1. Provide zinc-coated steel supports for reinforcement including bolsters, chairs, spacers, and other devices for spacing, supporting and fastening reinforcing bar type supports complying with CRSI specification, unless otherwise acceptable.

H. Portland Cement:

1. ASTM C 150/C 150M, Type I or II unless otherwise acceptable to SEPTA.
2. Use one (1) brand of cement throughout the Contract.

I. Fly Ash:

1. ASTM C 618, Type C or Type F.
2. Limit use of fly ash not to exceed 25 percent of cement content by weight.

J. Normal Weight Aggregates:

1. ASTM C 33/C 33M, and as herein specified. Provide aggregates from a single source.
2. Local aggregates not meeting ASTM C 33/C 33M but which have shown by special test or actual service to produce concrete of adequate strength and durability may be used when acceptable to SEPTA.

K. Water to be drinkable.

L. Air-entraining admixture to meet ASTM C 260/C 260M.

M. Grout to be ready-mix non-shrink non-metallic grout.

2.03 Proportioning and Design of Mixes

A. Prepare design mixes for the type and strength of concrete by either laboratory trial batch or field experience methods as specified in ACI 301. If trial batch method used, use an independent testing facility acceptable to SEPTA for preparing and reporting proposed mix designs. The testing facility shall not be the same as used for field quality control testing unless otherwise acceptable to SEPTA.

B. Design mixes to provide normal weight concrete with the following properties, as indicated on the Contact Drawings and schedules:

1. 4000 psi at twenty-eight (28) day compressive strength; W/C ratio, 0.35; entrained air to be 6 percent plus or minus 1 percent.

C. Proportion and design mixes to result in concrete slump at point of placement on slab to be between 3 inches to 5 inches.

2.04 Concrete Mixes

A. Job-Site Mixing:

1. Mix materials for concrete in appropriate drum type batch machine mixer. For mixers of 1.0 cu. yard, or smaller capacity, continue mixing at least one and one half (1 1/2) minutes, but not more than five (5) minutes after ingredients are in mixer, before any part of batch is released. For mixers of capacity larger than 1.0 cu. yard, increase minimum one and one half (1 1/2) minutes of mixing time by fifteen (15) seconds for each additional cu. yard, or fraction thereof.

2. Provide batch ticket for each batch discharged and used in work, indicating project identification name and number, date, mix type, mix time, quantity and amount of water used.

B. Ready-mix concrete to meet the requirements of ASTM C 94/C 94M, and as herein specified.

1. During hot weather, or under conditions contributing to rapid setting of concrete, a shorter mixing time than specified in ASTM C 94/C 94M may be required.

2. When air temperature is between 85° F and 90° F, reduce mixing and delivery time from one and one half (1 1/2) hours to seventy-five (75) minutes, and when air temperature is above 90° F, reduce mixing and delivery time to sixty (60) minutes.

PART 3 - EXECUTION

3.01 Placing Reinforcement

A. Meet Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars" for details and methods of reinforcement placement and supports, and as specified herein and on the Contract Drawings.

B. Accurately position, secure and support reinforcement against displacement by formwork, construction or concrete placement operations. Locate and support reinforcing by metal chairs, runners, bolsters, spacers and hangers as required.

C. Place reinforcement to obtain at least minimum coverage for concrete protection. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so that ends are directed into concrete, not toward exposed concrete surfaces.

3.02 Joints

A. No construction joints will be permitted.

3.03 Concrete Placement

A. Before placing concrete, inspect and complete formwork and installation of reinforcing steel.

B. Meet ACI 304 and as herein specified.

1. Deposit concrete continuously or in layers of such thickness that no concrete will be placed on concrete which has hardened sufficiently to cause the formation of seams or

planes of weakness. Deposit concrete as nearly as practicable to its final location to avoid segregation.

C. Deposit concrete in forms in horizontal layers in a manner to avoid inclined construction joints.

D. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding or tamping. Use equipment and procedures for consolidation of concrete in accordance with ACI recommended practices.

E. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations not further than visible effectiveness of machine. Place vibrators to rapidly penetrate placed layer and into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing segregation of mix.

F. Deposit and consolidate concrete slabs in a continuous operation, until the placing of a panel or section is completed.

G. Consolidate concrete during placing operations so that concrete is thoroughly worked around reinforcement and into corners.

H. Bring slab surfaces to correct level with straightedge and strike-off. Use bull floats or derbies to smooth surface, free of humps or hollows.

I. Maintain reinforcing in proper position during concrete placement operations.

J. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placement and curing. In hot weather meet ACI 305 and in cold weather meet ACI 306.

3.04 Concrete Curing and Protection

A. General:

1. Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

2. Start initial curing as soon as free water has disappeared from concrete surface after placing and finishing. Weather permitting, keep continuously moist for not less than seven (7) days.

3. Begin final curing procedures immediately following initial curing and before concrete has dried. Continue final curing for at least seven (7) days in accordance with ACI 301 procedures. Avoid rapid drying at end of final curing period.

B. Perform curing of concrete by curing and sealing compound, by moist curing, by moisture-retaining cover curing and by combinations thereof, as herein specified.

C. Provide moisture curing by any of the following methods:

1. Keep concrete surface continuously wet by covering with water.

2. Continuous water-fog spray.

3. Covering concrete surface with specified absorptive cover, thoroughly saturating cover with water and keeping continuously wet. Place absorptive cover to provide coverage of concrete surfaces and edges, with 4 inch lap over adjacent absorptive covers.

D. Provide moisture-cover curing as follows:

1. Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width with sides and ends lapped at least 3 inches and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

E. Provide curing compound and sealing compound as follows:

1. Apply specified curing and sealing compound to concrete slabs as soon as final finishing operations are complete (within two (2) hours). Apply uniformly in continuous operation by power-spray or roller in accordance with the manufacturer's directions. Maintain continuity of coating and repair damage during curing period.

3.05 Shores and Supports

A. Refer to Section 03100.

3.06 Quality Control Testing During Construction

A. To facilitate testing service, the Contractor shall:

1. Secure and deliver to SEPTA or its testing agency, without cost, preliminary representative samples of the materials the Contractor proposes to use, and which are required to be tested.

2. Permit SEPTA to take samples of the placement of concrete. The time that such samples shall be made will be at the discretion of SEPTA at the site. The Contractor shall permit slump tests to be made during the entire concrete placement operation at a frequency determined by SEPTA.

B. Sampling and testing for quality control during placement of concrete shall include the following, as directed by SEPTA.

1. Sampling fresh concrete to meet ASTM C 172/C 172M, except modified for slump to comply with ASTM C 94/C 94M.

2. Slump to meet ASTM C 143/C 143M; one (1) test per 60 feet at point of discharge for each day's pour of each type of concrete; additional tests when concrete consistency seems to have changed.

3. Air content to meet ASTM C 173/C 173M, volumetric method for lightweight or normal weight concrete; ASTM C 231/C 231M pressure method for normal weight concrete; one (1) for each day's pour of each type of air-entrained concrete.

4. Test concrete temperature hourly when air temperature is 40°F and below, and when 80°F and above; and each time a set of compression test specimens made.

5. Compression test specimen to meet ASTM C 31/C 31M; one (1) set of three (3) standard cylinders for each compressive strength test, unless otherwise directed. Mold and store cylinders for laboratory cured test specimens except when field-cure test specimens are required.

6. Compressive strength test to meet ASTM C 39/C 39M; one (1) specimens for each day's pour plus additional sets for each 5.0 cubic yard over and above the first 5.0 cubic yard of each concrete class placed in any one (1) day; one (1) specimen tested at seven (7) days, one (1) specimen tested at twenty-eight (28) days, and one (1) specimen retained in reserve for later testing if required.
7. When frequency of testing will provide less than five (5) strength tests for a given class of concrete, conduct testing from at least five (5) randomly selected batches or from each batch if fewer than five (5) are used.

C. Test results will be reported in writing to SEPTA within twenty-four (24) hours after tests are made. Reports of compressive strength tests shall contain the Project identification name and number, date of concrete placement, name of concrete testing service, concrete type and class, location of concrete batch in structure, design compressive strength at twenty-eight (28) days, concrete mix proportions and materials compressive breaking strength and type of break for both seven (7) day tests and twenty-eight (28) day tests.

D. Impact hammer, sonoscope, or other nondestructive device may be permitted for nondestructive testing but shall not be used as the sole basis for acceptance or rejection.

E. The independent testing service will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by SEPTA. Testing service may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed. The Contractor shall pay for such tests conducted, and any other additional testing as may be required, along with sample taking and patching, if required, when unacceptable concrete is verified.

F. Concrete work determined to be below specified requirements by results of load tests or by structural analysis or not meeting compressive strength requirements, or dimensional tolerance requirements, or appearance requirements, or strength of structural members will be rejected and removed and be replaced with new concrete at no expense to SEPTA.

END OF SECTION

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SECTION 03600

GROUT

PART 1 - GENERAL

1.01 Description

A. This Section specifies the grouts for the individual grouting requirements stated in other Sections of the Specifications and where indicated on the Contract Drawings.

1.02 Related Sections

A. Section 03930 – Concrete Repair

B. Section 04011 – Masonry Cleaning

1.03 Submittals

A. Submit manufacturer's descriptive product data and current specifications covering named manufactured products specified in this Section. Include placing instructions. Submit product data for the following:

1. Non-shrink non-metallic grout.

B. Submit mix proportions for all mortar and grout to be used throughout the Contract including material specifications and laboratory test results. With each mortar and grout mix, indicate locations to be used and whether mix is to be proportioned in the field or by off-site supplier.

1.04 Quality Assurance

A. Grout installer to be a certified installer with documented history installing the manufacturer’s products according to the manufacturer’s specifications.

B. Furnish the grout manufacturer's current independent laboratory test results on grout performance qualifications indicating the grout as non-shrink from time of placement as meeting the following:

1. Early height change of 0.0 percent to 4.0 percent, according to ASTM C 827/C 827M.

2. Hardened height change of 0.0 percent to 0.3 percent according to ASTM C 1090/C 1090M.

3. Indicating 4,000 psi strength developed with a trowelable mix within twenty-four (24) hours.

4. Indicating placement time based on initial set of not less than sixty (60) minutes, according to ASTM C 191.

5. Indicating 8,000 psi strength at twenty-eight (28) days.

C. Testing Agency Services:

1. Testing agency used for concrete sampling and testing shall be employed at the Contractor’s expense to take periodic field samples of mortar and grout for testing.

Grout shall be sampled and tested in accordance with ASTM C 1019. Mortar shall be sampled and tested in accordance with ASTM C 270 and ASTM C 780.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM C 109/C 109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch or 50-mm Cube Specimens).
2. ASTM C 191, Standard Test Methods for Time of Setting of Hydraulic Cement by Vicat Needle.
3. ASTM C 270, Standard Specification for Mortar for Unit Masonry.
4. ASTM C 596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
5. ASTM C 780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
6. ASTM C 827/ C 827M, Standard Test Method for Change in Height at Early Ages of Cylindrical Specimens of Cementitious Mixtures.
7. ASTM C 1019, Standard Test Method for Sampling and Testing Grout.
8. ASTM C 1090/C 1090M, Standard Test Method for Measuring Changes in Height of Cylindrical Specimens from Hydraulic-Cement Grout.
9. ASTM C 1107/C 1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (NonShrink).

1.05 Delivery, Storage and Handling

A. Provide protective covering over materials to prevent moisture damage and contamination of grout materials during delivery and handling.

B. Store grout materials in undamaged condition with seals and labels intact as packaged by the manufacturer.

1.06 Project Conditions

A. Protect against high and low temperatures and unfavorable environmental conditions in accordance with American Concrete Institute (ACI) standards for placement of concrete.

B. On any day when minimum anticipated nighttime temperature is 32°F or less, in addition to meeting with general procedures above, heat grout materials to 90°F to produce in-place grout temperature of not less than 70°F at end of work day. Retain protective blankets or enclosures for not less than forty-eight (48) hours.

1. Period of protection may be reduced to twenty-four (24) hours when Type III Portland cement is used for grout.

C. Do not heat water for mortar or grout to more than 160°F.

PART 2 - PRODUCTS

2.01 Materials

A. Provide a factory premixed non-shrink non-metallic grout material containing no corrosive irons, aluminums, chemicals or gypsums and meeting the following limitations:

1. Grout shall meet performance requirements of ASTM C 1107/C 1107M Grades A, B, and C.
2. Use Type I (Normal) cement for grout applications not in contact with sewage.
3. Use Type II (Sulfate Resistant) cement for grout applications in contact with sewage.
4. Manufacturers:
   a. U.S. Grout Corporation; FIVE STAR.
   b. Or Approved Equal.

B. Water to be potable quality, free from deleterious amounts of acids, alkalis and organic substances.

2.02 Grout Quality

A. Non-shrink non-metallic grout shall be ready-mix type requiring only the addition of water. Do not add other materials. Water requirement proportions shall meet the manufacturer's specifications for the desired mix consistency.

PART 3 - EXECUTION

3.01 Preparation

A. Clean surfaces to be grouted to be free of oil, grease, laitance, dirt and other contaminants. Remove loose material. Remove rust, paint and oil from metal components in contact with grout.

1. Perform additional surface preparation in accordance with the manufacturer's instructions.

B. Use forming procedures that allow proper and complete placement of grout.

1. Pre-treat wood forms with forming oils so that they do not absorb moisture.
2. Anchor support elements of formwork so no movement is possible. Remove supports only after grout has hardened.

C. Use power operated mechanical mixer of sufficient capacity to carry out batch mixing without interruption.

1. Mix non-shrink non-metallic grout in accordance with the manufacturer's instructions.

3.02 Installation

A. Perform grout placement in accordance with the recommendations of ACI and the manufacturer's published specifications for mixing and placing. Place non-shrink non-metallic grout only where indicated on the Contract Drawings.

3.03 Cleaning and Protection

A. Clean masonry after mortar is thoroughly set and cured.

1. Scrape off adhered mortar particles by hand, using non-metallic tools.
2. Test cleaning methods on half of sample panel, leaving other half in original state.
3. Meet the directions of the concrete unit masonry manufacturer and NCMA Tek Bulletin No. 45 for cleaning CMU. ALL EXPOSED CONCRETE MASONRY UNITS SHALL BE POWER WASHED FOR FINAL CLEANING. Refer to Section 04011.
4. NO ACID BASED CLEANING SOLUTIONS SHALL BE ALLOWED.

B. Institute protective measures as required to ensure that unit masonry work will be clean and undamaged at substantial completion.

END OF SECTION

SECTION 03710

REMOVING EFFLORESCENCE FROM CONCRETE

PART 1 - GENERAL

1.01 Description

A. The cleaning or removal of stains from concrete may involve the use of liquids, detergents or solvents which may run off on adjacent material, discolor the concrete or drive the stains deeper into porous concrete. Use the products and techniques described here only for the combinations of dirt/stain and concrete specified.

B. This procedure includes guidance on removing efflorescence from concrete using chemical solvents.

C. Efflorescence is a condition where white deposits form on the surface of the concrete. These deposits often contain calcium, sodium and potassium hydroxides or carbonates, bicarbonates, chlorides and sulfates of calcium and magnesium.

D. The surface deposits may originate as soluble compounds within the concrete or in the soil. These compounds combined with the presence of water gradually migrate in solution to the wall surface, where they remain when the water evaporates. Surface deposits may also result from acid etching with hydrochloric acid, sometimes used to roughen the concrete surface.

E. Surface deposits originating from within the concrete are usually soluble and may be removed by scrubbing with water alone or hosing with water under high pressure.

F. Surface deposits composed mainly of calcium acid carbonate and magnesium acid carbonate from the soil or calcium hydroxide should be washed off as soon as possible using water alone. These deposits are water soluble for only a brief period of time after reaching the atmosphere, when carbon dioxide converts them to water insoluble calcium carbonate and magnesium carbonate, which are impossible to remove without the use of acids.

G. Safety Precautions:

1. DO NOT save unused portions of stain removal materials.
2. DO NOT store any chemicals in unmarked containers.
3. EXCELLENT VENTILATION MUST BE PROVIDED WHEREVER ANY SOLVENT IS USED. USE RESPIRATORS WITH SOLVENT FILTERS.
4. No use of organic solvents should be allowed indoors without substantial air movement. Use only spark proof fans near operations involving flammable liquids.
5. Provide adequate clothing and protective gear where the chemicals are indicated to be dangerous.
6. Have available antidote and accident treatment chemicals where noted.

1.02 Submittals

A. Submit drawings showing intended areas of treatment.

B. Submit method of removal and type of chemicals.

C. Submit general protection precautions plan and description (surface and surrounding).

D. Submit Safety Data Sheets (SDS) for all materials.

E. Submit product data for all materials.

F. Submit plan for disposal of used materials.

PART 2 - PRODUCTS

2.01 Materials

A. Chemical products are sometimes sold under a common name. This usually means that the substance is not as pure as the same chemical sold under its chemical name. The grade of purity of common name substances, however, is usually adequate for stain removal work, and these products should be purchased when available, as they tend to be less expensive. Common names are indicated below by an asterisk (*).

B. Use one (1) of the following solvents (Article 3.02/A in this Section for mixing proportions):

1. Acetic Acid (C2H4O2):
    a. A colorless pungent liquid acid that is the chief acid of vinegar and that is used especially in synthesis (as of plastics).
    b. Other chemical or common names include Vinegar acid*. (Vinegar itself, which contains about 4 percent acetic acid, may be suitable for some purposes requiring acetic acid).
    c. Potential hazards are CORROSIVE TO FLESH, CONCRETE, STEEL, WOOD OR GLASS.
    d. Available from chemical supply house (both commercial and scientific), drugstore or pharmaceutical supply distributor, grocery store, supermarket or hardware store.
2. Hydrochloric Acid (30-35 Percent):
    a. A strong corrosive irritating acid.
    b. Other chemical or common names include Chlorhydric acid; Hydrogen chloride; Muriatic acid* (generally available in 18 degree and 20 degree Baume solutions); Marine acid*; Spirit of salt*; Spirit of sea salt*.
    c. Potential hazards are TOXIC, CORROSIVE TO FLESH; CORROSIVE TO CONCRETE, STEEL, WOOD OR GLASS, FLAMMABLE.
    d. Available from chemical supply house, drugstore, pharmaceutical supply distributor or hardware store.
3. Phosphoric Acid (H3PO4):
    a. A syrupy or deliquescent tribasic acid used especially in preparing phosphates (as for fertilizers), in rust proofing metals and as a flavoring in soft drinks. Other chemical or common names include Orthophosphoric acid.
    b. Potential hazards are CORROSIVE TO FLESH; CORROSIVE TO CONCRETE, STEEL, WOOD OR GLASS.
    c. Available from chemical supply house or hardware store.

4. Calcium Hydroxide:
    a. Other chemical or common names include Calcium hydrate*; Hydrated lime*; Lime hydrate*; Slaked lime*.
    b. Potential hazards are SKIN IRRITANT; AVOID INHALATION OF THE DRY POWDER.
    c. Available from chemical supply house, construction materials yard, construction specialties distributor, garden and lawn supply center or hardware store.

C. Filler material such as paper pulp.

D. Mineral water.

E. Plastic sheeting.

F. Clean dry towels for blotting the area after treatment.

G. Masking tape.

H. Accessible source of water, soap and towels for washing and rinsing in case of emergencies associated with the use of chemicals.

2.02 Equipment

A. Glass or ceramic container for mixing the poultice solution.

B. Rubber or plastic pail for mixing the acid and water solution.

C. Wooden utensil for stirring the ingredients.

D. Wood or plastic spatula.

E. Personal protective equipment, including, but not limited to, rubber gloves, safety glasses and appropriate respirators.

PART 3 - EXECUTION

3.01 Preparation

A. Protection:

1. Provide adequate wash solutions (i.e. water, soap and towels) before starting the job.

2. Whenever acid is used, the surface should be thoroughly rinsed with water as soon as its action has been adequate. Otherwise it will continue etching the concrete even though the stain is gone.

3.02 Erection, Installation and Application

A. DO NOT TRY MORE THAN ONE (1) TREATMENT ON A GIVEN AREA UNLESS THE CHEMICALS USED FROM PRIOR TREATMENT HAVE BEEN WASHED AWAY.

1. Mix in a glass or ceramic bowl ONE (1) of the following:
    a. One (1) part hydrochloric acid in 9 to 19 parts water, OR
    b. One (1) part phosphoric acid in 9 parts water, OR
    c. One (1) part phosphoric acid plus one (1) part acetic acid in 19 parts water.

B. ACID IS ALWAYS ADDED TO WATER; NEVER ADD WATER TO CONCENTRATED ACID BECAUSE THE WATER CAN BECOME SUPER HEATED AND TURN TO STEAM, SPLASHING ACID ON THE USER.

1. Saturate the concrete with clean, clear water.
2. Begin by using the first mixture listed above and apply to the affected concrete surface with a stiff, non-metallic bristle brush.
3. Thoroughly rinse the area with clean, clear water and allow to dry.
4. If the first mixture is unsuccessful in adequately removing the efflorescence, repeat the treatment using the other mixtures listed in the order displayed until successful results are achieved.
5. For concrete heavily laden with potential efflorescence:
   a. Remove all visible surface salts following Article 3.02 in this Section.
   b. Follow by applying a poultice of paper pulp saturated in water and allow to dry.
   c. Remove the dried poultice using a wood or plastic spatula.
   d. Thoroughly rinse the surface with clean, clear water and allow to dry.
   e. Repeat as necessary to achieve the desired level of cleanliness.

3.03 Adjusting/Cleaning

A. At the end of the job, if there is a supply of dilute acid to be disposed of, neutralize it by stirring in 3 pounds of powdered calcium hydroxide for every gallon of the dilute (1-3) acid. The resulting solution is a harmless mixture of calcium hydroxide and calcium fluoride.

END OF SECTION

SECTION 03930

CONCRETE REPAIR

PART 1 - GENERAL

1.01 Description

A. This work is removing and patching designated areas of deteriorated concrete of the existing horizontal and vertical surfaces, including the repair of cracks. Concrete repair is classified into five (5) types as follows:

1. Type 1 areas are where deteriorated concrete extends to a maximum depth of 3/4 inch, and/or a maximum area of 4 square feet.
2. Type 2 areas are where deteriorated concrete extends beyond the depth of 3/4 inch, and/or an area of 4 square feet.
3. Type 3 areas are where cracks, having a width greater than or equal to 0.05 inches, are present on exposed vertical concrete surfaces.
4. Type 4 areas where cracks, having a width greater than or equal to 0.125 inches, are present on exposed horizontal concrete surfaces.
5. Type 5 areas where there are holes in concrete slabs or concrete surfaces.

B. Parging of vertical and overhead surfaces with Portland cement-based, polymer-modified, finishing compound.

1.02 Related Sections

A. Section 03200 – Concrete Reinforcement

B. Section 03300 – Cast-In-Place Concrete

C. Section 09910 – Paints and Coatings

D. Section 09965 – Graffiti Resistant Coatings

1.03 Submittals

A. Submit product data for each type of product.

B. Submit design mixtures for each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results or other circumstances warrant adjustments.

1. Indicate amounts of mixing water to be withheld for later addition at Project site.

C. Submit material certificates for each of the following signed by the manufacturers:

1. Cementitious materials.
2. Admixtures.
3. Form materials and form-release agents.
4. Curing compounds.

5. Floor and slab treatments.
6. Bonding agents.
7. Adhesives.
8. Semi-rigid joint filler.
9. Joint-filler strips.
10. Repair materials.

D. Submit material test reports for the following from a qualified testing agency:

1. Include service record data indicating absence of deleterious expansion of concrete due to alkali aggregate reactivity.

E. Submit formwork shop drawings prepared by or under the supervision of a Professional Engineer licensed in the Commonwealth of Pennsylvania, detailing fabrication, assembly and support of formwork.

1. Indicate proposed schedule and sequence of stripping formwork, shoring removal, and re-shoring installation and removal.

F. Submit floor surface flatness and levelness measurements indicating compliance with specified tolerances.

G. Submit field quality control reports.

1.04 Quality Assurance

A. A qualified installer who employs on Project personnel qualified as ACI certified Flatwork Technician and Finisher and a supervisor who is an ACI certified Concrete Flatwork Technician.

B. A firm experienced in manufacturing ready-mixed concrete products and meets the ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's Certification of Ready Mixed Concrete Production Facilities.

C. An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-1 or an equivalent certification program.
2. Personnel performing laboratory tests shall be ACI certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician, Grade I. Testing agency laboratory supervisor shall be an ACI certified Concrete Laboratory Testing Technician, Grade II.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. ACI 301, Specifications for Structural Concrete for Buildings.

3. ACI 304, Guide for Measuring, Mixing, Transporting and Placing Concrete.
4. ACI 305, Guide for Hot Weather Concreting.
5. ACI 306, Guide to Cold Weather Concreting.
6. ACI 308, Standard Practice for Curing Concrete.
7. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
8. ASTM A 767/A 767M, Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement.
9. ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
10. ASTM C 33/C 33M, Standard Specification for Concrete Aggregates.
11. ASTM C 94/C 94M, Standard Specification for Ready-Mixed Concrete.
12. ASTM C 150/C 150M, Standard Specification for Portland Cement.
13. ASTM C 881/C 881M, Standard Specification for Epoxy-Resin Based Bonding Systems for Concrete.
14. ASTM C 1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
15. ASTM E 329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
16. Pennsylvania Department of Transportation Publication 408, Section 1042, Latex Modified Mortar.
17. SCAQMD 1168, Amended Rule 1168 for Adhesive and Sealant Applications.

1.05 Preconstruction Testing

A. Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

1.06 Field Conditions

A. Meet ACI 306 for cold weather placement and as follows:

1. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions or low temperatures.
2. When average high and low temperature is expected to fall below 40°F for three (3) successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
3. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
4. Do not use calcium chloride, salt or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.

B. Meet ACI 305 for hot weather placement and as follows:

1. Maintain concrete temperature below 90°F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is the Contractor's option.

2. Fog-spray forms, steel reinforcement and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots or dry areas.

PART 2 - PRODUCTS

2.01 Materials

A. Patching Material:

1. Class A Cement Concrete:
   a. Minimum compressive strength 4000 psi at twenty-eight (28) days.
2. Cement:
   a. ASTM C 150/C 150M, Type II.
3. Concrete Aggregates:
   a. Process aggregate meeting requirements of ASTM C 33/C 33M except use No. 8 coarse aggregate.
4. Concrete Bonding Compound:
   a. Compressive strength to be 8,000 psi minimum.
   b. Tensile strength to be 4,000 psi minimum.
   c. Bond strength to be 1,700 psi minimum.
   d. Mixed epoxy resin adhesive shall meet ASTM C 881/C 881M, Type II, Grade 2, Class B and C.
5. Latex Modified Mortar:
   a. Compressive strength to be 3,500 psi minimum at twenty-eight (28) days.

B. Reinforcement Bars:

1. Galvanized Reinforcement Bars:
   a. ASTM A 767/A 767M, Class 2, using ASTM A 615/A 615M, Grade 60, deformed steel.
2. Welded Wire Fabric:
   a. ASTM A 1064/A 1064M, plain-steel.

C. Finishing compound for vertical and overhead parging:

1. Portland cement based, polymer modified, finishing compound for interior or exterior overhead or vertical applications that will receive a coating of sealer or paint.
   a. ARDEX OVP; manufactured by ARDEX Engineered Cements; Or Approved Equal.
2. Meet or exceed the following values for material cured at 73°F and 50 percent relative humidity:
   a. Trowel application.
   b. VOC to be 0 g/L, calculated SCAQMD 1168.

c. Color to be concrete gray.

3. A smooth and uniform finished surface is required.

PART 3 - EXECUTION

3.01 Construction

A. To prepare the concrete surface, sound all exposed concrete surfaces with a light hammer to locate all areas of spalled or delaminated concrete in the presence of SEPTA's representative. Mark the edges of the delaminated and spalled area. Layout the repair area limits approximately 3 inches beyond the edges of the spalled and delaminated area. Square up all repair areas. Do not use irregular or odd repair areas. Outline the areas with a 1 inch deep vertical saw-cut before scarifying operations. Repair work may begin before scarifying operations. If after scarifying, another area or areas of deteriorated concrete are found beyond the initial saw-cut peripheries, make new saw-cuts for the extended repair limits. Sandblast or water blast to remove partially loosened chips of concrete. In the areas where reinforcement is found to be surrounded by deteriorated concrete or where at least one-half of the rebar surface area is exposed, the depth of concrete removal shall be such as to include all deteriorated concrete but not less than that depth necessary to allow for 1 inch minimum annular clearance around the reinforcing bars. Blow all removal areas clean with oil-free compressed air and protect them against any contaminate detrimental to the bond of the patching material. Care shall be taken during the removal of the designated portions of the structure to avoid damaging the portions that are to remain in place. Satisfactorily repair any damage to the structure beyond the limits of this work due to the construction operations at no expense to SEPTA.

B. Power driven hand tools for removal of deteriorated concrete are required and are subject to the following restrictions:

1. Do not use pneumatic hammers with more weight than nominal 30 pound class.

2. Do not operate pneumatic hammers or mechanical chipping tools at an angle in excess of 45 degrees relative to the surface of wall.

3. Do not place pneumatic tools in direct contact with reinforcing steel.

4. Use hand tools such as hammers and chisels, or small air chisels to remove final particles of unsound concrete or to provide necessary clearances around reinforcement bars.

C. Clean all existing reinforcement bars to remain with a wire brush, water blast or sand blast. Straighten and coat with neat cement. Remove all portions of damaged or heavily corroded reinforcement bars and replace with the same type of bars. Type 1 repairs will not require wire mesh reinforcement unless otherwise specified by SEPTA. In cases of Type 2 repairs, galvanized welded wire fabric (WWF 4 by 4 W2.9 by W2.9) shall be installed for areas where deteriorated concrete extends less than a depth of 4 inches or tied to dowel bars (#5 at 12 inches) for the area where deteriorated concrete extends beyond the depth of 4 inches. Place the wire mesh reinforcement with a 2 inch clearance from new concrete surface and a minimum 1 inch clearance from the existing sound concrete surface.

D. Prior to placing new concrete in Type 2 repairs, coat contact surfaces with an epoxy bonding compound. Place concrete against contact surface while epoxy bonding compound is still

tacky to ensure bond between contact surface and fresh concrete. Wire brush or sandblast hardened epoxy before recoating with fresh epoxy.

E. Repair all cracks in Type 3 repairs by injecting epoxy resin. Injection materials shall be a low viscosity, two (2) part epoxy-resin system meeting the requirements of ASTM C 881, Type II. Surfaces adjacent to cracks shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign materials detrimental to the bond of the epoxy-injection-surface seal system. Use of acids or other corrosives will not be permitted. Cleaning methods shall not introduce foreign materials into the crack repair area in such a manner that the penetration of the epoxy adhesive is hindered. A surface seal material as recommended by the adhesive manufacturer shall be used to confine the injection adhesive in the crack during injection and curing. It shall have adequate strength to hold injection fittings or ports and prevent vent leakage during injection. Do not inject the cracked area until after the surface sealer has hardened. Inject the epoxy with a hand gun, pressure pot, or injection machine or as recommended by the manufacturer. Injection of epoxy adhesive shall begin at the lowest point on the crack. When the material begins to flow from the next higher entry port, remove the nozzle, plug the port and insert the nozzle in the next higher entry port. Continue the operation until the crack is completely filled. If port to port travel of the epoxy adhesive is not indicated, the work shall immediately be stopped and SEPTA notified. When cracks are completely filled, epoxy shall be cured for sufficient time in accordance with the manufacturer's recommendations. The face of the crack shall be finished flush to the adjacent surface and show no indentations or protrusions caused by the placement of entry ports.

F. Patching

1. Type 1:
    a. Immediately before placement of the latex, thoroughly wet the clean surface for a period of not less than one (1) hour. Vacuum or blow out all standing water in depressions, holes or areas of concrete removal with clean, oil-free compressed air. Maintain surface in a damp, puddle-free condition. Brush latex mortar on to the damp, prepared surface. Ensure that all surfaces receive a thorough, even coating and the rate of progress is limited so that the brushed materials do not become dry before it is covered with additional material. Place the latex during periods where ambient temperature is 45°F or greater. Do not place latex above ambient temperatures of 84°F. Stop the placement at any time SEPTA's representative determines that a satisfactory surface finish is not being achieved.
2. Type 2:
    a. Construct Type 2 patches with Class A cement concrete. Immediately after final cleaning, apply epoxy bonding compound to all exposed surfaces within the repair area. Place concrete in repair area while epoxy bonding is still tacky. Sandblast and remove epoxy bonding compound that has hardened. Use a pencil or other appropriate vibrator to consolidate the concrete. Work concrete into saw cuts extending beyond the corners of the repair area. Strike-off and shape the concrete to match the surrounding wall surface. Use preformed cellular polystyrene temporary forms to keep concrete out of existing joints. Do not patch across a joint and saw cut later.
3. Use temporary forms and bracing, if necessary, to hold concrete until a "green" state has been reached.
4. Provide horizontal rustification grooves, vertical construction joints and exposed aggregate finish as necessary to match the existing wall finish.

G. Cure patches made with latex modified mortar and Class A cement concrete, but do not use liquid membrane curing unless allowed. Do not apply live loads to patches until concrete has reached a minimum compressive strength of 3,300 psi.

H. Apply anti-graffiti sealer to all exposed concrete wall surfaces after all the repairs have been made. Refer to Section 09965.

END OF SECTION

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SECTION 03932

CONCRETE WALL REPAIR

PART 1 - GENERAL

1.01 Description

A. This work is removing and patching designated areas of deteriorated concrete of the existing walls, including the repair of cracks. Concrete wall repair is classified into three (3) types as follows:

1. Type 1:
    a. Areas where deteriorated concrete extends to a maximum depth of 1 inch, and/or a maximum area of 4 square feet.
2. Type 2:
    a. Areas where deteriorated concrete extends beyond the depth of 1 inch, and/or an area of 4 square feet.
3. Type 3:
    a. Areas where cracks, having a width greater than or equal to 0.05 inches, are present on exposed concrete surfaces.

1.02 Related Sections

A. Section 03200 - Concrete Reinforcement

B. Section 03300 - Cast-In-Place Concrete

C. Section 09965 - Graffiti Resistant Coatings

1.03 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
2. ACI 301, Specifications for Structural Concrete.
3. ACI 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
4. ACI 308, Specification for Curing Concrete.
5. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
6. ASTM A 767/A 767M, Standard Specification for Zinc Coated (Galvanized) Steel Bars for Concrete Reinforcement.
7. ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
8. ASTM C 33/C 33M, Standard Specification for Concrete Aggregates.
9. ASTM C 150/C 150M, Standard Specification for Portland Cement.

10. ASTM C 881/C 881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
11. Commonwealth of Pennsylvania, Department of Transportation, Specifications, Publication 408 (PennDOT Specifications) Section 1042, Latex Modified.

PART 2 - PRODUCTS

2.01 Materials

A. Patching Material:

1. Class A cement concrete to have a minimum compressive strength 4,000 psi at twenty-eight (28) days.
2. Cement to meet ASTM C 150/C 150M, Type II.
3. Concrete aggregates to be process aggregate meeting requirements of ASTM C 33/C 33M except use No. 8 coarse aggregate.
4. Concrete bonding compound to have a compressive strength of 8,000 psi minimum; tensile strength to be 4,000 psi minimum; bond strength to be 1,700 psi minimum; mixed epoxy resin adhesive to meet ASTM C 881/C 881M, Type II, Grade 2, Class B and C.
5. Latex modified mortar to have a compressive strength of 3,500 psi minimum at twenty-eight (28) days.

B. Reinforcement Bars:

1. Galvanized reinforcement bars to meet ASTM A 767/A 767M, Class 2, using ASTM A 615/A 615M, Grade 60, deformed steel.
2. Welded wire fabric to meet ASTM A 1064/A 1064M, Class A coated, plain steel.

PART 3 - EXECUTION

3.01 Construction

A. Preparation of Surface:

1. Sound all exposed concrete surfaces with a light hammer to locate all areas of spalled or delaminated concrete in the presence of SEPTA's representative. Mark the edges of the delaminated and spalled area. Layout the repair area limits approximately 3 inches beyond the edges of the spalled and delaminated area. Square up all repair areas. Do not use irregular or odd repair areas.
2. Outline the areas with a 1 inch deep vertical saw cut before scarifying operations. Repair work may begin before scarifying operations. If after scarifying, another area or areas of deteriorated concrete are found beyond the initial saw cut peripheries, make new saw cuts for the extended repair limits. Sandblast or water blast to remove partially loosened chips of concrete. In the areas where reinforcement is found to be surrounded by deteriorated concrete or where at least one half of the rebar surface area is exposed, the depth of concrete removal shall be such as to include all deteriorated concrete but

not less than that depth necessary to allow for 1 inch minimum annular clearance around the reinforcing bars. Blow all removal areas clean with oil free compressed air and protect them against any contaminate detrimental to the bond of the patching material. Care shall be taken during the removal of the designated portions of the structure to avoid damaging the portions that are to remain in place. Satisfactorily repair any damage to the structure beyond the limits of this work due to the construction operations at no expense to SEPTA.

B. Equipment:

1. Power driven hand tools for removal of deteriorated concrete are required and are subject to the following restrictions:
   a. Do not use pneumatic hammers with more weight than nominal 30 pound class.
   b. Do not operate pneumatic hammers or mechanical chipping tools at an angle in excess of 45 degrees relative to the surface of wall.
   c. Do not place pneumatic tools in direct contact with reinforcing steel.
   d. Use hand tools such as hammers and chisels, or small air chisels to remove final particles of unsound concrete or to provide necessary clearances around reinforcement bars.

C. Placement of Reinforcement:

1. Clean all existing reinforcement bars to remain with a wire brush, water blast or sand blast. Straighten and coat with neat cement. Remove all portions of damaged or heavily corroded reinforcement bars and replace with the same type of bars.

2. Type 1 repairs will not require wire mesh reinforcement unless otherwise specified by SEPTA. In cases of Type 2 repairs, galvanized welded wire fabric (WWF 4 by 4 W2.9 by W2.9) shall be installed for areas where deteriorated concrete extends less than a depth of 4 inches, or tied to dowel bars (#5 @12 inches) for the area where deteriorated concrete extends beyond the depth of 4 inches. Place the wire mesh reinforcement with a 2 inch clearance from new concrete surface and a minimum 1 inch clearance from the existing sound concrete surface.

D. Concrete Bonding:

1. Prior to placing new concrete in Type 2 repairs, coat contact surfaces with an epoxy bonding compound. Place concrete against contact surface while epoxy bonding compound is still tacky to ensure bond between contact surface and fresh concrete. Wire brush or sandblast hardened epoxy before recoating with fresh epoxy.

E. Epoxy Injection:

1. Repair all cracks in Type 3 repairs by injecting epoxy resin. Injection materials shall be a low viscosity, two (2) part epoxy resin system meeting the requirements of ASTM C 881/C 881M, Type II.

2. Surfaces adjacent to cracks shall be cleaned of dirt, dust, grease, oil, efflorescence or other foreign materials detrimental to the bond of the epoxy injection surface seal system. Use of acids or other corrosives will not be permitted. Cleaning methods shall not introduce foreign materials into the crack repair area in such a manner that the penetration of the epoxy adhesive is hindered. A surface seal material as recommended by the adhesive manufacturer shall be used to confine the injection adhesive in the

crack during injection and curing. It shall have adequate strength to hold injection fittings or ports and prevent vent leakage during injection.

3. Do not inject the cracked area until after the surface sealer has hardened. Inject the epoxy with a handgun, pressure pot or injection machine or as recommended by the manufacturer. Injection of epoxy adhesive shall begin at the lowest point on the crack. When the material begins to flow from the next higher entry port, remove the nozzle, plug the port and insert the nozzle in the next higher entry port. Continue the operation until the crack is completely filled. If port to port travel of the epoxy adhesive is not indicated, the work shall immediately be stopped, and SEPTA notified.
4. When cracks are completely filled, epoxy shall be cured for sufficient time in accordance with the manufacture's recommendations. The face of the crack shall be finished flush to the adjacent surface and show no indentations or protrusions caused by the placement of entry ports.

F. Patching:

1. Type 1:
   a. Immediately before placement of the latex, thoroughly wet the clean surface for a period of not less than one (1) hour. Vacuum or blow out all standing water in depressions, holes or areas of concrete removal with clean, oil free compressed air. Maintain surface in a damp, puddle free condition. Brush latex mortar on to the damp, prepared surface. Ensure that all surfaces receive a thorough, even coating and the rate of progress is limited so that the brushed materials do not become dry before it is covered with additional material. Place the latex during periods where ambient temperature is 45°F or greater. Do not place latex above ambient temperatures of 84°F. Stop the placement at any time SEPTA determines that a satisfactory surface finish is not being achieved.
2. Type 2:
   a. Construct Type 2 patches with Class A cement concrete. Immediately after final cleaning, apply epoxy bonding compound to all exposed surfaces within the repair area. Place concrete in repair area while epoxy bonding is still tacky. Sandblast and remove epoxy bonding compound that has hardened. Use a pencil or other appropriate vibrator to consolidate the concrete. Work concrete into saw cuts extending beyond the corners of the repair area. Strike off and shape the concrete to match the surrounding wall surface. Use preformed cellular polystyrene temporary forms to keep concrete out of existing joints. Do not patch across a joint and saw cut later.
3. Use temporary forms and bracing, if necessary, to hold concrete until a "green" state has been reached.
4. Provide horizontal rustification grooves, vertical construction joints and exposed aggregate finish as necessary to match the existing wall finish.

G. Curing Patches:

1. Cure patches made with latex modified mortar and Class A cement concrete, but do not use liquid membrane curing unless allowed. Do not apply live loads to patches until concrete has reached a minimum compressive strength of 3,300 psi.

H. Sealing:

1. Apply anti-graffiti sealer to all exposed concrete surfaces after all the repairs have been made. Refer to Section 09965.

END OF SECTION

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SECTION 04011

MASONRY CLEANING

PART 1 - GENERAL

1.01 Description

A. The work of this Section includes testing approaches to masonry cleaning on a variety of stains, and the cleaning of all surfaces as listed on the Contract Drawings consisting of the brick and concrete masonry units.

B. The Contractor shall test each cleaning method for sufficiency. If a cleaning method and material are used and do not produce satisfactory results, the next level of harshness / abrasiveness cleaning is to be used. This is considered the testing method. Under no circumstances are any building materials to be damaged during this test cleaning process. If the masonry cannot be satisfactorily cleaned to a satisfactory condition as determined by SEPTA, the materials, not satisfactorily cleaned, shall be replaced as per Option "A."

C. Cleaning is intended to remove all surface dirt, other deposits and all coatings and paints including graffiti from the masonry to achieve a lighter, more uniform color. Surfaces shall be evenly cleaned with no evidence of streaking, bleaching or unnatural color variations. All masonry materials shall be left free of any residual chemical cleaner and pH neutral. Cleaning shall not damage adjacent materials.

1. The work involved in cleaning masonry work post repair or replacement shall follow the materials and methods as outlined in this Section. At interior locations, the cleaned area shall be isolated to repaired / replaced areas so as to reduce the amount of cleanup. This work shall be done a minimum of twenty-one (21) days after the work is complete, allowing for full cure times.

2. Areas at the interior and exterior which have excessive staining that was not removed under the recent cleaning campaign shall follow the methods and materials as outlined in this Section. This work shall be cleaned before the general building cleaning.

3. The work described in the Contract Documents that is specific to removal of these stains and substances is outlined in this Section. If the masonry cannot be cleaned to a satisfactory condition as determined by SEPTA, the materials shall be replaced as per Option "A."

4. A final general building cleaning will be conducted at the entire interior and exterior. This is to be the final and last step of cleaning. When cleaning any portion of the interior all measures shall be taken to eliminate the water / cleaning products from dispersing any further than the immediate area.

1.02 Related Sections

A. Section 04012 – Brick Masonry Repair

B. Section 07190 – Water Repellents

1.03 Submittals

A. Submit written description of method to be used for general masonry cleaning, based on cleaning tests.

B. Submit all manufacturers' literature for cleaning materials to be used including product data, use limitations and SDS.

C. Submit samples of each chemical cleaning agent to be tested in their original unopened containers.

D. Submit sample of agent proposed for protection of all glass, wood, metal, and polycarbonate materials from acids and alkaline cleaning agents.

E. Submit sample of solvent-resistant polyethylene sheeting for protection from acid and alkaline cleaning agents.

F. Submit cleaning tests:

1. Provide two (2) test panels, measuring 1 foot by 1 foot square that is representative of the effect of each cleaning material and method on the most heavily soiled and generally soiled areas of the interior and exterior façade for each different material covered in this Section. Notify SEPTA a minimum of seven (7) days in advanced of test panel inspection.

2. Repeat cleaning tests as required until desired results are reached and approval of materials and methods are obtained. Do not proceed with cleaning until SEPTA approval has been given.

1.04 Quality Assurance

A. A paint removing firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory authorized service representatives who are available for consultation and Project site inspection, preconstruction product testing and on site assistance.

B. A chemical cleaning firm regularly engaged in producing masonry cleaners that have been used for similar applications with successful results, and with factory authorized service representatives who are available for consultation and Project site inspection, preconstruction product testing and on site assistance.

C. Prepare a written cleaning program that describes cleaning process in detail, including materials, methods and equipment to be used; protection of surrounding materials; and control of runoff during operations. Include provisions for supervising worker performance and preventing damage.

1. If materials and methods other than those indicated are proposed for any stage of cleaning work, add a written description of such materials and methods, including evidence of successful use on comparable Projects and demonstrations to show their effectiveness for this Project.

D. Prepare mockups of cleaning on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Clean an area approximately 25 square feet for each type of masonry and surface condition.

a. Test cleaners and methods on samples of adjacent materials for possible adverse reactions. Do not test cleaners and methods known to have deleterious effect.

b. Allow a waiting period of not less than seven (7) days after completion of sample cleaning to permit a study of sample panels for negative reactions.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.

E. All environmental restrictions (city, state and federal) and safety code requirements regarding items in this Section should be observed. This will likely entail effluent collection and neutralization.

1.05 Definitions

A. Very low-pressure spray to be under 100 psi.

B. Low-pressure spray to be 100 to 400 psi; 4 to 6 gallons per minute.

C. Medium-pressure spray to be 400 to 800 psi; 4 to 6 gallons per minute.

D. High-pressure spray to be 800 to 1200 psi; 4 to 6 gallons per minute.

1.06 Coordination

A. The Contractor shall coordinate the work of this Section with all other Sections for the successful completion of the Contract.

B. Cleaning brick shall be carried out prior to pointing or other masonry repair work.

C. General cleaning shall not be performed within twenty-one (21) days of composite patching, pointing or masonry repair techniques to allow for repairs to fully cure.

1.07 Sequencing and Scheduling

A. Perform masonry-cleaning work in the following sequence:

1. Remove plant growth.

2. Inspect for open mortar joints. Where repairs are required, delay further cleaning work until after repairs are completed, cured and dried to prevent the intrusion of water and other cleaning materials into the wall.

3. Remove paint.

4. Clean masonry surfaces.

5. Where water repellents are to be used on or near masonry, delay application of these chemicals until after cleaning. Refer to Section 07190.

B. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in masonry units according to masonry repair Section 04012. Patch holes in mortar joints according to masonry repointing Sections.

1.08 Sample of Cleaning Methods and Agents

A. The purpose of testing is to determine most appropriate cleaning agent, strength and dwell time of cleaning agent, method of application, method and duration of rinsing, and to

ensure that cleaned masonry surfaces can be obtained with no detrimental effect to masonry or other materials on or adjacent to the building. The lowest strength cleaning agent bringing the desired degree of cleaning shall be used.

B. Apply materials as specified to at least two (2) designated areas, each approximately 1 foot by 1 foot. Modify soak and dwell time as needed to achieve satisfactory results. Rinse until pH of wet wall is equal to that of clean water from tap.

C. Follow all the product manufacturer's application instructions unless otherwise noted in this Section.

D. SEPTA will be on-site at all times during the testing process and will provide instruction and guidance throughout duration of process. Location of test areas will be determined by SEPTA prior to testing.

1.09 Evaluation of Cleaning Example

A. Sample shall be evaluated by SEPTA.

B. Cleaning method, agent, concentration and dwell time shall be selected by SEPTA.

C. Items to be evaluated:

1. Cleanliness of the test area. Masonry is not to be over-cleaned.
2. Discoloration of masonry.
3. Alteration to texture, sheen or loss of material.
4. Duration of water rinse and pressure.
5. Dilution of concentrate.
6. Duration of exposure.
7. Number of applications.

D. After receiving approval of cleaning materials and cleaning methods, the Contractor shall clean one (1) sample of 2 square feet. The approved samples shall serve as the standards of quality for the rest of the cleaning.

1.10 Product Handling

A. All materials are to be delivered to the job site in original unopened containers bearing the manufacturer name and label. Store and handle materials in strict compliance with the manufacturer's instructions. Do not store on the ground.

B. Protect materials from tampering, acts of vandalism, possible injury to workers, the general public, intrusion of foreign materials and moisture. All vessels shall have tight fitting covers. At no time shall vessels containing chemicals be carried to working levels when vessels are open.

1.11 Job Protection

A. Prevent chemical cleaning agents from spilling or dripping down surfaces, on to projections (sills, windows, ledges, etc.) or on to the ground. Remove any spilled or dripped materials immediately and rinse well.

B. Provide adequate protection from chemical cleaning agents and rinse water for all glass, metal and polycarbonate surfaces around and beneath the surfaces being worked on and any adjacent surfaces not included in this work. Ventilate as necessary to prevent fume build-up. Apply masking agent to comply with the manufacturer's recommendations. Do not apply liquid masking agent to painted or porous surfaces.

C. Cleaning shall not begin until average daily temperatures remain above 50°F. Do not clean during adverse weather conditions, except to wash down any cleaning agent already applied. The Contractor shall alter cleaning procedures if considered necessary because of temperature changes.

D. Do not clean if the temperature of air or masonry drops below 40°F. Do not clean within seven (7) days of anticipated freezing temperatures.

E. If temperatures rise above 85°F, protect areas being worked on with tarps or other shading devices to reduce heat from direct sun. Do not allow chemicals to dry on masonry.

F. Do not clean during rain or when rain is imminent.

G. Protect all surrounding areas and the general public from wind carried chemicals. Beware of wind drift.

H. Surrounding areas shall be protected from contact with chemical cleaning agents and rinse water. Surrounding areas shall include, but shall not be limited to, adjacent surfaces, including masonry and structures, private property including automobiles, vegetation and all other surfaces that would be adversely affected if placed in contact with the cleaning agents.

I. Do not allow run off from the cleaning process to enter sewer system or contaminate water supplies. Dispose of effluent in safe and legal way.

J. The Contractor shall take all necessary precautions for the protection of property and public safety from cleaning agents, rinse water, and wind-drifting chemical cleaners and water.

K. The Contractor will use all necessary precautions to protect persons performing the work and others from harmful effects of the cleaning agents and rinse water. Workers shall be required to wear protective clothing, goggles, face shields, gloves and other clothing or equipment in compliance with governing federal, state and local safety codes and regulations.

L. Staging must be well maintained and equipped with steel cables. Use only synthetic fiber ropes and safety lines, appropriate for use with approved cleaning compounds as to prevent damage to the lines.

M. The Contractor shall provide, erect and maintain barricades, danger signals and warning signs as needed.

PART 2 - PRODUCTS

2.01 Equipment

A. Brushes shall be stiff natural bristle brushes or soft-fiber masonry washing brushes, never metal.

B. No spray application of chemicals shall be allowed.

C. Use high pressure spray (800-1,200 psi) washer at EXTERIOR ONLY equipped with a fan-shaped spray tip, and a spacer to prevent work and application to occur at a minimum of 18 inches away which disperses water at an angle of 45 degrees.

D. No metal fittings that can corrode or deposit corrosive materials on the masonry are to be used.

E. Use non-staining closed-cell polyethylene foam backer rod stock for placing in open joints. Diameter of backer rod shall be 25 percent greater than joint width.

F. Polyethylene sheeting affixed with tape that will not leave residue or strippable, liquid, film-forming type for protection of glass, wood, metal, and polycarbonate materials from acidic cleaner to be used for masking.

1. Manufacturers:
    a. Diedrich Acid Guard, manufactured by Diedrich Chemicals.
    b. Sure Klean Acid Stop, manufactured by ProSoCo.
    c. Or Approved Equal.

2.02 Cleaning Agents

A. Dilute chemical cleaners with water to produce solutions not exceeding concentration recommended in writing by the chemical-cleaner manufacturer.

B. For mortar and grout spills use 101 Lime Solvent from ProSoCo, Kansas City, KS; Or Approved Equal.

1. Any additional cleaning shall leave all surfaces with no evidence of streaking, bleaching or unnatural color variations.

C. For stains, efflorescence, carbon build-up and mastics use light, medium and heavy duty restoration cleaners by ProSoCo., Kansas City, KS; Or Approved Equal.

1. Use the lightest duty cleaner for the application, even if the process takes two (2) to three (3) coats to produce acceptable quality.

D. Chemical cleaner for brick only, maximum 2 percent solution of hydrofluoric acid with trace of phosphoric acid and surfactants in water, such as Diedrich 101-G Granite; Or Approved Equal, Terra Cotta & Brick Cleaner, diluted 1:6 with water or as demonstrated by test panels. Areas of heavy soiling may require a higher chemical concentration. The most dilute combination of water and chemical, which is found to effectively clean the masonry, shall be used.

E. Dilute acidic cleaner solution for non-glazed masonry with water to produce hydrofluoric acid content of 3 percent or less, but not greater than that recommended in writing by the chemical-cleaner manufacturer.

PART 3 - EXECUTION

3.01 Inspection

A. Before starting any work of this Section, the Contractor shall make a complete inspection of entire facade to identify and confirm all surfaces to be cleaned and all areas that will require special care in cleaning. Review the Contract Drawings describing existing conditions of

concern (e.g. open joints, deteriorated brick or precast) and carefully inspect these areas on the building. Notify SEPTA immediately if discrepancies or changed conditions exist. Do not proceed until such discrepancies are resolved.

B. Prior to cleaning, determine degree of cleaning to be carried out and review areas requiring additional treatment with SEPTA. Approved cleaning test panels will serve as the standard for cleaning all materials outlined in Article 1.01 of this Section.

3.02 Preparation for Cleaning

A. Open Joints:

1. Remove deteriorated mortar carefully from joints. Follow procedures outlined in Section 04012.

2. Flush all debris and residual mortar dust from joints with water.

3. When joints are dry, point or install backer rod to depth equal to one-half the joint width. Maintain strict tolerance throughout installation.

B. Dry brush any areas with loose dirt or soil, or extreme dirt build-up, to remove as much material as possible, prior to wet cleaning.

3.03 General Cleaning Procedures

A. Cleaning shall begin at the bottom of the facade and slowly and continuously progress upward.

B. Thoroughly wet surfaces prior to application of detergent. Wet surfaces with low pressure water spray. Surfaces shall not be allowed to dry prior to application of chemical cleaner.

C. To avoid streaking on walls, all wall surfaces immediately below the area being cleaned shall be kept wet and rinsed free of dripping detergent.

D. Thoroughly pre-wet the area to be cleaned and that surrounding and below it. Take pH reading of masonry prior to the application of cleaning chemicals. A pressure water spray not to exceed 200 psi shall be used for pre-wetting and maximum of 500 psi for rinsing of masonry surfaces. Sprayer shall be equipped with fan tipped nozzle (45 degrees) and be capable of providing a minimum flow rate of 6 gallons per minute.

E. Apply a coating of diluted cleaner in the concentrations determined by cleaning tests to surface using a natural or synthetic fiber brush (i.e., soft bristled nylon).

F. Allow the chemical cleaner to remain on the surface for three (3) to five (5) minutes, scrubbing lightly with a natural or fiber brush. No metal or wire brushes are to be used.

G. Rinse making sure to wash each portion of the masonry surface with concentrated water pressure spray. Pressure rinse from the bottom of cleaned area upward and then down again. Take great care to ensure that all detergent is rinsed from masonry. Do not allow chemicals to dry on surfaces.

H. Reapply chemical cleaner if necessary. Do not exceed two (2) applications without SEPTA's approval.

I. Allow area of application and areas below and surrounding to fully dry after rinsing.

J. Rinsing:

1. Application of the rinse water is extremely important. As much water pressure as possible (without damaging the surface) shall be used to apply the rinse water so all traces of the chemical cleaning agents are completely removed. Thoroughly rinse from the bottom of the treated area to the top and down again covering each section of the surface.
2. Rinse until the wet masonry surface is of the same pH as the rinse water. Surfaces shall be tested with pH strips.

K. All scaffolding, platforms and barricades shall be water-washed in the middle and at the end of each work day. Ground area shall be water-washed at the end of each work day.

L. Protect the public from overspray.

3.04 Completion

A. Clean adjacent areas and remove any debris or accumulated matter.

B. Clean and restore all sidewalks, paving and adjacent areas/objects soiled or damaged as the result of cleaning operations.

C. Remove all protective materials.

END OF SECTION

SECTION 04012

BRICK MASONRY REPAIR

PART 1 - GENERAL

1.01 Description

A. Section Includes:

1. Repairing brick masonry, including replacing units.
2. Removing abandoned anchors.
3. Painting steel uncovered during the work.
4. Repointing joints with mortar.

1.02 Related Sections

A. Section 02070 – Selective Demolition

B. Section 04011 – Masonry Cleaning

1.03 Submittals

A. Submit product data for each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include recommendations for product application and use. Include test data substantiating that products meet the requirements.

B. Submit shop drawings:

1. Include plans, elevations, sections and locations of replacement masonry units on the structure, showing relation of existing and new or relocated units.
2. Include plans, elevations, sections and locations of repointing work on the structure.
3. Show provisions for expansion joints or other sealant joints.
4. Show provisions for flashing, lighting fixtures, conduits and weep holes as required.
5. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.

C. Submit samples for initial selection of the following:

1. Submit sets of colored mortar that will be left exposed in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
   a. Have each set contain a close color range of at least three (3) samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
   b. Submit with precise measurements on ingredients, proportions, gradations and source of colored sands from which each sample was made.

2. Sand Types Used for Mortar:
    a. Minimum 8 oz. of each in plastic screw-top jars.
3. Submit sets of patching compound samples in the form of plugs (patches in drilled holes) in sample units of masonry representative of the range of masonry colors on the building.
    a. Have each set contain a close color range of at least three (3) samples of different mixes of patching compound that matches the variations in existing masonry when cured and dry.
4. Include similar samples of accessories involving color selection.
5. Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
    a. Have each set contain a close color range of at least three (3) samples of different mixes of colored sands and cements that produce a mortar matching existing, cleaned mortar when cured and dry.
    b. Submit with precise measurements on ingredients, proportions, gradations and source of colored sands from which each sample was made.
6. Sand Type Used for Pointing Mortar:
    a. Minimum 8 oz. of each in plastic screw-top jars.

D. Submit samples for verification of the following:

1. Each type of brick unit to be used for replacing existing units. Include sets of samples to show the full range of shape, color and texture to be expected. For each brick type, provide straps or panels containing at least four (4) bricks. Include multiple straps for brick with a wide range.
2. Each type of patching compound in the form of briquettes, at least 3 inches long by 1 1/2 inches wide. Document each sample with the manufacturer and stock number or other information necessary to order additional material.
3. Each type of accessory and miscellaneous support.
4. Each type, color and texture of pointing mortar in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
    a. Include with each sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and brand names of cementitious materials and pigments if any.

E. Submit qualification data for brick masonry repair specialist including field supervisors and workers and testing service.

F. Submit preconstruction test reports for existing masonry units and mortar and replacement masonry units.

G. Submit quality control program.

1.04 Quality Assurance

A. Engage an experienced brick masonry repair firm to perform work of this Section. Firm shall have completed work similar in material, design and extent to that indicated for this Contract with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repair work.

1. Brick masonry repair specialist firm shall maintain experienced full time supervisors on the Project site during times that brick masonry repair work is in progress.
2. When masonry units are being patched, assign at least one (1) worker per crew who is trained and certified by the manufacturer of patching compound to apply its products.

B. Engage an experienced brick masonry repointing firm to perform work of this Section. Firm shall have completed work similar in material, design and extent to that indicated for this Contract with a record of successful in-service performance. Experience in only installing masonry is insufficient experience for masonry repointing work.

1. Brick masonry repointing specialist firms shall maintain experienced full time supervisors on the Project site during times that brick masonry repointing work is in progress.

C. Prepare a written quality control program for this Contract to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising performance and preventing damage.

D. Prepare mockups of brick masonry repair and repointing to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.

1. Prepare sample areas for each type of masonry repair work performed. If not otherwise indicated, size each mockup not smaller than two (2) adjacent whole units or approximately 48 inches in least dimension. Construct sample areas in locations in existing walls where directed by the SEPTA Project Manager unless otherwise indicated. Demonstrate quality of materials, workmanship and blending with existing work. Include the following as a minimum:
   a. Four (4) brick units replaced.
   b. Three (3) small holes as directed for each type of brick indicated to be patched.
2. Rake out joints in two (2) separate areas, each approximately 36 inches high by 48 inches wide for each type of repointing required, and repoint one (1) of the areas.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the SEPTA Project Manager specifically approves such deviations in writing.
4. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

E. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
3. ASTM C 67, Standard Test Method for Sampling and Testing Brick and Structural Clay Tile.
4. ASTM C 91/C 91M, Standard Specification for Masonry Cement.
5. ASTM C 114, Standard Test Methods for Chemical Analysis of Hydraulic Cement.

6. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
7. ASTM C 150/C 150M, Standard Specification for Portland Cement.
8. ASTM C 207, Standard Specification for Hydrated Lime for Masonry Purposes.
9. ASTM C 216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
10. ASTM C 270, Standard Specification for Mortar for Unit Masonry.
11. ASTM C 295/ C 295M, Standard Guide for Petrographic Examination of Aggregates for Concrete.
12. ASTM C 979/C 979M, Standard Specification for Pigments for Integrally Colored Concrete.
13. ASTM C 1329/C 1329M, Standard Specification for Mortar Cement.
14. SSPC-SP 2, Hand Tool Cleaning.
15. SSPC-SP 3, Power Tool Cleaning.
16. SSPC-SP 6, Commercial Blast Cleaning.

1.05 Delivery, Storage and Handling

A. Deliver masonry units to the Project site strapped together in suitable packs or pallets or in heavy duty cartons and protected against impact and chipping.

B. Deliver packaged materials to the Project site in the manufacturer's original and unopened containers, labeled with the manufacturer's name and type of products.

C. Store cementitious materials on elevated platforms, under cover and in a dry location. Do not use cementitious materials that have become damp.

D. Store hydrated lime in the manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two (2) days.

E. Store sand where grading and other required characteristics can be maintained and contamination avoided.

F. Handle masonry units to prevent overstressing, chipping, defacement and other damage.

1.06 Definitions

A. Low Pressure Spray to be 100 to 400 psi; 4 to 6 gallons per minute.

B. Rebuilding (Setting) Mortar is mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

C. Saturation Coefficient is the ratio of the weight of water absorbed during immersion in cold water to weight absorbed during immersion in boiling water; used as an indication of resistance of masonry units to freezing and thawing.

1.07 Sequencing and Scheduling

A. Order sand and gray Portland cement for colored mortar immediately after approval of mockups. Take delivery of and store at Project site enough quantity to complete Contract.

B. Perform brick masonry repair work in the following sequence, which includes work specified in this and other Sections:

1. Remove plant growth.
2. Inspect masonry for open mortar joints and point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean masonry.
5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
6. Repair masonry, including replacing existing masonry with new masonry materials.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.

1.08 Preconstruction Testing

A. Engage a qualified testing agency to perform preconstruction testing on masonry units as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Test each proposed type of replacement masonry unit according to sampling and testing methods in ASTM C 67 for compressive strength, twenty-four (24) hour cold water absorption, five (5) hour boil absorption, saturation coefficient and initial rate of absorption (suction).
3. Test each type of existing masonry unit indicated for replacement according to testing methods in ASTM C 67 for compressive strength, twenty-four (24) hour cold water absorption, five (5) hour boil absorption, saturation coefficient and initial rate of absorption (suction). Carefully remove five (5) existing units from locations designated by the SEPTA Project Manager. Take testing samples from these units.
4. Test existing mortar according to ASTM C 295/C 295M, modified as agreed by testing service and the SEPTA Project Manager for Contract requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates, and approximate strength.
5. As directed by the SEPTA Project Manager, provide temporary patch materials followed by permanent repairs at locations from which existing samples were taken.

1.09 Field Conditions

A. Proceed with installation only when existing and forecasted weather conditions permit brick masonry repair work to be performed according to the product manufacturers' written instructions and specified requirements.

B. Repair masonry units only when air temperature is between 40°F and 90°F and is predicted to remain so for at least seven (7) days after completion of the work unless otherwise indicated.

C. Meet the following cold weather procedures for masonry repair unless otherwise indicated:

1. When air temperature is below 40°F, heat mortar ingredients, masonry repair materials and existing masonry walls to produce temperatures between 40°F and 120°F.

2. When mean daily air temperature is below 40°F, provide enclosure and heat to maintain temperatures above 32°F within the enclosure for seven (7) days after repair.

D. Meet the following hot weather procedures for masonry repair unless otherwise indicated:

1. Protect masonry repairs when temperature and humidity conditions produce excessive evaporation of water from mortar and repair materials. Provide artificial shade and wind breaks, and use cooled materials as required to minimize evaporation. Do not apply mortar to substrates with temperatures of 90°F and above unless otherwise indicated.

E. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

PART 2 - PRODUCTS

2.01 Materials

A. Source Limitations:

1. Obtain each type of material for repairing brick masonry (brick, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2. Obtain each type of material for repointing brick masonry (cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.02 Masonry Materials

A. Face Brick:

1. As required to complete brick masonry repair work.

2. Units with colors, color variation within units, surface texture, size and shape that match existing brickwork and with physical properties within 10 percent of those determined from preconstruction testing of selected existing units.

3. Special Shapes:

a. Provide molded, 100 percent solid shapes for applications where core holes or "frogs" could be exposed to view or weather when in final position and where shapes produced by sawing would result in sawed surfaces being exposed to view.

b. Provide specially ground units, shaped to match patterns, for arches and where indicated.

c. Mechanical chopping or breaking brick, or bonding pieces of brick together by adhesive, are unacceptable procedures for fabricating special shapes.

4. Tolerances as fabricated to meet the tolerance requirements in ASTM C 216, Type FBX.

2.03 Mortar Materials

A. Portland cement to meet ASTM C 150/C 150M, Type I or Type II, except Type III may be used for cold weather construction; white or gray, or both where required for color matching of mortar.

1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated lime to meet ASTM C 207, Type S.

C. Mortar sand to meet ASTM C 144.

1. Match size, texture and gradation of existing exposed mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.

2. Natural sand or ground marble, granite or other sound stone of color necessary to produce required mortar color.

D. Mortar pigments to meet ASTM C 979/C 979M, compounded for use in mortar mixes and having a record of satisfactory performance in masonry mortars.

E. Water to be potable.

2.04 Manufactured Repair Materials

A. Factory mixed cementitious product that is custom manufactured for patching brick masonry.

1. Use formulation that is vapor and water permeable (equal to or more than the masonry unit), exhibits low shrinkage, has lower modulus of elasticity than masonry units being repaired and develops high bond strength to all types of masonry.

2. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.

3. Formulate patching compound in colors and textures to match each masonry unit being patched. Provide sufficient number of colors to enable matching of the color, texture and variation of each unit.

2.05 Ties and Anchors

A. Ties and anchors shall extend at least 1 1/2 inches into veneer but with at least a 5/8 inch cover on outside face.

B. Provide ties and anchors specified in this Article that are made from materials that meet the following unless otherwise indicated:

1. Hot dip galvanized, carbon steel wire to meet ASTM A 82/A 82M, with ASTM A 153/A 153M, Class B-2 coating.

C. Adjustable Masonry Veneer Anchors:

1. Provide anchors that allow vertical adjustment but resist a 100-lbf load in both tension and compression perpendicular to plane of wall without deforming or developing play in excess of 1/16 inch.

2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075 inch thick steel sheet, galvanized after fabrication

3. Fabricate wire ties from 0.187 inch diameter, hot dip galvanized steel wire unless otherwise indicated.

4. Fabricate wire connector sections from 0.187 inch steel wire.

2.06 Accessory Materials

A. Setting buttons and shims to be resilient plastic, non-staining to masonry, sized to suit joint thicknesses and bed depths of masonry units, less the required depth of pointing materials unless removed before pointing.

B. Masking tape to be non-staining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

C. Antirust coating to be fast-curing, lead- and chromate-free, self-curing, universal modified-alkyd primer according to MPI #23 (surface-tolerant, anticorrosive metal primer) or SSPC-Paint 20 or SSPC-Paint 29 zinc-rich coating.

1. Use coating requiring no better than SSPC-SP 2, SSPC-SP 3 or SSPC-SP 6 surface preparation according to the manufacturer's literature or certified statement.

2. Use coating with a VOC content of 400 g/L or less.

D. Select materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.

2. Minimal possibility of damaging exposed surfaces.

3. Consistency of each application.

4. Uniformity of the resulting overall appearance.

5. Do not use products or tools that could leave residue on surfaces.

2.07 Mortar Mixes

A. Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

1. Thoroughly mix pointing mortar cementitious materials and sand together before adding any water. Then mix again, adding only enough water to produce a damp, unworkable mix that retains its form when pressed into a ball. Maintain mortar in this dampened condition for fifteen (15) to thirty (30) minutes. Add remaining water in small

portions until mortar reaches desired consistency. Use mortar within one (1) hour of final mixing; do not re-temper or use partially hardened material.

B. Produce mortar of color required by using specified ingredients. Do not alter specified proportions without the SEPTA Project Manager's approval.

1. Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

C. Do not use admixtures in mortar unless otherwise indicated.

D. Mix mortar materials in the following proportions:

1. Rebuilding (setting) mortar by volume to meet ASTM C 270, proportion specification is to match existing mortar mix.

2. Add mortar pigments to produce exposed, rebuilding (setting) mortar of colors required.

3. Pointing mortar by type to meet ASTM C 270, proportion specification, Type N unless otherwise indicated; with cementitious material limited to Portland cement and lime, masonry cement or mortar cement. Add mortar pigments to produce mortar colors required.

PART 3 - EXECUTION

3.01 Protection

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges and other projecting items to protect them from mortar droppings.

2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.

3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

B. Remove gutters and downspouts and associated hardware adjacent to masonry and store during masonry repointing. Reinstall when repointing is complete.

3.02 Masonry Repair and Repointing

A. Repaired and/or repointed surfaces are to have a uniform appearance as viewed from 20 feet away by the SEPTA Project Manager.

3.03 Abandoned Anchor Removal

A. Remove abandoned anchors, brackets, wood nailers and other extraneous items no longer in use unless indicated to remain.

1. Remove items carefully to avoid spalling or cracking masonry.

2. Notify the SEPTA Project Manager before proceeding if an item cannot be removed without damaging surrounding masonry. Do the following where directed:

a. Cut or grind off item approximately 3/4 inch beneath surface and core drill a recess of same depth in surrounding masonry as close around item as practical.

b. Immediately paint exposed end of item with two (2) coats of antirust coating, following the coating manufacturer's written instructions and without exceeding the manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.

3. Patch hole where each item was removed unless directed to remove and replace masonry unit.

3.04 Brick Removal and Replacement

A. At locations indicated, remove bricks that are damaged, spalled or deteriorated or are to be reused. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full-size units.

1. When removing single bricks, remove material from center of brick and work toward outside edges.

B. Support and protect remaining masonry that surrounds removal area.

C. Maintain flashing, reinforcement, lintels and adjoining construction in an undamaged condition. Coordinate with new flashing, reinforcement and lintels, which are specified in other Sections.

D. Notify the SEPTA Project Manager of unforeseen detrimental conditions including voids, cracks, bulges and loose units in existing masonry backup, rotted wood, rusted metal and other deteriorated items.

E. Remove in an undamaged condition as many whole bricks as possible.

1. Remove mortar, loose particles and soil from brick by cleaning with hand chisels, brushes and water.

2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.

3. Store brick for reuse. Store off ground, on skids and protected from weather.

4. Deliver cleaned brick not required for reuse to SEPTA unless otherwise indicated.

5. Refer to Section 02070.

F. Clean masonry surrounding removal areas by removing mortar, dust and loose particles in preparation for brick replacement.

G. Replace removed damaged brick with other removed brick in good condition, where possible, or with new brick matching existing brick. Do not use broken units unless they can be cut to usable size.

H. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor-driven saw designed to cut masonry with clean, sharp, unchipped edges.

1. Maintain joint width for replacement units to match existing joints.

2. Use setting buttons or shims to set units accurately spaced with uniform joints.

I. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head and collar joints. Butter ends with enough mortar to fill head joints and shove into place.

Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.

1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing brickwork.
2. Rake out mortar used for laying brick before mortar sets according to this Section. Point at same time as repointing of surrounding area.
3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.

J. Cure mortar by maintaining in thoroughly damp condition for at least seventy-two (72) consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.05 Repointing Masonry

A. Rake out and repoint joints to the following extent:

1. Joints at locations indicated and of the following defects:
   a. Holes and missing mortar.
   b. Cracks that can be penetrated 1/4 inch or more by a knife blade 0.027 inch thick.
   c. Cracks 1/8 inch or more in width and of any depth.
   d. Hollow-sounding joints when tapped by metal object.
   e. Eroded surfaces 1/4 inch or more deep.
   f. Deterioration to point that mortar can be easily removed by hand, without tools.
   g. Joints filled with substances other than mortar.
2. Do not rake out and repoint joints where not required.

B. Rake out joints as follows, and in accordance with procedures demonstrated in approved mockup:

1. Remove mortar from joints to minimum depth of two and one-half (2 1/2) times joint width, but not less than 5/8 inch or not less than that required to expose sound, un-weathered mortar. Do not remove unsound mortar more than 2 inches deep; consult SEPTA for direction.
2. Remove mortar from masonry surfaces within raked-out joints to provide reveals with square backs and to expose masonry for contact with pointing mortar. Brush, vacuum or flush joints to remove dirt and loose debris.
3. Do not spall edges of masonry units or widen joints. Replace or patch damaged masonry units as directed by the SEPTA Project Manager.

C. Notify SEPTA of unforeseen detrimental conditions including voids in mortar joints, cracks, loose masonry units, rotted wood, rusted metal and other deteriorated items.

D. Pointing with Mortar:

1. Rinse joint surfaces with water to remove dust and mortar particles. Time rinsing application so, at time of pointing, joint surfaces are damp but free of standing water. If rinse water dries, dampen joint surfaces before pointing.

2. Apply pointing mortar first to areas where existing mortar was removed to depths greater than surrounding areas. Apply in layers not greater than 3/8 inch until a uniform depth is formed. Fully compact each layer and allow it to become thumbprint hard before applying next layer.

3. After deep areas have been filled to same depth as remaining joints, point joints by placing mortar in layers not greater than 3/8 inch. Fully compact each layer and allow to become thumbprint hard before applying next layer. Where existing masonry units have worn or rounded edges, slightly recess finished mortar surface below face of masonry to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed masonry surfaces or to featheredge the mortar.

4. When mortar is thumbprint hard, tool joints to match original appearance of joints as demonstrated in approved mockup. Remove excess mortar from edge of joint by brushing.

5. Cure mortar by maintaining in thoroughly damp condition for at least seventy-two (72) consecutive hours, including weekends and holidays.

6. Hairline cracking within mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

E. Where repointing work precedes cleaning of existing masonry, allow mortar to harden at least thirty (30) days before beginning cleaning work.

3.06 Painting Steel Uncovered During the Work

A. Notify the SEPTA Project Manager if steel is exposed during masonry removal. Where the SEPTA Project Manager determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Remove paint, rust and other contaminants according to SSPC-SP 2, SSPC-SP 3 or SSPC-SP 6 as applicable to meet the paint manufacturer's recommended preparation.

2. Immediately paint exposed steel with two (2) coats of antirust coating, following the coating manufacturer's written instructions and without exceeding the manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch, notify the SEPTA Project Manager before proceeding.

3.07 Masonry Unit Patching

A. Patch the following masonry units unless another type of repair or replacement is indicated:

1. Units indicated to be patched.

2. Units with holes.

3. Units with chipped edges or corners. Patch chipped edges or corners measuring more than 3/4 inch in least dimension.
4. Units with small areas of deep deterioration. Patch deep deteriorations measuring more than 3/4 inch in least dimension and more than 1/4 inch deep.

B. Remove and replace existing patches unless otherwise indicated or approved by the SEPTA Project Manager.

C. Patching Bricks:

1. Remove loose material from masonry surface. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch thick, but not less than recommended in writing by the patching compound manufacturer.
2. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of masonry unit.
3. Mix patching compound in individual batches to match each unit being patched. Combine one (1) or more colors of patching compound, as needed, to produce exact match.
4. Rinse surface to be patched and leave damp, but without standing water.
5. Brush-coat surfaces with slurry coat of patching compound according to the manufacturer's written instructions.
6. Place patching compound in layers as recommended in writing by the patching compound manufacturer, but not less than 1/4 inch or more than 2 inches thick. Roughen surface of each layer to provide a key for next layer.
7. Trowel, scrape or carve surface of patch to match texture and surrounding surface plane or contour of masonry unit. Shape and finish surface before or after curing, as determined by testing, to best match existing masonry unit.
8. Keep each layer damp for seventy-two (72) hours or until patching compound has set.
9. Remove and replace patches with hairline cracks or that show separation from brick at edges, and those that do not match adjoining brick in color or texture.

3.08 Final Cleaning

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff-nylon or -fiber brushes and clean water applied by low pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Clean adjacent non-masonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.

3.09 Field Quality Control

A. Engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.

B. Allow SEPTA the use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the work completed.

C. Notify the inspectors and SEPTA in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors and SEPTA have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.10 Masonry Waste Disposal

A. Unless otherwise indicated, excess masonry materials are the Contractor's property.

B. Remove masonry waste and legally dispose of off SEPTA's property.

END OF SECTION

SECTION 04014

STONE RESTORATION

PART 1 - GENERAL

1.01 Description

A. Section Includes:

1. Repairing stone masonry, including replacing whole and partial units.
2. Removing abandoned anchors.
3. Painting steel uncovered during the work.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 04011 - Masonry Cleaning

C. Section 04012 - Brick Masonry Repair

D. Section 07190 - Water Repellents

1.03 Submittals

A. Submit product data for each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include recommendations for product application and use. Include test data substantiating that products meet the requirements.

B. Submit shop drawings:

1. Include plans, elevations, sections, and locations of replacement stone units on the structure and their jointing, showing relation of existing and new or relocated units.
2. Show partial replacement stone units (dutchmen).
3. Indicate setting number of each new stone unit and its location on the structure in annotated plans and elevations.
4. Show provisions for expansion joints or other sealant joints.
5. Show provisions for flashing, lighting fixtures, conduits and weep holes as required.
6. Show replacement and repair anchors, including drilled-in pins. Include details of anchors within individual stone units, with locations of anchors and dimensions of holes and recesses in stone required for anchors, including direction and angle of holes for pins.
7. Show locations of scaffolding and points of scaffolding in contact with stone. Include details of each point of contact or anchorage.

C. Submit samples for initial selection for the following items:

1. Submit sets of colored mortar that will be left exposed in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.
    a. Have each set contain a close color range of at least three (3) samples of different mixes of colored sands and cements that produce a mortar matching the existing, cleaned mortar when cured and dry.
    b. Submit with precise measurements on ingredients, proportions, gradations and source of colored sands from which each sample was made.
2. Sand types used for mortar to be a minimum 8 oz. of each in plastic screw top jars.
3. Submit sets of patching compound samples in the form of plugs (patches in drilled holes) in sample units of stone representative of the range of stone colors on the building.
    a. Have each set contain a close color range of at least three (3) samples of different mixes of patching compound that matches the variations in existing stone when cured and dry.
4. Include similar samples of accessories involving color selection.

D. Submit samples for verification for the following items:

1. Each type of replacement stone. Include sets of samples to show full range of color, texture, grain, veining and finish to be expected. Provide sets of at least three (3) 12 inch by 12 inch samples for each type, but no fewer than necessary to indicate full range and proportion of variations within range.
2. Each type of patching compound in form of briquettes, at least 3 inches long by 1 1/2 inches wide. Document each sample with manufacturer and stock number or other information necessary to order additional material.
3. Each type of adhesive.
4. Each type of anchor, accessory and miscellaneous support.

E. Submit qualification data for stone repair specialist and testing service.

F. Submit preconstruction test reports for existing stone and mortar and replacement stone.

G. Submit quality control program.

1.04 Quality Assurance

A. Engage an experienced stone repair firm to perform work of this Section. Firm shall have completed work similar in material, design and extent to that indicated for this Project with a record of successful in-service performance. Experience in only installing standard unit masonry or new stone masonry is insufficient experience for stone repair work.

1. Stone repair specialist firms shall maintain experienced full time supervisors on Project site during times that stone repair work is in progress.
2. When stone units are being patched, assign at least one (1) worker per crew who is trained and certified by manufacturer of patching compound to apply its products.

B. Prepare a written quality control program for this Contract to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without

damaging stonework. Include provisions for supervising performance and preventing damage.

C. Prepare mockups of stone repair to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.

1. Prepare sample areas for each type of stone indicated to have repair work performed. If not otherwise indicated, size each mockup not smaller than two (2) adjacent whole units or approximately 48 inches in least dimension. Construct sample areas in locations in existing walls where directed by SEPTA unless otherwise indicated. Demonstrate quality of materials, workmanship and blending with existing work. Include the following as a minimum:
    a. Four (4) stone units replaced.
    b. Two (2) partial stone replacements (dutchman repairs).
    c. Two (2) stone plug repairs for each type of stone indicated to be plugged.
    d. Apply crack injection in two (2) separate areas as directed.
    e. Patch three (3) small holes as directed.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.
3. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM C 91/C 91M, Standard Specification for Masonry Cement.
2. ASTM C 97/C 97M, Standard Test Methods for Absorption and Bulk Specific Gravity of Dimension Stone.
3. ASTM C 99/C 99M, Standard Test Method for Modulus of Rupture of Dimension Stone.
4. ASTM C 114, Standard Test Methods for Chemical Analysis of Hydraulic Cement.
5. ASTM C 119, Standard Terminology Relating to Dimension Stone.
6. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
7. ASTM C 150/C 150M, Standard Specification for Portland Cement.
8. ASTM C 170/C 170M, Standard Test Method for Compressive Strength of Dimension Stone.
9. ASTM C 207, Standard Specification for Hydrated Lime for Masonry Purposes.
10. ASTM C 270, Standard Specification for Mortar for Unit Masonry.
11. ASTM C 295/C 295M, Standard Guide for Petrographic Examination of Aggregates for Concrete.
12. ASTM C 979/C 979M, Standard Specification for Pigments for Integrally Colored Concrete.
13. ASTM C 1329/C 1329M, Standard Specification for Mortar Cement.
14. MPI No. 23, Primer, Metal, Surface Tolerant.

15. SSPC-SP 3, Power Tool Cleaning.

1.05 Delivery, Storage and Handling

A. Deliver stone units to Project site strapped together in suitable packs or pallets or in heavy duty crates and protected against impact and chipping.

B. Deliver each piece of stone with code mark or setting number on unexposed face, corresponding to shop drawings, using non-staining paint.

C. Deliver packaged materials to Project site in the manufacturer's original and unopened containers, labeled with the manufacturer's name and type of products.

D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

E. Store hydrated lime in the manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two (2) days.

F. Store sand where grading and other required characteristics can be maintained and contamination avoided.

G. Handle stone to prevent overstressing, chipping, defacement and other damage.

1.06 Definitions

A. Low Pressure Spray to be 100 to 400 psi.

B. Rebuilding (Setting) Mortar is mortar used to set and anchor masonry in a structure, distinct from pointing mortar installed after masonry is set in place.

C. Rift is the most pronounced direction of splitting or cleavage of a stone.

D. Stone Terminology to meet ASTM C 119.

1.07 Pre-Installation Meetings

A. Conduct per-installation conference at the Project site.

1. Review methods and procedures related to stone repair including, but not limited to, the following:

a. Verify stone repair specialist's personnel, equipment, and facilities needed to make progress and avoid delays.

b. Materials, material application, sequencing, tolerances and required clearances.

c. Quality control program.

d. Coordination with building occupants.

1.08 Sequencing and Scheduling

A. Order sand and gray Portland cement for colored mortar immediately after approval of samples. Take delivery of and store at Project site enough quantity to complete Contract.

B. Perform stone repair work in the following sequence, which includes work specified in this and other Sections:

1. Remove plant growth.

2. Inspect stone for open mortar joints and permanently or temporarily point them before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean stone.
5. Rake out mortar from joints surrounding stone to be replaced and from joints adjacent to stone repairs along joints.
6. Repair stonework, including replacing existing stone with new stone.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near stonework, delay application of these chemicals until after pointing and cleaning.

C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in stone according to Article 3.10 in this Section. Patch holes in mortar joints according to Section 04014.

1.09 Pre-Construction Testing

A. Engage a qualified testing agency to perform pre-construction testing on stone units as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Test each proposed type of replacement stone according to ASTM C 170/C 170M for compressive strength, ASTM C 99/C 99M for modulus of rupture, and ASTM C 97/C 97M for absorption and bulk specific gravity.
3. Test each type of existing stone indicated for replacement according to ASTM C 170/C 170M for compressive strength, wet and dry, perpendicular and parallel to rift; ASTM C 99/C 99M for modulus of rupture, wet and dry, perpendicular and parallel to rift; and ASTM C 97/C 97M for absorption and bulk specific gravity. Carefully remove five (5) existing stones from locations designated by SEPTA. Take testing samples from these stones.
4. Test existing mortar according to ASTM C 295/C 295M, modified as agreed by testing service and SEPTA for Contract requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates and approximate strength.
5. As directed by SEPTA, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

1.10 Field Conditions

A. Proceed with installation only when existing and forecasted weather conditions permit stone repair work to be performed according to the product manufacturers' written instructions and specified requirements.

B. Repair stone units only when air temperature is between 40°F and 90°F and is predicted to remain so for at least seven (7) days after completion of the work unless otherwise indicated.

C. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

PART 2 - PRODUCTS

2.01 Materials

A. Obtain each type of material for repairing stone (stone, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.02 Stone Materials

A. Natural building stone of variety, color, texture, grain, veining, finish, size, and shape that match existing stone and with physical properties within 10 percent of those determined from pre-construction testing of selected existing stone.

1. For existing stone that exhibits a range of colors, texture, grain, veining, finishes, sizes, or shapes, provide stone that proportionally matches that range rather than stone that matches an individual color, texture, grain, veining, finish, size or shape within that range.

B. Cut each new stone so that, when it is set in final position, the rift or natural bedding planes will match the rift orientation of existing stones.

2.03 Mortar Materials

A. Portland cement to meet ASTM C 150/C 150M, Type I or Type II, except Type III may be used for cold weather construction; white, gray or both where required for color matching of mortar.

1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated lime to meet ASTM C 207, Type S.

C. Mortar sand to meet ASTM C 144.

1. Match size, texture, gradation, and hardness of existing exposed mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.

2. Natural sand or ground marble, granite or other sound stone of color necessary to produce required mortar color.

D. Mortar pigments to meet ASTM C 979/C 979M, compounded for use in mortar mixes, and having a record of satisfactory performance in stone mortars.

E. Water to be potable.

2.04 Manufactured Repair Materials

A. Stone patching compound to be a factory mixed cementitious product that is custom manufactured for patching stone.

1. Use formulation that is vapor and water permeable (equal to or more than the stone), exhibits low shrinkage, has lower modulus of elasticity than stone units being repaired, and develops high bond strength to all types of stone.

2. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.

3. Formulate patching compound in colors, textures and grain to match stone being patched. Provide no fewer than three (3) colors to enable matching of each piece of stone.

B. Cementitious crack filler to be ultrafine super plasticized grout that can be injected into cracks, is suitable for application to wet or dry cracks, exhibits low shrinkage and develops high bond strength to all types of stone.

C. Stone-to-stone adhesive to be two (2) part polyester or epoxy resin stone adhesive with a fifteen (15) to forty-five (45) minute cure at 70°F , recommended in writing by the adhesive manufacturer for type of stone repair indicated, and matching stone color.

2.05 Accessory Materials

A. Stone repair anchors and pins to be mechanical fasteners and pins of Type 316 stainless steel; designed for stone stabilization and pinning stone pieces; matching shape and size of existing anchors unless otherwise indicated.

B. Setting buttons and shims to be resilient plastic, non-staining to stone, sized to suit joint thicknesses and bed depths of stone units, less the required depth of pointing materials unless removed before pointing.

C. Masking tape to be non-staining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

D. Antirust coating to be fast curing, lead and chromate free, self-curing, universal modified alkyd primer according to MPI No. 23 (surface tolerant, anticorrosive metal primer).

1. Use coating requiring no better than SSPC-SP 3 surface preparation according to the manufacturer's literature or certified statement.

2. Use coating with a VOC content of 3.3 pounds/gallon or less.

E. Select other product materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.

2. Minimal possibility of damaging exposed surfaces.

3. Consistency of each application.

4. Uniformity of the resulting overall appearance.

5. Do not use products or tools that could leave residue on surfaces.

2.06 Mortar Mixes

A. Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

B. Produce mortar of color required by using specified ingredients. Do not alter specified proportions without SEPTA's approval.

1. Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

C. Do not use admixtures in mortar unless otherwise indicated.

D. Mix mortar materials in the following proportions:

1. Rebuilding (setting) mortar by volume to be 1 part Portland cement, 1 part lime, and 6 parts sand.

2. Rebuilding (setting) mortar by type to meet ASTM C 270, proportion specification, Type N unless otherwise indicated, with cementitious material limited to Portland cement and lime, masonry cement or mortar cement.

3. Rebuilding (setting) mortar by property to meet ASTM C 270, property specification, Type N unless otherwise indicated; with cementitious material limited to Portland cement and lime, masonry cement or mortar cement.

4. Add mortar pigments to produce exposed, setting (rebuilding) mortar of colors required.

PART 3 - EXECUTION

3.01 Protection

A. Prevent mortar from staining face of surrounding stone and other surfaces.

1. Cover sills, ledges and other projecting items to protect them from mortar droppings.

2. Keep wall area wet below rebuilding and repair work to discourage mortar from adhering.

3. Immediately remove mortar splatters in contact with exposed stone and other surfaces.

B. Remove gutters and downspouts, and associated hardware adjacent to stone and store during stone repair. Reinstall when repairs are complete.

1. Provide temporary rain drainage during work to direct water away from building.

3.02 Stone Repair

A. Repaired surfaces are to have a uniform appearance as viewed from 20 feet away by SEPTA.

3.03 Abandoned Anchor Removal

A. Remove abandoned anchors, brackets, wood nailers and other extraneous items no longer in use unless indicated to remain.

1. Remove items carefully to avoid spalling or cracking stone.

2. Notify SEPTA before proceeding if an item cannot be removed without damaging surrounding stone. Do the following where directed:
    a. Cut or grind off item approximately 3/4 inch beneath surface and core drill a recess of same depth in surrounding stone as close around item as practical.
    b. Immediately paint exposed end of item with two (2) coats of antirust coating, following the coating manufacturer's written instructions and without exceeding the manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
3. Patch hole where each item was removed unless directed to remove and replace stone unit.

3.04 Stone Removal and Replacement

A. At locations indicated, remove stone that has deteriorated or is damaged beyond repair. Carefully remove entire units from joint to joint, without damaging surrounding stone, in a manner that permits replacement with full size units.

B. Support and protect remaining stonework that surrounds removal area.

C. Maintain flashing, reinforcement, lintels and adjoining construction in an undamaged condition. Coordinate with new flashing, reinforcement and lintels, which are specified in other Sections.

D. Notify SEPTA of unforeseen detrimental conditions including voids, cracks, bulges, and loose units in existing stone or unit masonry backup, rotted wood, rusted metal and other deteriorated items.

E. Remove in an undamaged condition as many whole stone units as possible.
    1. Remove mortar, loose particles, and soil from stone by cleaning with hand chisels, brushes and water.
    2. Remove sealants by cutting close to stone with utility knife and cleaning with solvents.
    3. Store stone for reuse. Store off ground, on skids, and protected from weather.
    4. Deliver cleaned stone not required for reuse to SEPTA unless otherwise indicated.

F. Clean stone surrounding removal areas by removing mortar, dust and loose particles in preparation for stone replacement.

G. Replace removed damaged stone with other removed stone in good condition, where possible, or with new stone matching existing stone, including direction of rift or natural bedding planes. Do not use broken units unless they can be cut to usable size.

H. Install replacement stone into bonding and coursing pattern of existing stone. If cutting is required, use a motor driven saw designed to cut stone with clean, sharp, unchipped edges. Finish edges to blend with appearance of edges of existing stone.
    1. Maintain joint width for replacement stone to match existing joints.
    2. Use setting buttons or shims to set stone accurately spaced with uniform joints.

I. Set replacement stone with rebuilding (setting) mortar and with completely filled bed, head and collar joints. Butter vertical joints for full width before setting and set units in full bed of mortar unless otherwise indicated. Replace existing anchors with new anchors matching existing configuration.

1. Tool exposed mortar joints in repaired areas to match joints of surrounding existing stonework.
2. Rake out mortar used for laying stone before mortar sets according to Section 04014. Point at same time as repointing of surrounding area.
3. When mortar is hard enough to support units, remove shims and other devices interfering with pointing of joints.

J. Cure mortar by maintaining in thoroughly damp condition for at least seventy-two (72) consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.05 Painting Steel Uncovered During the Work

A. Notify SEPTA if steel is exposed during stone removal. Where SEPTA determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Remove paint, rust, and other contaminants according SSPC-SP 3 as applicable to meet the paint manufacturer's recommended preparation.
2. Immediately paint exposed steel with two (2) coats of antirust coating, following the coating manufacturer's written instructions and without exceeding the manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch, notify SEPTA before proceeding.

3.06 Partial Stone Replacement

A. Remove defective portion of existing stone unit (backing stone). Carefully remove defective portion of stone by making vertical and horizontal saw cuts at face of backing stone and removing defective material to depth required for fitting partial replacement (dutchman).

1. Make edges of backing stone at cuts smooth and square to each other and to finished surface; essentially rectangular. Make back of removal area flat and parallel to stone face.
2. Do not overcut at corners and intersections. Hand trim to produce clean sharp corners with no rounding and no damage to existing work to remain.
3. If backing stone becomes further damaged, remove damaged area and enlarge partial replacement as required.

B. Remove mortar from joints that abut area of stone removal to same depth as stone was removed. Remove loose mortar particles and other debris from surfaces to be bonded and surfaces of adjacent stone units that will receive mortar by cleaning with stiff fiber brush.

C. Cut and trim partial replacement to accurately fit area where material was removed from backing stone. Fabricate to size required to produce joints between partial replacement and backing stone of no more than 1/16 inch in width, and to produce joints between partial replacement and other stones that match existing joints between stones. Cut partial replacement so that, when it is set in final position, natural bedding planes will match the orientation of bedding planes of the backing stone unless otherwise indicated.

D. Before applying adhesive, prepare for mechanical anchorage consisting of 1/4 inch diameter, threaded stainless steel pins set into 1/4 inch diameter holes drilled at a 45 degree downward angle through face of partial replacement and into backing stone. Center and space pins 3 inches to 5 inches apart and at least 2 inches from any edge. Insert pins at least 2 inches into backing stone and 2 inches into partial replacement with end countersunk at least 3/4 inch from exposed face of partial replacement.

E. Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/4 inch diameter, threaded stainless steel pins set into 1/4 inch diameter holes drilled into backing stone and into, but not through, the partial replacement. Center and space pins 3 inches to 5 inches apart and at least 2 inches from any edge. Insert pins at least 2 inches into backing stone and 2 inches into partial replacement, but no closer than 3/4 inch from exposed face of partial replacement.

F. Apply stone-to-stone adhesive according to the adhesive manufacturer's written instructions. Coat bonding surfaces of backing stone and partial replacement, completely filling all crevices and voids.

G. Apply partial replacement while adhesive is still tacky and hold securely in place until adhesive has cured. Use shims, clamps, wedges or other devices as necessary to align face of partial replacement with face of backing stone.

H. Clean adhesive residue from exposed surfaces and patch chipped areas and exposed drill holes as specified in Article 3.10 in this Section.

3.07 Stone Plug Repair

A. Remove cylindrical piece of damaged stone by core drilling perpendicular to stone surface.

B. Prepare a replacement plug by core drilling replacement stone. Use a drill sized to produce a core that will fit into hole drilled in damaged stone with only minimum gap necessary for adhesive. Cut and install plug so that, when it is set in final position, natural bedding planes will match the orientation of bedding planes of the backing stone unless otherwise indicated.

C. Apply stone-to-stone adhesive according to the adhesive manufacturer's written instructions. Coat bonding surfaces of existing stone and plug, completely filling all crevices and voids.

D. Apply plug while adhesive is still tacky and hold securely in place until adhesive has cured.

E. Clean adhesive residue from exposed surfaces.

3.08 Stone Fragment Repair

A. Carefully remove cracked or fallen stone fragment indicated to be repaired. Reuse only stone fragment that is in sound condition.

B. Remove soil, loose particles, mortar, and other debris or foreign material from fragment surfaces to be bonded and from parent stone where fragment had broken off, by cleaning with stiff fiber brush.

C. Before applying adhesive, prepare for mechanical anchorage consisting of 1/4 inch diameter, threaded stainless steel pins set into 1/4 inch diameter holes drilled at a 45 degree downward angle through face of fragment and into parent stone. Center and space

pins between 3 inches and 5 inches apart and at least 2 inches from any edge. Insert pins at least 2 inches into parent stone and 2 inches into fragment with end countersunk at least 3/4 inch from exposed face of fragment.

D. Before applying adhesive, prepare for concealed mechanical anchorage consisting of 1/4 inch diameter, threaded stainless steel pins set into 1/4 inch diameter holes drilled into parent stone and into, but not through, the fragment. Center and space pins between 3 inches and 5 inches apart and at least 2 inches from any edge. Insert pins at least 2 inches into parent stone and 2 inches into fragment, but no closer than 3/4 inch from exposed face of fragment.

E. Apply stone-to-stone adhesive according to the adhesive manufacturer's written instructions. Coat bonding surfaces of fragment and parent stone, completely filling all crevices and voids.

F. Fit stone fragment onto parent stone while adhesive is still tacky and hold fragment securely in place until adhesive has cured. Use shims, clamps, wedges or other devices as necessary to align face of fragment with face of parent stone.

G. Clean adhesive residue from exposed surfaces and patch chipped areas and exposed drill holes as specified in Article 3.10 in this Section.

3.09 Crack Injection

A. Meet the cementitious crack filler manufacturer's written instructions.

B. Drill 1/4 inch diameter injection holes as follows:

1. Drill holes through center of crack at 12 inches to 18 inches on center for transverse cracks less than 3/8 inch wide.

2. Drill holes through center of crack at 18 inches to 36 inches on center for transverse cracks more than 3/8 inch wide.

3. Drill holes at approximately 18 inches on center both vertically and horizontally for delaminations.

4. Drill holes 2 inches deep.

C. Clean out drill holes and cracks with compressed air and water. Remove dirt and organic matter, loose material, sealants and failed crack repair materials.

D. Place plastic injection ports in drilled holes and seal face of cracks between injection ports with clay or other non-staining, removable plugging material. Leave openings at upper ends of cracks for air release.

E. Inject cementitious crack filler through ports sequentially, beginning at one end of area and working to opposite end; where possible, begin at lower end of injection area and work upward. Inject filler until it extrudes from adjacent ports. After port has been injected, plug with clay or other suitable material and begin injecting filler at adjacent port, repeating process until all ports have been injected.

F. Clean cementitious crack filler from face of stone before it sets by scrubbing with water.

G. After cementitious crack filler has set, remove injection ports, plugging material and excess filler. Patch injection holes and surface of cracks as specified in Article 3.10 in this Section.

3.10 Stone Patching

A. Patch the following stone units unless another type of repair or replacement is indicated:

1. Units indicated to be patched.
2. Units with holes.
3. Units with chipped edges or corners. Patch chipped edges or corners measuring more than 3/4 inch in least dimension.
4. Units with small areas of deep deterioration. Patch deep deteriorations measuring more than 3/4 inch in least dimension and more than 1/4 inch deep.

B. Remove and replace existing patches unless otherwise indicated or approved by SEPTA.

C. Remove deteriorated material and remove adjacent material that has begun to deteriorate. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch thick, but not less than recommended in writing by the patching compound manufacturer.

D. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of stone unit.

E. Mix patching compound in individual batches to match each stone unit being patched. Combine one (1) or more colors of patching compound, as needed, to produce exact match.

F. Brush coat stone surfaces with slurry coat of patching compound according to the manufacturer's written instructions.

G. Place patching compound in layers as recommended in writing by the patching compound manufacturer, but not less than 1/4 inch or more than 2 inches thick. Roughen surface of each layer to provide a key for next layer.

1. Trowel, scrape, or carve surface of patch to match texture and surrounding surface plane or contour of the stone. Shape and finish surface before or after curing, as determined by testing, to best match existing stone.
2. Build patch up 1/4 inch above surrounding stone, and carve surface to match adjoining stone after patching compound has hardened.

H. Keep each layer damp for seventy-two (72) hours or until patching compound has set.

I. Remove and replace patches with hairline cracks or that show separation from stone at edges, and those that do not match adjoining stone in color or texture.

3.11 Final Cleaning

A. After mortar has fully hardened, thoroughly clean exposed stone surfaces of excess mortar and foreign matter; use wood scrapers, stiff nylon or fiber brushes, and clean water, applied by low pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Clean adjacent non-stone surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.

3.12 Field Quality Control

A. The Contractor will engage a qualified testing agency to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.

B. Allow SEPTA use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the work completed.

C. Notify inspectors and SEPTA in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors and SEPTA have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.13 Stone Waste Disposal

A. Unless otherwise indicated, excess stone materials are the Contractor's property.

B. Remove stone waste and legally dispose of off SEPTA’s property.

END OF SECTION

SECTION 04200

UNIT MASONRY

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section includes unit masonry.

1. Concrete Masonry Units (CMUs):
   a. Standard block to be utilized in concealed or cavity wall applications.
2. Face brick.
3. Extruded brick.
4. Glazed brick.
5. Stone trim units.
6. Mortar and grout.
7. Steel reinforcing bars.
8. Masonry joint reinforcement.
9. Ties and anchors.
10. Embedded flashing.
11. Miscellaneous masonry accessories.
12. Masonry cell fill.
13. Products installed but not furnished under this Section:
    a. Steel lintels in unit masonry.
    b. Steel shelf angles for supporting unit masonry.
    c. Cavity wall insulation.

1.02 Related Sections

A. Section 04011 – Masonry Cleaning

B. Section 04012 – Brick Masonry Repair

C. Section 04212 – Terra Cotta Masonry

D. Section 05120 – Structural Steel

E. Section 07190 – Water Repellents

F. Section 07620 – Sheet Metal Flashing and Trim

G. Section 07841 – Penetration Fire Stopping

H. Section 07842 – Joint Fire Stopping

I. Section 07900 – Joint Sealers

J. Section 09910 – Paints and Coatings

1.03 Submittals

A. Submit product data for each type of product.

B. Submit shop drawings for the following:

1. Masonry Units:
   a. Show sizes, profiles, coursing and locations of special shapes.
2. Reinforcing Steel:
   a. Detail bending, lap lengths and placement of unit masonry reinforcing bars. Meet ACI 315. Show elevations of reinforced walls.
3. Fabricated Flashing:
   a. Detail corner units, end-dam units and other special applications.

C. Submit samples for verification for each type and color of the following:

1. Exposed CMUs.
2. Common brick, in the form of straps of five (5) or more bricks.
3. Extruded brick, in the form of straps of five (5) or more bricks.
4. Special brick and concrete shapes.
5. Pigmented and colored-aggregate mortar. Make samples using same sand and mortar ingredients to be used on Contract.
6. Weep holes and cavity vents.
7. Accessories embedded in masonry.

D. Submit a list of materials used in constructing mockups indicating the product names together with the manufacturers, the manufacturers' product names, model numbers, lot numbers, batch numbers, source of supply and other information as required to identify materials used. Include mix proportions for mortar and grout and source of aggregates.

1. Submittal is for information only. Receipt of list does not constitute approval of deviations from the Contract Documents unless such deviations are specifically brought to the attention of SEPTA and approved in writing.

E. Submit qualification data for testing agencies.

F. Submit material certificates for each type and size of the following:

1. Masonry Units:
   a. Include data on material properties and material test reports substantiating compliance with requirements.
   b. For brick, include size-variation data verifying that actual range of sizes falls within specified tolerances.
   c. For exposed brick, include test report for efflorescence according to ASTM C 67.
   d. For masonry units used in structural masonry, include data and calculations establishing average net area compressive strength of units.
2. Include name of the manufacturer, brand name and type for cementitious materials.

3. Mortar admixtures for face brick.
4. Include description of type and proportions of ingredients for pre-blended, dry mortar mixes.
5. Include description of type and proportions of ingredients for grout mixes.
6. Reinforcing bars.
7. Joint reinforcement.
8. Anchors, ties and metal accessories.

G. Submit mix designs for each type of mortar and grout. Include description of type and proportions of ingredients.

1. Include test reports for mortar mixes required to comply with property specification. Test according to ASTM C 109/C 109M for compressive strength, ASTM C 1506 for water retention and ASTM C 91/C 91M for air content.
2. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.
    a. For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type and resulting net-area compressive strength of masonry determined according to TMS 602.
    b. Detailed description of methods, materials and equipment to be used to meet the requirements for cold weather and hot weather procedures.

1.04 Quality Assurance

A. Coordinate masonry with all trades requiring items to be built-in.

B. Particular care is to be taken in designing interfaces of masonry anchors and waterproofing membrane and in placement of through wall flashing to bring any water that penetrates the system out to the exterior.

C. Testing agency to be qualified according to ASTM C 1093 for testing indicated.

D. Build mockups to verify selections made under sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Build mockups for each type of exposed unit masonry construction 72 inches long, 60 inches high by full thickness, including face and backup wythes and accessories.
    a. Include a sealant-filled joint at least 16 inches long in each mockup.
    b. Include lower corner of window opening, at upper corner of exterior wall mockup. Make opening approximately 12 inches wide by 16 inches high.
    c. Include through wall flashing installed for a 24 inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12 inch length of flashing left exposed to view (omit masonry above half of flashing).
    d. Include metal studs, water resistive barrier, veneer anchors, flashing, cavity drainage material and weep holes in exterior masonry veneer wall mockup.
2. Erect mockups in the presence of SEPTA before installation of materials.
3. Use mockup as standard of comparison for masonry work built of same material.

4. Where masonry is to match existing, erect mockups adjacent and parallel to existing surface.
5. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
6. Protect accepted mockups from the elements with weather resistant membrane.
7. Approval of mockups is for color, texture and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
    a. Approval of mockups is also for other material and construction qualities specifically approved by SEPTA in writing.
    b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.
8. Do not destroy or move mockup until work is completed and accepted.

E. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 117, Standard Specifications for Tolerance for Concrete Construction and Materials.
2. ACI 315, Details and Detailing for Concrete Reinforcement.
3. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
4. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
5. ASTM A 276/A 276M, Standard Specification for Stainless Steel Bars and Shapes.
6. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
7. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
8. ASTM A 641/A 641M, Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
9. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
11. ASTM A 767/A 767M, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
12. ASTM A 951/A 951M, Standard Specification for Steel Wire for Masonry Joint Reinforcement.
13. ASTM A 1008/A 1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
14. ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.

15. ASTM B 370, Standard Specification for Copper Sheet and Strip for Building Construction.
16. ASTM C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
17. ASTM C 90, Standard Specification for Loadbearing Concrete Masonry Units.
18. ASTM C 91/C 91M, Standard Specification for Masonry Cement.
19. ASTM C 109/C 109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
20. ASTM C 114, Standard Test Methods for Chemical Analysis of Hydraulic Cement.
21. ASTM C 140/C 140M, Standard Test Methods for Sampling and Testing Concrete Masonry Units and Related Units.
22. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
23. ASTM C 150/C 150M, Standard Specification for Portland Cement.
24. ASTM C 207, Standard Specification for Hydrated Lime for Masonry Purposes.
25. ASTM C 216, Standard Specification for Facing Brick (Solid Masonry Units Made from Clay or Shale).
26. ASTM C 270, Standard Specification for Mortar for Unit Masonry.
27. ASTM C 331/C 331M, Standard Specification for Lightweight Aggregates for Concrete Masonry Units.
28. ASTM C 404, Standard Specification for Aggregates for Masonry Grout.
29. ASTM C 426, Standard Test Method for Linear Drying Shrinkage of Concrete Masonry Units.
30. ASTM C 476, Standard Specification for Grout in Masonry.
31. ASTM C 549, Standard Specification for Perlite Loose Fill Insulation.
32. ASTM C 578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
33. ASTM C 744, Standard Specification for Prefaced Concrete and Calcium Silicate Masonry Units.
34. ASTM C 780, Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry.
35. ASTM C 979/C 979M, Standard Specification for Pigments for Integrally Colored Concrete.
36. ASTM C 1019, Standard Test Method for Sampling and Testing Grout.
37. ASTM C 1093, Standard Practice for Accreditation of Testing Agencies for Masonry.
38. ASTM C 1262, Standard Test Method for Evaluating the Freeze-Thaw Durability of Dry-Cast Segmental Retaining Wall Units and Related Concrete Units.
39. ASTM C 1314, Standard Test Method for Compressive Strength of Masonry Prisms.
40. ASTM C 1329/C 1329M, Standard Specification for Mortar Cement.

41. ASTM C 1405, Standard Specification for Glazed Brick (Single Fired, Brick Units).
42. ASTM C 1506, Standard Test Method for Water Retention of Hydraulic Cement-Based Mortars and Plasters.
43. ASTM D 226/D 226M, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
44. ASTM D 1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
45. ASTM D 2000, Standard Classification System for Rubber Products in Automotive Applications.
46. ASTM E 119, Standard Test Methods for Fire Tests of Building Construction and Materials.
47. NCMA TEK 8-4A, Cleaning Concrete Masonry.
48. TMS 402, Building Code Requirements for Masonry Structures.
49. TMS 602, Specification for Masonry Structures.

1.05 Delivery, Storage and Handling

A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.

B. Store cementitious materials on elevated platforms, under cover and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Deliver pre-blended, dry mortar mix in moisture-resistant containers. Store pre-blended, dry mortar mix in delivery containers on elevated platforms in a dry location or in covered weatherproof dispensing silos.

E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.06 Definitions

A. CMU(s) is a Concrete Masonry Unit(s).

B. Reinforced Masonry is masonry containing reinforcing steel in grouted cells.

1.07 Field Conditions

A. Protect masonry during construction by covering tops of walls, projections and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.

1. Extend cover a minimum of 24 inches down both sides of walls and hold cover securely in place.

2. Where one (1) wythe of multiwythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.

B. Do not apply uniform floor or roof loads for at least twelve (12) hours and concentrated loads for at least three (3) days after building masonry walls or columns.

C. Prevent grout, mortar and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar and soil that come in contact with such masonry.

1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.

2. Protect sills, ledges and projections from mortar droppings.

3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.

4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.

D. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Meet cold weather construction requirements contained in TMS 602.

1. Use liquid cleaning methods only when air temperature is 40°F and higher and will remain so until masonry has dried, but not less than seven (7) days after completing cleaning.

E. Meet hot weather construction requirements contained in TMS 602.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source or single manufacturer for each product required.

B. Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.

2.02 Performance Requirements

A. Provide structural unit masonry that develops indicated net area compressive strengths at twenty-eight (28) days.

1. Determine net area compressive strength of masonry from average net area compressive strengths of masonry units and mortar types (unit strength method) according to TMS 602.

2. Determine net area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.

2.03 Unit Masonry

A. Masonry standard to meet TMS 602, except as modified by requirements in the Contract Documents.

B. Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks or other defects exceeding limits stated. Do not use units where such defects are exposed in the completed work and will be within 20 feet vertically and horizontally of a walking surface.

C. Meet the requirements for fire resistance rated assembly designs indicated.

1. Where fire resistance rated construction is indicated, units shall be listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction.

2.04 Concrete Masonry Units

A. Manufacturers:

1. Normal Weight CMU to be 16 inch by 8 inch face dimension by thickness indicated on the Contract Drawings. Plain face with the manufacturer’s standard color and texture.

B. Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

1. Provide special shapes for sills, stretchers, lintels, corners, jambs, sashes, movement joints, headers, bonding and other special conditions.

C. CMUs to meet ASTM C 90.

1. Provide units with minimum average net-area compressive strength of 2150 psi.

2. Density classification to be normal weight.

3. Manufactured to dimensions 3/8 inch less than nominal dimensions.

4. Provide color and texture matching the range represented by the Contractor's sample for exposed faces.

2.05 Brick

A. Manufacturer:

1. Glen grey color to match existing, Sanded Smooth, Type 1 Standard:
   a. Brick mortar color to be selected from the manufacturer’s standard color options.

2. Or Approved Equal.

B. Provide shapes indicated and as follows, with exposed surfaces matching finish and color of exposed faces of adjacent units:

1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, soldiers and lintels.

3. Provide special shapes for applications requiring brick of size, form, color and texture on exposed surfaces that cannot be produced by sawing.
4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.

C. Face brick to meet ASTM C 216, Grade SW, type FBX.
1. Use for masonry cavity wall applications.
2. Provide units with minimum average net area compressive strength of 3000 psi (average of five (5) brick for ASTM C 216 grade brick).
3. Actual dimensions of units to be 3 5/8 inches wide by 2 1/4 inches high by 7 5/8 inches long.

D. Extruded brick to meet ASTM C 216, Grade SW, Type FBS.
1. Use for double wythe brick wall applications.
2. Provide units with minimum average net area compressive strength of 3000 psi (average of five (5) brick for ASTM C 216 grade brick.)
3. Actual dimensions of units to be 3 5/8 inches wide by 2 1/4 inches high by 7 5/8 inches long, cored.

E. Refer to Section 07190 for clear sealer for exterior brick

F. Glazed brick to be single-fired glazed brick meeting ASTM C 1405, Division H40V (void areas between 25 and 40 percent of gross cross sectional area).
1. Where shown to "match existing," provide glazed brick matching color range, texture, and size of existing adjacent brickwork.

2.06 Mortar and Grout Materials

A. Portland cement to meet ASTM C 150/C 150M, Type I or II, except Type III may be used for cold weather construction. Provide natural color or white cement as required to produce mortar color indicated.
1. Alkali content shall not be more than 0.1 percent when tested according to ASTM C 114.
a. Hydrated lime to meet ASTM C 207, Type S.
b. Portland cement lime mix to be packaged blend of Portland cement and hydrated lime containing no other ingredients.
c. Mortar pigments to be natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and meeting ASTM C 979/C 979M. Use only pigments with a record of satisfactory performance in masonry mortar.
d. Colored cement products to be packaged blend made from Portland cement and hydrated lime or masonry cement and mortar pigments, all meeting the specified requirements, and containing no other ingredients.
1) Formulate blend as required to produce color indicated or, if not indicated, as selected from the manufacturer's standard colors.
2) Pigments shall not exceed 10 percent of Portland cement by weight.
3) Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
e. Aggregate for mortar to be ASTM C 144.

1) For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
2) For joints less than 1/4 inch thick, use aggregate graded with 100 percent passing the No. 16 sieve.
3) White mortar aggregates to be natural white sand or crushed white stone.
4) Colored mortar aggregates to be natural sand or crushed stone of color necessary to produce required mortar color.

f. Aggregate for grout to meet ASTM C 404.
g. Water to be potable.

2.07 Reinforcement

A. Zinc-coated galvanized steel reinforcing bars to meet ASTM A 767/A 767M, Grade 60 (Grade 420).

B. Reinforcing bar positioners to be wire units designed to fit into mortar bed joints spanning masonry unit cells and to hold reinforcing bars in center of cells. Units are formed from 0.148 inch steel wire, hot dip galvanized after fabrication. Provide units designed for number of bars indicated.

1. Masonry joint reinforcement to meet ASTM A 951/A 951M.
   a. Interior walls to be mill galvanized carbon steel.
   b. Exterior walls to be hot dip galvanized carbon steel.
   c. Wire size for side rods to be 0.187 inch diameter minimum.
   d. Wire size for cross rods to be 0.148 inch diameter minimum.
   e. Wire size for veneer ties to be 0.148 inch diameter minimum.
   f. Spacing of cross rods, tabs and cross ties to be not more than 16 inches on center.
   g. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

C. Masonry joint reinforcement for single wythe masonry to be ladder type with single pair of side rods.

D. Masonry Joint Reinforcement for Multiwythe Masonry:

1. Ladder type with one (1) side rod at each face shell of hollow masonry units more than 4 inches wide, plus two (2) side rods at each wythe of masonry 4 inches wide or less.
2. Tab type, either ladder or truss design, with one (1) side rod at each face shell of backing wythe and with rectangular tabs sized to extend at least halfway through facing wythe, but with at least 5/8 inch cover on outside face.
3. Adjustable (two (2) piece) type, either ladder or truss design, with one (1) side rod at each face shell of backing wythe and with separate adjustable ties with pintle and eye connections having a maximum horizontal play of 1/16 inch and maximum vertical adjustment of 1 1/4 inches. Size ties to extend at least halfway through facing wythe but with at least 5/8 inch cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.

E. Masonry joint reinforcement for veneers anchored with veneer anchors to be single 0.187 inch diameter, hot dip galvanized carbon steel continuous wire.

2.08 Ties and Anchors

A. Ties and anchors shall extend at least 1 1/2 inches into veneer but with at least a 5/8 inch cover on outside face.

B. Provide ties and anchors specified in this Article that are made from materials that meet the following unless otherwise indicated:

1. Mill galvanized, carbon steel wire to meet ASTM A 1064/A 1064M, with ASTM A 641/A 641M, Class 1 coating.
2. Hot dip galvanized, carbon steel wire to meet ASTM A 1064/A 1064M, with ASTM A 153/A 153M, Class B-2 coating.
3. Galvanized steel sheet to meet ASTM A 653/A 653M, commercial steel, G60 zinc coating.
4. Steel sheet, galvanized after fabrication to meet ASTM A 1008/A 1008M, commercial steel, with ASTM A 153/A 153M, Class B coating.
5. Steel plates, shapes and bars to meet ASTM A 36/A 36M.
6. Stainless steel bars to meet ASTM A 276/A 276M or ASTM A 666, Type 304.

C. Corrugated metal ties to be metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 inch to 0.5 inch and an amplitude of 0.06 inch to 0.10 inch made from 0.030 inch thick steel sheet, galvanized after fabrication.

D. Individual wire ties to be rectangular units with closed ends and not less than 4 inches wide.

1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches long may be used for masonry constructed from solid units.
2. Where wythes do not align and are of different materials, use adjustable ties with pintle and eye connections having a maximum adjustment of 1 1/4 inches.
3. Fabricate wire from 1/4 inch diameter, hot dip galvanized steel wire.

E. Provide adjustable anchors for connecting to structural steel framing that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Anchor section for welding to steel frame via crimped 1/4 inch diameter, hot dip galvanized steel wire.
2. Tie section to be triangular shaped wire tie made from 1/4 inch diameter, hot dip galvanized steel wire.

F. Provide adjustable anchors for connecting to concrete that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.

1. Connector section to have dovetail tabs for inserting into dovetail slots in concrete and attached to tie section; formed from 0.105 inch thick steel sheet, galvanized after fabrication.
2. Tie section to be triangular shaped wire tie made from 1/4 inch diameter, hot dip galvanized steel wire.

3. Corrugated metal ties to be metal strips not less than 7/8 inch wide with corrugations having a wavelength of 0.3 inch to 0.5 inch and an amplitude of 0.06 inch to 0.10 inch made from 0.105 inch thick steel sheet, galvanized after fabrication with dovetail tabs for inserting into dovetail slots in concrete.

G. Partition top anchors to be 0.105 inch thick metal plate with a 3/8 inch diameter metal rod 6 inches long welded to plate and with closed end plastic tube fitted over rod that allows rod to move in and out of tube. Fabricate from steel, hot dip galvanized after fabrication.

1. Fabricate rigid anchors from steel bars 1 1/2 inches wide by 1/4 inch thick by 24 inches long, with ends turned up 2 inches or with cross pins unless otherwise indicated.
   a. Corrosion protection to be hot dip galvanized to meet ASTM A 153/A 153M.

2.09 Embedded Flashing Materials

A. Provide metal flashing meeting Section 07620 and as follows:

1. Copper to meet ASTM B 370, Temper H00, cold rolled copper sheet, 16-oz. /sq. ft. weight or 0.0216 inch thick or ASTM B 370, Temper H01, high yield copper sheet, 12-oz. /sq. ft. weight or 0.0162 inch thick.

2. Fabricate through wall flashing with drip edge where indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.

3. Fabricate through wall flashing with sealant stop where indicated. Fabricate by bending metal back on itself 3/4 inch at exterior face of wall and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
   a. Fabricate metal drip edges from stainless steel or copper (refer to the Contract Drawings for locations of each material.) Extend at least 3 inches into wall and 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.
   b. Fabricate metal sealant stops from stainless steel. Extend at least 3 inches into wall and out to exterior face of wall. At exterior face of wall, bend metal back on itself for 3/4 inch and down into joint 1/4 inch to form a stop for retaining sealant backer rod.
   c. Fabricate metal expansion joint strips from stainless steel to shapes indicated.
   d. Solder metal items at corners.

B. Unless otherwise indicated, use the following:

1. Where flashing is indicated to receive counterflashing, use metal flashing.

2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.

3. Where flashing is partly exposed and is indicated to terminate at the wall face, use metal flashing with a drip edge.

4. Where flashing is fully concealed, use metal flashing.

C. Single wythe CMU flashing system is a system of CMU cell flashing pans and interlocking CMU web covers made from UV resistant, high density polyethylene. Cell flashing pans have integral weep spouts designed to be built into mortar bed joints and that extend into the cell to prevent clogging with mortar.

D. Solder and sealants for sheet metal flashings to be as specified in Section 07620.

E. Provide the flashing manufacturer's standard adhesives, primers and seam tapes products or products recommended by the flashing manufacturer for bonding flashing sheets to each other and to substrates.

F. Termination bars for flexible flashing to be stainless steel sheet 0.019 inch by 1 1/2 inches with a 3/8 inch sealant flange at top.

2.10 Miscellaneous Masonry Accessories

A. Pre-molded filler strips meeting ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene.

B. Preformed control joint gaskets to be made from styrene butadiene rubber compound, meeting ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.

C. Bond breaker strips to be asphalt saturated felt meeting ASTM D 226/D 226M, Type I (No. 15 asphalt felt).

D. Use the following weep/cavity vent products unless otherwise indicated:

1. Rectangular plastic weep/vent tubing to be clear butyrate, 3/8 inch by 1 1/2 inches by 3 1/2 inches long.

2. Mesh weep/vent to be free draining mesh; made from polyethylene strands, full height and width of head joint and depth 1/8 inch less than depth of outer wythe; in color selected from the manufacturer's standard, color to match the mortar.

E. Cavity drainage material to be a free draining mesh, made from polymer strands that will not degrade within the wall cavity.

1. Provide one (1) of the following configurations:

a. Strips, full depth of cavity and 10 inches high, with dovetail shaped notches 7 inches deep that prevent clogging with mortar droppings.

2.11 Masonry Cell Fill

A. Lightweight aggregate fill to meet ASTM C 331/C 331M.

2.12 Mortar and Grout Mixes

A. Do not use admixtures, including pigments, air entraining agents, accelerators, retarders, water repellent agents, antifreeze compounds or other admixtures unless otherwise indicated.

1. Do not use calcium chloride in mortar or grout.

2. Use Portland cement lime mortar unless otherwise indicated.

3. For exterior masonry, use Portland cement lime mortar.

4. For reinforced masonry, use Portland cement lime mortar.

5. Add cold weather admixture (if used) at same rate for all mortar that will be exposed to view, regardless of weather conditions, to ensure that mortar color is consistent.

6. All mortar shall be mixed from Portland cement, lime, sand and potable water only. No masonry cement or mortar cement products will be accepted for concrete masonry unit construction.

B. Furnish dry mortar ingredients in form of a pre-blended mix. Measure quantities by weight to ensure accurate proportions and thoroughly blend ingredients before delivering to Project site.

C. Mortar for unit masonry to meet ASTM C 270, proportion specification. Provide the following types of mortar for applications stated unless another type is indicated:

1. For masonry below grade or in contact with earth use Type M.
2. For reinforced masonry use Type S.
3. For mortar parge coats use Type S.
4. For exterior, above grade, load bearing and non-load bearing walls and parapet walls; for interior load bearing walls; for interior non-load bearing partitions; and for other applications where another type is not indicated use Type N.
5. For interior non-load bearing partitions Type O may be used instead of Type N.

D. Use colored cement product or select and proportion pigments with other ingredients to produce color required for pigmented mortar. Do not add pigments to colored cement products.

1. Pigments may be added to mortar to obtain colored mortars, provided that they are produced specifically for use in mortar mixes and they can be demonstrated to have been successfully employed for this purpose. All colored mortars must be pre-approved by SEPTA.
2. Pigments shall not exceed 10 percent of Portland cement by weight.
3. Pigments shall not exceed 5 percent of masonry cement or mortar cement by weight.
4. Mix to match the Contractor's sample.
5. Use pigmented mortar for exposed mortar joints as indicated on the Contract Drawings.
    a. Pigmented mortar to be used with CMU block and brick visible to public.

E. Produce required mortar color by using colored aggregate mortar and natural color or white cement as necessary to produce required mortar color.

1. Mix to match the Contractor's sample.
2. Use colored aggregate mortar for exposed mortar joints as indicated on the Contract Drawings.

F. Grout for unit masonry to meet ASTM C 476.

1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that meet TMS 602 for dimensions of grout spaces and pour height.
2. Proportion grout in accordance with ASTM C 476, with a minimum compressive strength of 3000 psi and installed in accordance with TM 402 for high or low lift procedures.

2.13 Masonry Cleaners

A. The manufacturer's proprietary acidic standard strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by the cleaner manufacturer and the manufacturer of masonry units being cleaned.

B. Refer to Section 04011 for cleaning of existing unit masonry.

PART 3 - EXECUTION

3.01 Examination

A. Examine conditions, with installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

1. For the record, prepare written report, endorsed by installer, listing conditions detrimental to performance of the work.
2. Verify that foundations are within tolerances specified.
3. Verify that reinforcing dowels are properly placed.
4. Verify that substrates are free of substances that impair mortar bond.

B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Installation

A. Build cavity and composite walls and other masonry construction to full thickness shown. Build single wythe walls to actual widths of masonry units, using units of widths indicated.

B. Build chases and recesses to accommodate items specified in this and other Sections.

C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match construction immediately adjacent to opening.

D. Use full size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.

E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures. Mix units from several pallets or cubes as they are placed.

F. Match coursing, bonding, color and texture of existing masonry.

G. Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

3.03 Tolerances

A. Dimensions and Locations of Elements:

1. For dimensions in cross section or elevation, do not vary by more than plus 1/2 inch or minus 1/4 inch.
2. For location of elements in plan, do not vary from that indicated by more than plus or minus 1/2 inch.
3. For location of elements in elevation, do not vary from that indicated by more than plus or minus 1/4 inch in a story height or 1/2 inch total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls, do not vary from level by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
3. For vertical lines and surfaces, do not vary from plumb by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
5. For lines and surfaces, do not vary from straight by more than 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch maximum.
6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet or 1/2 inch maximum.
7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch.
2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.
3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch or minus 1/4 inch.
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed joint and head joint thicknesses by more than 1/8 inch.
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one (1) masonry unit to the next.

3.04 Laying Masonry Walls

A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement type joints, returns and offsets. Avoid using less than half size units, particularly at corners, jambs, and, where possible, at other locations.

B. Coursing shall be coordinated with windows and door heads so that fractions of courses are avoided at openings.

C. Unless otherwise indicated, lay exposed masonry in running bond do not use units with less than nominal 4 inch horizontal face dimensions at corners or jambs.

D. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4 inches. Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4 inch horizontal face dimensions at corners or jambs.

E. Stop work by stepping back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.

F. As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.

G. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.

H. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh or plastic mesh in the joint below, and rod mortar or grout into core.

I. Fill cores in hollow CMUs with grout 24 inches under bearing plates, beams, lintels, posts and similar items unless otherwise indicated.

J. Build non-load bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.

1. Install compressible filler in joint between top of partition and underside of structure above.

2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2 inch clearance between end of anchor rod and end of tube. Space anchors 48 inches on center unless otherwise indicated.

3. Wedge non-load bearing partitions against structure above with small pieces of tile, slate or metal. Fill joint with mortar after dead-load deflection of structure above approaches final position.

3.05 Mortar Bedding and Joints

A. Lay CMUs as follows:

1. Bed face shells in mortar and make head joints of depth equal to bed joints.

2. Bed webs in mortar in all courses of piers, columns and pilasters.

3. Bed webs in mortar in grouted masonry, including starting course on footings.

4. Fully bed entire units, including areas under cells, at starting course on footings where cells are not grouted.
5. Fully bed units and fill cells with mortar at anchors and ties as needed to fully embed anchors and ties in mortar.

B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.

C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.

D. Cut joints flush for masonry walls to receive plaster or other direct applied finishes (other than paint) unless otherwise indicated.

E. Cut joints flush where indicated to receive waterproofing unless otherwise indicated.

3.06 Cavity Walls

A. Cavity walls shall be designed so that all components including the air space, air/vapor barrier, flashing, cavity drainage mat, weeps, and vents and all other elements work in an integrated fashion to allow free drainage of water through the cavity, out of the weeps and away from the structure as well as allowing the movement of air through weeps and vents to allow drying of the cavity. Locate weeps in conjunction with through wall flashing at lintels, sills, relieving angles and a minimum of 8 inches above finish grade at the bottom of the wall; vents should be positioned near the top of the cavity wall, above the highest flashing/weep location.

B. Bond wythes of cavity walls together using one (1) of the following methods:

1. Provide individual metal ties as shown installed in horizontal joints, but not less than one (1) metal tie for 2.67 square feet of wall area spaced not to exceed 16 inches on center horizontally and 16 inches on center vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 24 inches on center vertically.
    a. Where bed joints of wythes do not align, use adjustable type (two (2) piece type) ties.
    b. Where one (1) wythe is of clay masonry and the other of concrete masonry, use adjustable type (two (2) piece type) ties to allow for differential movement regardless of whether bed joints align.
2. Install masonry joint reinforcement in horizontal mortar joints.
    a. Where bed joints of both wythes align, use ladder type reinforcement extending across both wythes.
    b. Where bed joints of wythes do not align, use adjustable type (two (2) piece type) reinforcement with continuous horizontal wire in facing wythe attached to ties.
    c. Where one (1) wythe is of clay masonry and the other of concrete masonry, use adjustable type (two (2) piece type) reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
3. Provide masonry unit headers extending not less than 3 inches into each wythe. Space headers not more than 8 inches clear horizontally and 16 inches clear vertically.

C. Bond wythes of cavity walls together using bonding system indicated on the Contract Drawings.

D. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

E. Parge cavity face of backup wythe in a single coat approximately 3/8 inch thick. Trowel face of parge coat smooth.

3.07 Masonry Cell Fill

A. Pour lightweight aggregate fill into cavities to fill void spaces. Maintain inspection ports to show presence of fill at extremities of each pour area. Close the ports after filling has been confirmed. Limit the fall of fill to one (1) story high, but not more than 20 feet.

3.08 Masonry Joint Reinforcement

A. Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch on exterior side of walls, 1/2 inch elsewhere. Lap reinforcement a minimum of 6 inches.

1. Space reinforcement not more than 16 inches on center.
2. Space reinforcement not more than 8 inches on center in foundation walls and parapet walls.
3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.

B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.

C. Provide continuity at wall intersections by using prefabricated T- and L-shaped units.

D. Provide continuity at corners by using prefabricated L-shaped units.

E. Cut and bend reinforcing units as directed by the manufacturer for continuity at corners, returns, offsets, column fireproofing, pipe enclosures and other special conditions.

F. All structural reinforcement shall meet ASTM A 615/A 615M grade 60.

3.09 Anchoring Masonry to Structural Steel and Concrete

A. Anchor masonry to structural steel and concrete, where masonry abuts or faces structural steel or concrete, to meet the following:

1. Provide an open space not less than 1/2 inch wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
3. Space anchors as indicated, but not more than 24 inches on center vertically and 36 inches on center horizontally.

3.10 Control and Expansion Joints

A. Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.

B. Form control joints in concrete masonry using one (1) of the following methods:

1. Fit bond breaker strips into hollow contour in ends of CMUs on one (1) side of control joint. Fill resultant core with grout and rake out joints in exposed faces for application of sealant.

2. Install preformed control joint gaskets designed to fit standard sash block.

3. Install interlocking units designed for control joints. Install bond breaker strips at joint. Keep head joints free and clear of mortar or rake out joint for application of sealant.

4. Install temporary foam plastic filler in head joints and remove filler when unit masonry is complete for application of sealant.

C. Form expansion joints in brick as follows:

1. Build flanges of metal expansion strips into masonry. Lap each joint 4 inches in direction of water flow. Seal joints below grade and at junctures with horizontal expansion joints if any.

2. Build flanges of factory fabricated, expansion joint units into masonry.

3. Build in compressible joint fillers where indicated.

4. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Section 07900.

D. Provide horizontal, pressure relieving joints by either leaving an airspace or inserting a compressible filler of width required for installing sealant and backer rod specified in Section 07900, but not less than 3/8 inch.

1. Locate horizontal, pressure-relieving joints beneath shelf angles supporting masonry.

3.11 Lintels

A. Install steel lintels where indicated.

B. Provide minimum bearing of 8 inches at each jamb unless otherwise indicated.

3.12 Flashing, Weep Holes and Cavity Vents

A. Placement of reinforcement, veneer anchors, flashing and similar items to be built into masonry systems are to be coordinated by the system installers.

B. Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall and where indicated. Install cavity vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.

C. Install flashing as follows unless otherwise indicated:

1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant or tape as recommended by the flashing manufacturer.
2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches, and through inner wythe to within 1/2 inch of the interior face of wall in exposed masonry. Where interior face of wall is to receive furring or framing, carry flashing completely through inner wythe and turn flashing up approximately 2 inches on interior face.
3. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 8 inches and 1 1/2 inches into the inner wythe. Form 1/4 inch hook in edge of flashing embedded in inner wythe.
4. At masonry veneer walls, extend flashing through veneer, across airspace behind veneer, and up face of sheathing at least 8 inches with upper edge tucked under water resistive barrier and air barrier, lapping at least 4 inches. Fasten upper edge of flexible flashing to sheathing through termination bar
5. At lintels and shelf angles, extend flashing a minimum of 6 inches into masonry at each end. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
6. Interlock end joints of ribbed sheet metal flashing by overlapping ribs not less than 1 1/2 inches or as recommended by the flashing manufacturer, and seal lap with elastomeric sealant meeting the requirements in Section 07900 for application indicated.
7. Install metal drip edges and sealant stops with ribbed sheet metal flashing by interlocking hemmed edges to form hooked seam. Seal seam with elastomeric sealant meeting the requirements in Section 07900 for application indicated.
8. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal drip edge.
9. Install metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch back from outside face of wall and adhere flexible flashing to top of metal flashing termination.
10. Cut flexible flashing off flush with face of wall after masonry wall construction is completed.

D. Install single wythe CMU flashing system in bed joints of CMU walls where indicated to meet the manufacturer's written instructions. Install CMU cell pans with upturned edges located below face shells and webs of CMUs above and with weep spouts aligned with face of wall. Install CMU web covers so that they cover upturned edges of CMU cell pans at CMU webs and extend from face shell to face shell.

E. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.

F. Install weep holes in exterior wythes and veneers in head joints of first course of masonry immediately above embedded flashing.

1. Use specified weep/cavity vent products to form weep holes.
2. Use wicking material to form weep holes above flashing under brick sills. Turn wicking down at lip of sill to be as inconspicuous as possible.
3. Space weep holes formed from plastic tubing or wicking material 16 inches on center.
4. Cover cavity side of weep holes with plastic insect screening at cavities insulated with loose fill insulation.
5. Trim wicking material flush with outside face of wall after mortar has set.

G. Place pea gravel in cavities as soon as practical to a height equal to height of first course above top of flashing, but not less than 2 inches, to maintain drainage.

1. Fill cavities full height by placing pea gravel in cavities as masonry is laid, so that at any point, masonry does not extend more than 24 inches above top of pea gravel.

H. Place cavity drainage material in airspace behind veneers to meet the configuration requirements for cavity drainage material in Article 2.10 in the Section.

I. Install cavity vents in head joints in exterior wythes at spacing indicated. Use specified weep/cavity vent products to form cavity vents.

1. Close cavities off vertically and horizontally with blocking in manner indicated. Install through wall flashing and weep holes above horizontal blocking.

3.13 Reinforced Unit Masonry Installation

A. Construct temporary formwork and shores as needed to support reinforced masonry elements during construction.

1. Construct formwork to provide shape, line and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie and support forms to maintain position and shape during construction and curing of reinforced masonry.
2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and that of other loads that may be placed on them during construction.

B. Meet the requirements in TMS 602 for placing reinforcement.

C. Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.

1. Meet the requirements in TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

3.14 Field Quality Control

A. Engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas as needed to perform tests and inspections.

Retesting of materials that fail to meet the specified requirements shall be done at the Contractor's expense.

B. Special inspections according to Level B in TMS 402.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.

2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes and locations of reinforcement.

3. Place grout only after inspectors have verified proportions of site prepared grout.

a. One (1) set of tests to be conducted prior to construction.

b. One (1) set of tests for each 5000 square feet of wall area or portion thereof.

C. Test each type of concrete masonry unit provided according to ASTM C 140/C 140M for compressive strength.

D. For each mix provided, test mortar aggregate ratio test (proportion specification) according to ASTM C 780.

E. For each mix provided, test according to ASTM C 780. Test mortar (property specification) for mortar air content and compressive strength.

F. For each mix provided, test grout (compressive strength) according to ASTM C 1019.

G. For each type of construction provided, prism test according to ASTM C 1314 at seven (7) days and at twenty-eight (28) days.

3.15 Parging

A. Parge exterior faces of below grade masonry walls, where indicated, in two (2) uniform coats to a total thickness of 3/4 inch. Dampen wall before applying first coat and scarify first coat to ensure full bond to subsequent coat.

B. Use a steel trowel finish to produce a smooth, flat, dense surface with a maximum surface variation of 1/8 inch per foot. Form a wash at top of parging and a cove at bottom.

C. Damp cure parging for at least twenty-four (24) hours and protect parging until cured.

3.16 Repairing, Pointing and Cleaning

A. Remove and replace masonry units that are loose, chipped, broken, stained or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.

B. During the tooling of joints, enlarge voids and holes, except weep holes and completely fill with mortar. Point up joints, including corners, openings and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.

C. Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.

D. After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.

2. Test cleaning methods on sample wall panel; leave one-half of panel un-cleaned for comparison purposes. Obtain SEPTA's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent stone and non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
6. Clean concrete masonry by applicable cleaning methods indicated in NCMA TEK 8-4A.

3.17 Masonry Waste Disposal

A. Unless otherwise indicated, excess masonry materials are the Contractor's property. At completion of unit masonry work, remove from Project site.

END OF SECTION

SECTION 04212

TERRA COTTA MASONRY

PART 1 - GENERAL

1.01 Description

A. Section includes work consisting of repairing terra cotta masonry as follows:

1. Repairing unit masonry, including replacing units.
2. Removing abandoned anchors.
3. Painting steel uncovered during the work.
4. Re-anchoring veneers.

1.02 Related Sections

A. Section 04012 – Brick Masonry Repair

1.03 Submittals

A. Submit product data for each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include recommendations for product application and use. Include test data substantiating that products meet the requirements.

B. Submit shop drawings:

1. Include plans, elevations, sections and locations of masonry repair work on the structure.
2. Show full size patterns with complete dimensions for new terra cotta units and their jointing, showing relationship of existing units to new units.
3. Indicate setting number of each new terra cotta unit and its location on the structure in annotated plans and elevations.
4. Show provisions for expansion joints or other sealant joints.
5. Show provisions for flashing, lighting fixtures, conduits and weep holes as required.
6. Show replacement and repair anchors. Include details of anchors within individual terra cotta units, with locations of anchors and dimensions of holes and recesses in units required for anchors.
7. Show locations of scaffolding and points of scaffolding in contact with masonry. Include details of each point of contact or anchorage.

C. Submit samples for initial selection for the following:

1. Submit sets of colored mortar that will be left exposed in the form of sample mortar strips, 6 inches long by 1/4 inch wide, set in aluminum or plastic channels.

a. Have each set contain a close color range of at least three (3) samples of different mixes of colored sands and cements that produce a mortar matching the existing, cleaned mortar when cured and dry.
b. Submit with precise measurements on ingredients, proportions, gradations and sources of colored sands from which each sample was made.

2. Sand Types Used for Mortar:
   a. Minimum 8 oz. of each in plastic screw top jars.
   b. For blended sands, provide samples of each component and blend. Identify blend ratio.
   c. Identify sources, both supplier and quarry, of each type of sand.
3. Submit sets of patching compound samples in the form of plugs (patches in drilled holes) in sample units of masonry representative of the range of masonry colors on the building.
   a. Have each set contain a close color range of at least three (3) samples of different mixes of patching compound that match the variations in existing masonry when cured and dry.
4. Submit sets of terra cotta glaze replacement samples applied to terra cotta shingle, with glaze colors representative of the range of glaze colors on the building.
   a. Have each set contain a close color range of at least three (3) samples of different formulas that match the variations in existing terra cotta glazes.
5. Include similar samples of accessories involving color selection.

D. Submit samples for verification for the following:
   1. Each type of terra cotta composition and color to be used for replacing existing units. Include sets of samples to show the full range of color and texture to be expected.
      a. Before manufacturing terra cotta units, submit the actual patterns from which molds will be made for casting new units. Package and ship to prevent loss or damage, or make patterns available for inspection by SEPTA at fabrication plant.
      b. Provide one (1) of each shape, color, and texture of unit, suitable and ready for installation. Submit unit samples after acceptance of patterns for terra cotta.
   2. Each type of patching compound in the form of briquettes, at least 3 inches long by 1 1/2 inches wide. Document each sample with the manufacturer and stock number or other information necessary to order additional material.
   3. Each color of terra cotta glaze replacement applied to briquettes, at least 3 inches long by 1 1/2 inches wide. Document each sample with the manufacturer and stock number or other information necessary to order additional material.
   4. Each type of anchor, accessory and miscellaneous support.

E. Submit qualification data for terra cotta masonry specialists including field supervisors and workers, terra cotta manufacturer and testing service.

F. Submit preconstruction test reports for existing terra cotta units and mortar and replacement terra cotta units.

G. Submit quality control program.

H. Submit terra cotta historic treatment program.

1.04 Quality Assurance

A. Engage a qualified terra cotta repair specialist. Experience installing standard unit masonry is insufficient experience for masonry terra cotta work.

1. When terra cotta units are being patched, assign at least one (1) worker per crew who is trained and certified by the manufacturer of patching compound to apply its products.

B. Engage a firm regularly engaged in manufacturing custom architectural terra cotta units for building restoration purposes, of same type and of similar size, complexity and tolerances as those required for the work.

C. Prepare a written quality control program for this Contract to systematically demonstrate the ability of personnel to properly follow methods and use materials and tools without damaging masonry. Include provisions for supervising worker performance and preventing damage.

D. Prepare a written terra cotta restoration program, detailed description of materials, methods, equipment, and sequence of operations to be used for each stage of historic treatment work, including protection of surrounding materials and Project site.

1. Include methods for keeping exposed mortar damp during curing period.

2. If materials and methods other than those indicated are proposed for any stage of restoration work, add to the quality control program a written description of such materials and methods, including evidence of successful use on comparable Projects, and demonstrations to show their effectiveness for this Contract.

E. Prepare mockups to demonstrate aesthetic effects and to set quality standards for materials and execution and for fabrication and installation.

1. Prepare sample areas for each type of terra cotta material and assembly indicated to have repair work performed. If not otherwise indicated, size each mockup not smaller than two (2) adjacent whole units or approximately 48 inches in least dimension. Construct sample areas in locations in existing walls where directed by SEPTA unless otherwise indicated. Demonstrate quality of materials, workmanship and blending with existing work. Include the following as a minimum:

a. Four (4) terra cotta units replaced.

b. Install three (3) masonry repair anchors in mockup wall assembly of each anchor type required.

c. Three (3) small holes at least 1 inch in diameter for each type of terra cotta material indicated to be patched, so as to leave no evidence of repair.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of substantial completion.

F. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM C 5, Standard Specification for Quicklime for Structural Purposes.

2. ASTM C 62, Standard Specification for Building Brick (Solid Masonry Units Made From Clay or Shale).
3. ASTM C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
4. ASTM C 114, Standard Test Methods for Chemical Analysis of Hydraulic Cement.
5. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
6. ASTM C 150/C 150M, Standard Specification for Portland Cement.
7. ASTM C 207, Standard Specification for Hydrated Lime for Masonry Purposes.
8. ASTM C 212, Standard Specification for Structural Clay Facing Tile.
9. ASTM C 270, Standard Specification for Mortar for Unit Masonry.
10. ASTM C 295/C 295M, Standard Guide for Petrographic Examination of Aggregates for Concrete.
11. ASTM C 979/C 979M, Standard Specification for Pigments for Integrally Colored Concrete.
12. ASTM C 1489, Standard Specification for Lime Putty for Structural Purposes.
13. MPI No. 23, Primer, Metal, Surface Tolerant.
14. 40 CFR, Subpart D (EPA Method 24), National Volatile Organic Compound Emission Standards for Architectural Coatings.
15. SSPC-SP 3, Power Tool Cleaning.

1.05 Delivery, Storage and Handling

A. Deliver terra cotta units to Project site strapped together in suitable packs or pallets or in heavy duty cartons and protected against impact and chipping.

B. Deliver each piece of terra cotta with code mark or setting number on unexposed face, corresponding to shop drawings, using non-staining paint.

C. Deliver packaged materials to Project site in the manufacturer's original and unopened containers, labeled with the manufacturer's name and type of products.

D. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

E. Store hydrated lime in the manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than two (2) days.

F. Store lime putty covered with water in sealed containers.

G. Store sand where grading and other required characteristics can be maintained and contamination avoided.

H. Handle terra cotta units to prevent overstressing, chipping, defacement and other damage.

1.06 Pre-installation Meetings

A. Conduct pre-installation conference on masonry repair and repointing at Project site.

1. Review methods and procedures related to repairing terra cotta masonry, including, but not limited to, the following:
    a. Materials, material application, sequencing, tolerances and required clearances.
    b. Quality control program.
    c. Fire protection plan.

1.07 Sequencing and Scheduling

A. Order sand and gray Portland cement for colored mortar immediately after approval of samples. Take delivery of and store at Project site a sufficient quantity to complete Contract.

B. Perform masonry work in the following sequence, which includes work specified in this and other Sections:

1. Remove plant growth.
2. Inspect masonry for open mortar joints and repair before cleaning to prevent the intrusion of water and other cleaning materials into the wall.
3. Remove paint.
4. Clean masonry.
5. Rake out mortar from joints surrounding masonry to be replaced and from joints adjacent to masonry repairs along joints.
6. Repair terra cotta masonry, including replacing existing masonry with new masonry materials. If required, repair backup masonry.
7. Rake out mortar from joints to be repointed.
8. Point mortar and sealant joints.
9. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.
10. Where water repellents are to be used on or near masonry work, delay application of these chemicals until after pointing and cleaning.

C. As scaffolding is removed, patch anchor holes used to attach scaffolding. Patch holes in terra cotta units according to Article 3.08 in this Section.

1.08 Preconstruction Testing

A. Engage a qualified testing agency to perform preconstruction testing on terra cotta units as follows:

1. Provide test specimens as indicated and representative of proposed materials and existing construction.
2. Test each proposed type of replacement masonry unit, according to sampling and testing methods in ASTM C 67 for compressive strength, twenty-four (24) hour cold water absorption, five (5) hour boil absorption, saturation coefficient and initial rate of absorption (suction).
3. Test each type of existing masonry unit indicated for replacement, according to testing methods in ASTM C 67 for compressive strength, twenty-four (24) hour cold water

absorption, five (5) hour boil absorption, saturation coefficient and initial rate of absorption (suction). Carefully remove three (3) existing units from locations designated by SEPTA. Take testing samples from these units.

4. Test existing mortar according to ASTM C 295/C 295M, modified as agreed by testing service and SEPTA for Contract requirements, to determine proportional composition of original ingredients, sizes and colors of aggregates and approximate strength. Use X-ray diffraction, infrared spectroscopy and differential thermal analysis to supplement microscopical methods. Carefully remove existing mortar from within joints at three (3) locations designated by testing service.
5. As directed by SEPTA, provide temporary materials followed by permanent repairs at locations from which existing samples were taken.

1.09 Field Conditions

A. Proceed with installation only when existing and forecasted weather conditions permit repair work to be performed according to the product manufacturers' written instructions and specified requirements.

B. Repair terra cotta units only when air temperature is between 40°F and 90°F and is predicted to remain so for at least seven (7) days after completion of the work unless otherwise indicated.

C. For manufactured repair materials, perform work within the environmental limits set by each manufacturer.

1.10 Terra Cotta Molds

A. On completion of the manufacturing of units, deliver one (1) unused mold of each shape and size of unit delivered to Project site. Deliver to a location and at a time determined by SEPTA, to become property of SEPTA.

B. Have molds delivered carefully packed; protected from dirt, moisture, and breakage; so as to arrive in usable, undamaged condition and enable long term storage and possible future use.

PART 2 - PRODUCTS

2.01 Materials

A. Obtain each type of material for repairing historic masonry (terra cotta, cement, sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties.

2.02 SEPTA Furnished Material

A. Terra cotta molds from previous repair work. Return to SEPTA after acceptance of terra cotta repair work.

2.03 Masonry Materials

A. Provide new terra cotta units to match existing terra cotta units in physical properties, color, gloss, surface texture, thickness, profile, dimensions and composition of surface glaze.

1. Provide units with tested physical properties within 10 percent of those determined from preconstruction testing of selected existing units.
2. Fabricated tolerances according to tolerance requirements in ASTM C 212, Type FTX.
3. Emboss date identification in the clay body on a concealed, interior surface of each unit in easily read 1/2 inch high characters, "MADE <Insert year>." The manufacturer's name may also be embossed.

B. Provide new, unglazed, through body colored, brownstone terra cotta units to match existing terra cotta units in physical properties, colors, color variation within units, surface texture, unit profile and dimensions.

1. Provide units with tested physical properties within 10 percent of those determined from preconstruction testing of selected existing units.
2. Fabricated tolerances according to tolerance requirements in ASTM C 212, Type FTX.
3. For existing terra cotta that exhibits a range of colors or color variation within units, provide terra cotta that proportionally matches that range and variation rather than terra cotta that matches an individual color within that range.
4. Emboss date identification in the clay body on a concealed, interior surface of each unit in easily read 1/2 inch high characters, "MADE <Insert year>." The manufacturer's name may also be embossed.

C. Building brick having same vertical dimension as existing backup brick, according to ASTM C 62, Grade SW.

2.04 Mortar Materials

A. Portland cement to meet ASTM C 150/C 150M, Type I or Type II; white, gray or both where required for color matching of mortar.

1. Provide cement containing not more than 0.60 percent total alkali when tested according to ASTM C 114.

B. Hydrated lime to meet ASTM C 207, Type S.

C. Factory prepared lime putty to meet ASTM C 1489.

D. Quicklime to meet ASTM C 5, pulverized lime.

E. Mortar sand to meet ASTM C 144 unless otherwise indicated.

1. Match size, texture and gradation of existing mortar sand as closely as possible. Blend several sands if necessary to achieve suitable match.
2. Provide natural sand, ground marble, granite, or other sound stone of color necessary to produce required mortar color.
3. For exposed mortar, provide sand with rounded edges.

F. Mortar pigments to meet ASTM C 979/C 979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.

G. Water to be potable.

2.05 Manufactured Repair Materials

A. Terra cotta patching compound to be a factory mixed cementitious product that is custom manufactured for patching terra cotta masonry.

1. Use formulation that is vapor and water permeable (equal to or more than the masonry unit), exhibits low shrinkage, has lower modulus of elasticity than the terra cotta units being repaired, and develops high bond strength to all types of masonry.

2. Use formulation having working qualities and retardation control to permit forming and sculpturing where necessary.

3. Formulate patching compound used for patching terra cotta in colors and textures to match each unit being patched. Provide no fewer than three (3) colors to enable matching the color, texture and variation of each unit.

B. A high solids, non-yellowing, fade resistant, waterborne acrylic latex, polyurethane, or epoxy coating intended for exterior use as terra cotta glaze replacement. Product shall be custom mixed by the manufacturer to match color and gloss of existing terra cotta glaze.

2.06 Accessory Materials

A. Terra cotta anchors to be type and size indicated or, if not indicated, to match existing, formed metal anchors in size and type. Fabricate anchors from Type 316 stainless steel.

B. Masonry repair anchors, expansion type, to be mechanical fasteners designed for masonry veneer stabilization consisting of 1/4 inch diameter, Type 316 stainless steel rod with brass expanding shells at each end and water shedding washer in the middle. Expanding shells shall be designed to provide positive mechanical anchorage to veneer on one (1) end and backup masonry on the other.

C. Masonry repair anchors, spiral type to be driven-in, Type 316 stainless steel spiral rods designed to be installed in drilled holes and relying on screw effect rather than adhesive to secure them to backup and veneer. Anchors are flexible in plane of veneer but rigid perpendicular to it.

D. Masonry repair anchors, rod/screen tube type to be Type 316 stainless steel screen tube, with Type 316 stainless steel rod, adhesive installed by injection with the manufacturer's standard epoxy adhesive, and complete with other devices required for installation.

E. Masonry repair anchors, expanding grout sleeve type to be fabric sleeve system with Type 316 stainless steel tube through which the system manufacturer's grout is pumped to expand the sleeve, fill cavities within wall, and bond mechanically and chemically with interior of wall construction; and complete with other devices required for installation.

F. Setting buttons and shims to be resilient plastic, non-staining to masonry, sized to suit joint thicknesses and bed depths of terra cotta units, less the required depth of pointing materials unless removed before pointing.

G. Masking tape to be non-staining, nonabsorbent material; compatible with mortar, joint primers, sealants, and surfaces adjacent to joints; and that easily comes off entirely, including adhesive.

H. Antirust coating to be fast curing, lead and chromate free, self-curing, universal modified alkyd primer according to MPI No. 23 (surface tolerant, anticorrosive metal primer).

1. Use coating requiring no better than SSPC-SP 3 surface preparation according to the manufacturer's literature or certified statement.

2. Use coating with a VOC content of 3.3 pounds/gallon or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

I. Select other materials and methods of use based on the following, subject to approval of a mockup:

1. Previous effectiveness in performing the work involved.

2. Minimal possibility of damaging exposed surfaces.

3. Consistency of each application.

4. Uniformity of the resulting overall appearance.

5. Do not use products or tools that could do the following:

a. Remove, alter, or harm the present condition or future preservation of existing surfaces, including surrounding surfaces not in Contract.

b. Leave residue on surfaces.

2.07 Mortar Mixes

A. Slake quicklime and prepare lime putty according to appendix to ASTM C 5 and the manufacturer's written instructions.

B. Measure cementitious materials and sand in a dry condition by volume or equivalent weight. Do not measure by shovel; use known measure. Mix materials in a clean, mechanical batch mixer.

C. Produce mortar of color required by using specified ingredients. Do not alter specified proportions without SEPTA's approval.

1. Where mortar pigments are indicated, do not add pigment exceeding 10 percent by weight of the cementitious or binder materials, except for carbon black, which is limited to 2 percent, unless otherwise demonstrated by a satisfactory history of performance.

D. Do not use admixtures in mortar unless otherwise indicated.

E. Mix mortar materials in the following proportions:

1. Rebuilding (setting) mortar by property to meet ASTM C 270, property specification, Type N unless otherwise indicated; with cementitious material limited to Portland cement and lime. Hardness and texture shall match existing mortar with tested physical properties within 10 percent of those determined from preconstruction testing of selected specimens.

2. Add mortar pigments to produce exposed, rebuilding (setting) mortar of colors required.

PART 3 - EXECUTION

3.01 Protection

A. Prevent mortar from staining face of surrounding masonry and other surfaces.

1. Cover sills, ledges and other projecting items to protect them from mortar droppings.
2. Keep wall area wet below rebuilding and pointing work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed masonry and other surfaces.

B. Remove gutters and downspouts and associated hardware adjacent to immediate work area, and store during masonry repair work. Reinstall when repairs are complete.

1. Provide temporary rain drainage during work to direct water away from building.

3.02 Masonry

A. Repaired surfaces are to have a uniform appearance as viewed from 20 feet away by SEPTA.

3.03 Abandoned Anchor Removal

A. Remove abandoned anchors, brackets, wood nailers and other extraneous items no longer in use unless indicated to remain.

1. Remove items carefully to avoid spalling or cracking masonry.
2. Notify SEPTA before proceeding if an item cannot be removed without damaging surrounding masonry. Do the following where directed:
   a. Cut or grind off item approximately 3/4 inch beneath surface, and core drill a recess of same depth in surrounding masonry as close around item as practicable.
   b. Immediately paint exposed end of item with two (2) coats of antirust coating, following the coating manufacturer's written instructions and without exceeding the manufacturer's recommended dry film thickness per coat. Keep paint off sides of recess.
3. Patch the hole where each item was removed unless directed to remove and replace the masonry unit.

3.04 Terra Cotta Removal and Replacement

A. At locations indicated, remove terra cotta units that are damaged, spalled or deteriorated. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full size units.

B. Support and protect remaining masonry that was supported by removed units.

C. Maintain flashing, reinforcement, lintels and adjoining construction in an undamaged condition. Coordinate with new flashing, reinforcement, and lintels, which are specified in other Sections.

D. Notify SEPTA of unforeseen detrimental conditions, including voids, cracks, bulges, loose units in existing masonry backup, rotted wood, rusted metal and other deteriorated items.

E. Clean masonry surrounding removal areas by removing mortar, dust and loose particles in preparation for terra cotta replacement.

F. Install replacement units into bonding and coursing pattern of existing units.

1. Do not cut or grind glazed terra cotta.

2. If minor cutting of replacement brownstone terra cotta is required, use a motor driven grinder or saw designed to cut masonry with clean, sharp, unchipped edges. Do not cut or grind more than 1/8 inch along any edge.

3. Maintain joint width for replacement units to match existing joints.

4. Use setting buttons or shims to set units accurately spaced with uniform joints.

G. Set replacement units in a full bed of rebuilding (setting) mortar. Replace existing, formed metal anchors with new terra cotta anchors matching existing configuration.

1. Embed anchors in mortar and fill voids behind units with mortar.

2. Tool exposed mortar joints in repaired areas to match joints of surrounding existing terra cotta.

3. Rake out mortar used for setting terra cotta before mortar sets. Point at same time as repointing of surrounding area.

4. When mortar is sufficiently hard to support units, remove shims and other devices interfering with pointing of joints.

H. Cure mortar by maintaining in thoroughly damp condition for at least seventy-two (72) consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.05 Backup Masonry Removal and Replacement

A. Where backup masonry is fractured or unstable and at locations indicated, remove mortar and masonry units that are broken or deteriorated and rebuild with whole, new brick or whole salvaged units. Carefully remove entire units from joint to joint, without damaging surrounding masonry, in a manner that permits replacement with full size units.

B. Perform backup masonry removal and replacement according to requirements in Section 04012.

C. Support and protect remaining masonry that surrounds removal area.

D. Maintain flashing, reinforcement, anchors, lintels and adjoining construction in an undamaged condition. Coordinate with new flashing, reinforcement, and lintels, which are specified in other Sections.

E. Notify SEPTA of unforeseen detrimental conditions, including voids, cracks, bulges, loose units beyond the removal area, rotted wood, rusted metal and other deteriorated items.

F. Remove in an undamaged condition as many whole bricks as possible.

1. Remove mortar, loose particles and soil from brick by cleaning with hand chisels, brushes and water.

2. Remove sealants by cutting close to brick with utility knife and cleaning with solvents.
3. Store brick for reuse. Store off ground, on skids, and protected from weather.
4. Deliver cleaned brick not required for reuse to SEPTA unless otherwise indicated.

G. Clean masonry surrounding removal areas by removing mortar, dust and loose particles in preparation for brick replacement.

H. Replace removed damaged brick with salvaged backup brick in good condition, where possible, or with new building brick matching existing backup brick. Do not use broken units unless they can be cut to usable size.

I. Install replacement brick into bonding and coursing pattern of existing brick. If cutting is required, use a motor driven saw designed to cut masonry with clean, sharp, unchipped edges.

J. Lay replacement brick with rebuilding (setting) mortar and with completely filled bed, head and collar joints. Butter ends with sufficient mortar to fill head joints and shove into place. Wet both replacement and surrounding bricks that have ASTM C 67 initial rates of absorption (suction) of more than 30 g/30 sq. in. per min. Use wetting methods that ensure that units are nearly saturated but surface is dry when laid.

K. Cure mortar by maintaining in thoroughly damp condition for at least seventy-two (72) consecutive hours, including weekends and holidays.

1. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Completely remove such mortar and repoint.

3.06 Re-anchoring Veneers

A. Install masonry repair anchors in horizontal mortar joints and according to the manufacturer's written instructions. Space anchors not more than 16 inches on center vertically and 24 inches on center horizontally apart unless otherwise indicated. Install at locations to avoid penetrating flashing.

B. Recess anchors 5/8 inch or more from surface of mortar joint and fill recess with pointing mortar.

3.07 Painting Steel Uncovered during the Work

A. Notify SEPTA if steel is exposed during masonry removal. Where SEPTA determines that steel is structural, or for other reasons cannot be totally removed, prepare and paint it as follows:

1. Remove paint, rust and other contaminants according to SSPC-SP 3 as applicable to meet the paint manufacturer's recommended preparation.
2. Immediately paint exposed steel with two (2) coats of antirust coating, following the coating manufacturer's written instructions and without exceeding the manufacturer's recommended rate of application (dry film thickness per coat).

B. If on inspection and rust removal, the thickness of a steel member is found to be reduced from rust by more than 1/16 inch, notify SEPTA before proceeding.

3.08 Terra Cotta Patching

A. Patch the following terra cotta units unless another type of repair or replacement is indicated:

1. Units indicated to be patched.
2. Units with holes.
3. Units with chipped edges or corners. Patch chipped edges or corners measuring more than 3/4 inch in least dimension.
4. Units with small areas of deep deterioration. Patch deep deteriorations measuring more than 3/4 inch in least dimension and more than 1/4 inch deep.

B. Remove and replace existing patches unless otherwise indicated or approved by SEPTA.

C. Patching Terra Cotta:

1. Remove deteriorated material as determined by sounding gently with a small hammer. Carefully remove additional material so patch does not have feathered edges but has square or slightly undercut edges on area to be patched and is at least 1/4 inch thick, but not less than recommended in writing by the patching compound manufacturer.
2. Mask adjacent mortar joint or rake out for repointing if patch extends to edge of unit.
3. Mix patching compound in individual batches to match each unit being patched. Combine one (1) or more colors of patching compound, as needed, to produce exact match.
4. Rinse surface to be patched and leave damp, but without standing water.
5. Brush coat surfaces with slurry coat of patching compound according to the manufacturer's written instructions.
6. Place patching compound in layers as recommended in writing by the patching compound manufacturer, but not less than 1/4 inch or more than 2 inches thick. Roughen surface of each layer to provide a key for next layer.
7. Do not apply patching compound over mortar joints. If patching compound bridges mortar joints, cut out joints after patching compound hardens.
8. Trowel, scrape, or carve surface of patch to match texture, details, and surrounding surface plane or contour of terra cotta. Shape and finish surface before or after curing, as determined by testing, to best match existing terra cotta.
9. Keep each layer damp for seventy-two (72) hours or until patching compound has set.
10. After final layer of patching compound has cured, apply terra cotta glaze replacement according to the manufacturer's written instructions. Apply two (2) or more coats, as needed, to match glaze of adjacent terra cotta units.

3.09 Terra Cotta Glaze Repair

A. Repair the glaze on the following terra cotta units that are otherwise sound unless another type of repair or replacement is indicated:

1. Units indicated to have glaze repaired.

2. Units with abraded or chipped glaze.
3. Units with spots or areas of shallow deterioration greater than glaze thickness and less up to 1/16 inch deep.

B. Remove and replace discolored or mismatched glaze repairs unless otherwise indicated or approved by SEPTA.

C. After other repairs have cured, apply terra cotta glaze replacement according to the manufacturer's written instructions. Apply two (2) or more coats, as needed, to match glaze of adjacent terra cotta units. Do not apply glaze to joint surfaces between units or within joints that will be mortared or sealed.

3.10 Final Cleaning

A. After mortar has fully hardened, thoroughly clean exposed masonry surfaces of excess mortar and foreign matter; use wood scrapers, stiff nylon or fiber brushes, and clean water, applied by low pressure spray.

1. Do not use metal scrapers or brushes.
2. Do not use acidic or alkaline cleaners.

B. Clean adjacent non-masonry surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from roof; remove debris from gutters and downspouts. Rinse off roof and flush gutters and downspouts.

D. Remove masking materials, leaving no residues that could trap dirt.

3.11 Field Quality Control

A. The Contractor will engage qualified independent testing agencies to perform tests and inspections. Allow inspectors use of lift devices and scaffolding, as needed, to perform inspections.

B. Allow SEPTA use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the work completed.

C. Notify SEPTA in advance of times when lift devices and scaffolding will be relocated. Do not relocate lift devices and scaffolding until inspectors and SEPTA have had reasonable opportunity to make inspections and observations of work areas at lift device or scaffold location.

3.12 Terra Cotta Waste Disposal

A. Unless otherwise indicated, excess terra cotta materials are the Contractor's property.

B. Remove terra cotta waste and legally dispose of off SEPTA's property.

END OF SECTION

SECTION 04270

GLASS UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.01 Description

A. This Section includes glass block set in mortar.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 05500 - Metal Fabrications

C. Section 07900 - Joint Sealers

1.03 Submittals

A. Submit product data for each type of product indicated. Include glass block, cementitious materials, waterproofing admixtures for mortar and accessories.

B. Submit shop drawings showing fabrication and installation details for glass unit masonry, including vertical and horizontal coursing, anchors, reinforcement and expansion strips.

C. Submit sample glass block units and joint materials involving color selection.

1.04 Quality Assurance

A. Obtain glass block through one (1) source from a single manufacturer.

B. Obtain each cementitious material, admixture and accessory component through one (1) source from a single manufacturer.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
3. ASTM A 563, Standard Specification for Carbon and Alloy Steel Nuts.
4. ASTM A 951/A 951M, Standard Specification for Steel Wire and Masonry Joint Reinforcement.
5. ASTM B 633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
6. ASTM C 144, Standard Specification for Aggregate for Masonry Mortar.
7. ASTM C 150/C 150M, Standard Specification for Portland Cement.
8. ASTM C 207, Standard Specification for Hydrated Lime for Masonry Purposes.

9. ASTM C 270, Standard Specification for Mortar for Unit Masonry.
10. ASTM D 1187/D 1187M, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
11. ASTM D 1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
12. ASTM F 593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
13. ASTM F 594, Standard Specification for Stainless Steel Nuts.

1.05 Delivery, Storage and Handling

A. Store glass block in unopened cartons on elevated platforms, under cover and in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store glass block grid materials in unopened cartons in an enclosed, dry location.

C. Store cementitious materials on elevated platforms, under cover and in a dry location. Do not use cementitious materials that have become damp.

D. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

E. Store accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.

1.06 Project Conditions

A. Proceed with installation of glass unit masonry assemblies only when ambient and material temperatures are 40°F or higher.

B. Maintain temperature in installation areas at 40°F or above for forty-eight (48) hours after installing.

1.07 Sequencing and Scheduling

A. Sequence and coordinate completion of glass unit masonry assemblies so sealants can be installed immediately after mortar has attained final set.

PART 2 - PRODUCTS

2.01 Glass Block

A. Solid Glass Block:

1. Colorless, transparent, solid glass blocks with smooth faces and the manufacturer's standard edge coating.
2. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
    a. Vistabrik Solid Glass Block by Pittsburgh Corning Corporation.
    b. Circle Redmont.
    c. Weck Glass Blocks by Glashaus, Inc.

d. Or Approved Equal.

3. Solid glass block to be 7 3/4 inches square by 3 inches thick, actual size.

2.02 Mortar Materials

A. Portland cement lime mix to be packaged blend of Portland cement meeting ASTM C 150/C 150M, Type I or Type III, and hydrated lime meeting ASTM C 207, Type S.

B. Aggregate to meet ASTM C 144, with 100 percent passing No. 8 sieve.

1. For pointing mortar, use aggregate graded with 100 percent passing No. 16 sieve.

2. White aggregates to be natural white sand or crushed white stone.

C. The manufacturer's standard dry mixture of stearates, water reducing agents and fine aggregates intended to reduce capillarity in mortar.

1. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

a. Sonneborn, Div. of ChemRex, Inc.

b. Hydrocide Powder.

c. Or Approved Equal.

D. Water to be potable.

2.03 Glass Unit Masonry Accessories

A. Panel reinforcement to be ladder type units, butt welded, not lapped and welded; meeting ASTM A 951/A 951M in straight lengths of not less than 10 feet, and as follows:

1. Exterior walls to be hot dip galvanized, carbon steel wire.

2. Wire size to be W1.7 or 0.148 inch diameter.

3. Width to be 1 5/8 inches.

4. Spacing of cross rods to be not more than 16 inches apart.

B. Panel anchors to be the glass block manufacturer's standard perforated steel strips, 0.0359 inch by 1 3/4 inches wide by 24 inches long, hot dip galvanized after fabrication to meet ASTM A 153/A 153M.

C. Unless otherwise indicated, provide Type 304 or Type 316 stainless steel fasteners at exterior walls and zinc plated fasteners with coating meeting ASTM B 633, Class Fe/Zn 5, at interior walls. Select fasteners for type, grade and class required.

D. Carbon steel bolts to meet ASTM A 307, Grade A with hex nuts, ASTM A 563, if applicable.

E. Stainless steel bolts to meet ASTM F 593, Alloy Group 1 or 2 with hex nuts, ASTM F 594, if applicable.

F. Provide metal expansion sleeve anchors or metal impact expansion post installed anchors of type and size necessary for installation indicated, as recommended by manufacturer, unless otherwise indicated.

G. Asphalt emulsion to be cold applied asphalt emulsion meeting ASTM D 1187/D 1187M or ASTM D 1227.

H. Plastic foam expansion strips to be polyethylene foam meeting the requirements of the glass block manufacturer; 3/8 inch thick by 2 1/2 inches wide.

1. Use plastic foam expansion strips for non-fire-rated assemblies.

I. The manufacturer's standard chemically curing, elastomeric sealants of base polymer and characteristics indicated below that meet the applicable requirements in Section 07900.

J. Provide sealant accessories, including primers, bond breaker tape and cylindrical sealant backing that meets the applicable requirements in Section 07900.

K. Spacers to be the manufacturer’s standard recommended spacers.

2.04 Mortar Mixes

A. Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders or antifreeze compounds, unless otherwise indicated.

1. Do not use calcium chloride in mortar.

2. For mortar in exterior panels, use water repellent admixture according to the admixture manufacturer's written instructions.

B. Mortar for glass unit masonry assemblies to meet ASTM C 270, proportion specification for Type S mortar.

1. Combine and thoroughly mix cementitious materials, water and aggregates in a mechanical batch mixer, unless otherwise indicated. Mix mortar to produce a stiff but workable consistency that is drier than mortar for brick or concrete masonry. Discard mortar when it has reached initial set.

PART 3 - EXECUTION

3.01 Examination

A. Examine sills, jambs and heads surrounding glass unit masonry assemblies to meet the requirements for installation tolerances and other conditions affecting performance.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Installing Glass Block with Mortar

A. Apply a heavy coat of asphalt emulsion to sill and adhere expansion strips to jambs and heads with asphalt emulsion. Allow asphalt emulsion to dry before placing mortar. Trim expansion strips to width required to fit glass block and to full lengths of heads and jambs.

B. Set glass block with completely filled bed and head joints, with no furrowing, accurately spaced and coordinated with other construction. Maintain 3/8 inch exposed joint widths, unless otherwise indicated.

C. Install panel reinforcement in horizontal joints at spacing indicated and continuously from end to end of panels; meeting the following requirements:

1. Vertical spacing of panel reinforcement for exterior panels to be every other course but not more than 16 inches on center, starting with first course above sill.

2. Do not bridge expansion joints with panel reinforcement.
3. Place panel reinforcement in joints immediately above and below all openings within glass unit masonry assemblies.
4. Lap panel reinforcement not less than 6 inches if more than one (1) length is necessary.
5. Embed panel reinforcement in mortar bed by placing lower half of mortar bed first, pressing panel reinforcement into place and covering with upper half of mortar bed.

D. Install panel anchors at locations indicated and in same horizontal joints where panel reinforcement occurs. Extend panel anchors at least 12 inches into joints and bend within expansion joints at edges of panels and across the head. Attach panel anchors as follows:
1. For new unit masonry assemblies, embed other ends of panel anchors, after bending portions crossing expansion joint, in horizontal mortar joints closest in elevation to joints in glass unit masonry assemblies containing panel anchors.

E. Use rubber mallet to tap units into position. Do not use steel tools, and do not allow units to come into contact with metal accessories and frames.

F. Use plastic spacers in mortar joints to produce uniform joint widths and to prevent mortar from being squeezed out of joints.

G. Keep expansion joints free of mortar.

H. Rake out joints indicated to be pointed to a uniform depth sufficient to accommodate pointing material but not less than joint width.
1. If temporary wedges are used, remove them before raking out and pointing joints.
2. Point joints at both faces of exterior panels with mortar.

I. Point joints with mortar by filling raked joints and voids. Place and compact pointing mortar in layers not more than 3/8 inch thick. Compact each layer thoroughly and allow to become thumbprint hard before applying next layer.
1. Tool exposed joints slightly concave when pointing mortar is thumbprint hard. Use a smooth plastic jointer larger than joint width.

J. Clean glass unit masonry assemblies as work progresses. Remove mortar fins and smears immediately, using a clean, wet sponge or a scrub brush with stiff fiber bristles. Do not use harsh cleaners, acids, abrasives, steel wool, or wire brushes when removing mortar or cleaning glass unit masonry assemblies.

K. Install sealant at jambs, heads, mullions and other locations indicated. Prepare joints, including installation of primer and bond breaker tape or cylindrical sealant backing, and apply elastomeric sealants to meet the requirements in Section 07900.

L. Set glass block to meet the following tolerances:
1. Variation from plumb for lines and surfaces of vertical elements and arris, does not exceed 1/4 inch in 10 feet, 3/8 inch in 20 feet, or 1/2 inch in 40 feet or more.
2. Variation from level for bed joints, and other conspicuous lines, does not exceed 1/4 inch in 20 feet or 1/2 inch in 40 feet or more.

3. Variation of linear building line for positions shown in plan and related portions of walls and partitions, does not exceed 1/2 inch in 20 feet or 3/4 inch in 40 feet or more.
4. Variation in mortar joint thickness does not vary from joint thickness indicated by more than plus or minus 1/16 inch.

3.03 Cleaning

A. On surfaces adjacent to glass unit masonry assemblies, remove mortar, sealants and other residue resulting from glass block installation, in a manner approved by the manufacturers of materials involved.

B. Remove excess sealants with commercial solvents of type recommended by the sealant manufacturer. Exercise care not to damage sealant in joints.

C. Perform final cleaning of glass unit masonry assemblies when surface is not exposed to direct sunlight. Start at top of panel using generous amounts of clean water. Remove water with clean, dry, soft cloths; change cloths frequently to eliminate dried mortar particles and aggregate.

END OF SECTION

SECTION 04720

CAST STONE

PART 1 - GENERAL

1.01 Description

A. This Section includes the following:

1. Cast stone trim including the following:
   a. Wall caps.
   b. Decorative elements.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 02822 - High Security Ornamental Fences and Gates

E. Section 04200 - Unit Masonry

F. Section 07900 - Joint Sealers

G. Section 09965 - Graffiti Resistant Coatings

1.03 Submittals

A. Submit shop drawings showing fabrication and installation details for cast stone units. Include dimensions, details of reinforcement and anchorages if any, and indication of finished faces.

1. Include elevations showing layout of units and locations of joints and anchors.

B. Submit samples of colored mortar for initial selection.

C. Submit samples for verification:

1. For each color and texture of cast stone required, 10 inches square in size.

2. For colored mortar; make samples using same sand and mortar ingredients to be used on the Contract.

D. Submit qualification data for manufacturers:

1. Include copies of material test reports for completed Projects, indicating compliance of cast stone with ASTM C 1364.

E. Submit manufacturer's written quality-control plan that includes all elements of the Cast Stone Institute's "Quality Control Procedures Required for Plant Inspection."

1. Provide copies of documentation showing compliance with quality control plan as requested by SEPTA.

F. For each mix required to produce cast stone, based on testing according to ASTM C 1364.

1. Provide test reports based on testing within previous two (2) years.

1.04 Quality Assurance

A. A qualified manufacturer of cast stone units similar to those indicated for this Contract, with sufficient production capacity to manufacture required units.

1. Manufacturer is a producing member of the Cast Stone Institute or has on file and follows a written quality control plan approved by SEPTA that includes all elements of the Cast Stone Institute's "Quality Control Procedures Required for Plant Inspection."

B. Obtain cast stone units through one (1) source from a single manufacturer.

C. Obtain mortar ingredients of a uniform quality, including color, from one (1) manufacturer for each cementitious component and from one (1) source or producer for each aggregate.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ACI 530.1/ASCE 6/TMS 602, Specifications for Masonry Structures.
2. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
3. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
4. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
5. ASTM A 767/A 767M, Standard Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
6. ASTM C 33/C 33M, Standard Specification for Concrete Aggregates.
7. ASTM C 114, Standard Test Methods for Chemical Analysis of Hydraulic Cement.
8. ASTM C 150/C 150M, Standard Specification for Portland Cement.
9. ASTM C 260/C 260M, Standard Specification for Air-Entraining Admixtures for Concrete.
10. ASTM C 494/C 494M, Standard Specification for Chemical Admixtures for Concrete.
11. ASTM C 979/C 979M, Standard Specification for Pigments for Integrally Colored Concrete.
12. ASTM C 1364, Standard Specification for Architectural Cast Stone.

1.05 Delivery, Storage and Handling

A. Coordinate delivery of cast stone with unit masonry work to minimize the need for on-site storage and to avoid delaying the work.

B. Pack, handle and ship cast stone units in suitable packs or pallets.

1. Lift with wide belt slings; do not use wire rope or ropes that might cause staining. Move cast stone units, if required, using dollies with wood supports.

2. Store cast stone units on wood skids or pallets with nonstaining, waterproof covers. Arrange to distribute weight evenly and to prevent damage to units. Ventilate under covers to prevent condensation.

C. Store installation materials on elevated platforms, under cover, and in a dry location.

D. Store mortar aggregates where grading and other required characteristics can be maintained and contamination can be avoided.

1.06 Definitions

A. Cast stone to be architectural precast concrete building units intended to simulate natural cut stone.

1.07 Project Conditions

A. Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Meet the cold weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

1. Use liquid cleaning methods only when air temperature is 40°F and above and will remain so until cast stone has dried, but not less than seven (7) days after completing cleaning.

B. Meet the hot weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.01 Manufacturers

A. In other Part 2 articles where titles in this Section introduce lists, the following requirements apply to product selection:

1. Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, products specified.

2. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, manufacturers specified.

2.02 Cast Stone Materials

A. Meet ASTM C 1364 and the following requirements.

B. Portland cement to meet ASTM C 150/C 150M, Type I, containing not more than 0.60 percent total alkali when tested according to ASTM C 114.

C. Coarse aggregates to be granite, quartz or limestone meeting ASTM C 33/C 33M; gradation as needed to produce required textures and colors as needed to produce required cast stone colors.

D. Fine aggregates to be natural sand or crushed stone meeting ASTM C 33/C 33M, gradation as needed to produce required textures and colors as needed to produce required cast stone colors.

E. Color pigment to meet ASTM C 979/C 979M, synthetic mineral oxide pigments or colored water reducing admixtures; color stable, free of carbon black, nonfading, and resistant to lime and other alkalis.

F. Do not use admixtures unless specified or approved in writing by SEPTA.

1. Do not use admixtures that contain more than 0.1 percent water soluble chloride ions by mass of cementitious materials. Do not use admixtures containing calcium chloride.

2. Use only admixtures that are certified by the manufacturer to be compatible with cement and other admixtures used.

3. Air entraining admixture to meet ASTM C 260/C 260M.

4. Water reducing admixture to meet ASTM C 494/C 494M, Type A.

5. Water reducing, retarding admixture to meet ASTM C 494/C 494M, Type D.

6. Water reducing, accelerating admixture to meet ASTM C 494/C 494M, Type E.

G. Reinforcement to be deformed steel bars meeting ASTM A 615/A 615M.

1. Galvanized coating to meet ASTM A 767/A 767M.

H. Embedded anchors and other inserts to be fabricated from steel meeting ASTM A 36/A 36M, and hot dip galvanized to meet ASTM A 123/A 123M.

2.03 Cast Stone Units

A. Available Manufacturers:

1. Continental Cast Stone East; Russell, Inc.

2. Pineapple Grove Designs.

3. Sun Precast Co., Inc.

4. Or Approved Equal.

B. Provide cast stone units meeting ASTM C 1364 using the vibrant dry tamp or wet cast method.

C. Fabricate units with sharp arris and details accurately reproduced with indicated texture on all exposed surfaces, unless otherwise indicated.

1. Slope exposed horizontal surfaces 1:12, unless otherwise indicated.

2. Provide raised fillets at backs of sills and at ends indicated to be built into jambs.

3. Provide drips on projecting elements, unless otherwise indicated.

D. Fabrication Tolerances:

1. Variation in cross section does not vary from indicated dimensions by more than 1/8 inch.

2. Variation in length does not vary from indicated dimensions by more than 1/360 of the length of unit or 1/8 inch, whichever is greater, but in no case by more than 1/4 inch.

3. Warp, bow and twist not to exceed 1/360 of the length of unit or 1/8 inch, whichever is greater.

4. Location of grooves, false joints, holes, anchorages and similar features do not vary from indicated position by more than 1/8 inch on formed surfaces of units and 3/8 inch on unformed surfaces.

E. Insulation:

1. Fiberglass with liner pan.

2. Cure units with steam in enclosed curing room at temperature of 105°F or above and 95 to 100 percent relative humidity for six (6) hours.

3. Cure units with dense fog and water spray in enclosed warm curing room at 95 to 100 percent relative humidity for twenty-four (24) hours.

4. Cure units to meet one (1) of the following:

a. Not less than five (5) days at mean daily temperature of 70°F or above.

b. Not less than six (6) days at mean daily temperature of 60°F or above.

c. Not less than seven (7) days at mean daily temperature of 50°F or above.

d. Not less than eight (8) days at mean daily temperature of 45°F or above.

F. Acid etch units after curing to remove cement film from surfaces to be exposed to view.

G. Colors and textures to be selected by SEPTA from the manufacturer's full range.

2.04 Mortar Materials

A. Provide mortar materials that meet Section 04200.

2.05 Accessories

A. Anchors to be type and size indicated, fabricated from Type 304 stainless steel meeting ASTM A 240/A 240M, ASTM A 276 or ASTM A 666.

B. Dowels to be round Type 304 stainless steel bars meeting ASTM A 240/A 240M, ASTM A 276, or ASTM A 666, 1/2 inch diameter.

2.06 Mortar Mixes

A. Meet the requirements in Section 04200 for mortar mixes.

2.07 Source Quality Control

A. Employ an independent testing agency to sample and test cast stone units according to ASTM C 1364.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of cast stone.

1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Setting Cast Stone in Mortar

A. Install cast stone units to meet the requirements in Section 04200.

3.03 Setting Anchored Cast Stone with Sealant Filler Joints

A. Set cast stone as indicated on the Contract Drawings. Set units accurately in locations indicated with edges and faces aligned according to established relationships and indicated tolerances.

1. Install anchors, supports, fasteners, and other attachments indicated or necessary to secure units in place.

2. Shim and adjust anchors, supports and accessories to set cast stone in locations indicated with uniform joints.

B. Keep cavities open where unfilled space is indicated between back of cast stone units and backup wall; do not fill cavities with mortar or grout.

C. Fill anchor holes with sealant.

1. Where dowel holes occur at pressure-relieving joints, provide compressible material at ends of dowels.

D. Set cast stone supported on clip or continuous angles on resilient setting shims. Use material of thickness required to maintain uniform joint widths. Hold shims back from face of cast stone a distance at least equal to width of joint.

E. Keep joints free of mortar and other rigid materials. Remove temporary shims and spacers from joints after anchors and supports are secured in place and cast stone units are anchored. Do not begin sealant installation until temporary shims and spacers are removed.

1. Form open joint of width indicated, but not less than 3/8 inch.

F. Prepare joints and apply sealant of type and at locations indicated to meet applicable requirements in Section 07900.

1. Prime cast stone surfaces to receive sealant and install compressible backer rod in joints before applying sealant, unless otherwise indicated.

3.04 Installation Tolerances

A. Variation from plumb does not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

B. Variation from level does not exceed 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.

C. Variation in joint width does not vary joint thickness more than 1/8 inch in 36 inches or one fourth of nominal joint width, whichever is less.

D. Variation in plane between adjacent surfaces (lipping) does not vary from flush alignment with adjacent units or adjacent surfaces indicated to be flush with units by more than 1/16 inch, except due to warpage of units within tolerances specified.

3.05 Adjusting and Cleaning

A. Remove and replace stained and otherwise damaged units and units not matching approved samples. Cast stone may be repaired if methods and results are approved by SEPTA.

B. Replace units in a manner that results in cast stone matching approved samples, meeting other requirements and showing no evidence of replacement.

C. Clean cast stone as work progresses:

1. Remove mortar fins and smears before tooling joints.
2. Remove excess sealant immediately, including spills, smears and spatter.

D. Final cleaning after mortar is thoroughly set and cured, clean exposed cast stone as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample; leave one (1) sample un-cleaned for comparison purposes. Obtain SEPTA's approval of sample cleaning before proceeding with cleaning of cast stone.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet surfaces with water before applying cleaners; remove cleaners promptly by rinsing thoroughly with clear water.
5. Clean cast stone by bucket and brush hand cleaning method described in BIA Technical Notes No. 20.

END OF SECTION

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SECTION 05090

METAL FASTENERS, JOINING AND WELDING

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section includes all metal fasteners, joining, welding, brazing, and soldering.

B. Select appropriate fastener types, sizes, styles, lengths, materials, grades and finishes for all equipment. If fastener details are not listed on the Contract Drawings, fasteners shall be selected in accordance with industry standards and the manufacturer's recommendations.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control – Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

E. Section 01822 – Demonstration and Training – Traction Power Equipment

F. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment

G. Section 09910 – Paints and Coatings

H. Section 16060 – Grounding and Bonding

I. Section 16075 – Electrical Identification

J. Section 16230 – Generator Assemblies

K. Section 16260 – Traction Power Rectifier

L. Section 16271 – Auxiliary Power Transformers

M. Section 16273 – Traction Power Rectifier Transformers

N. Section 16274 – Transformer and Rectifier Unit

O. Section 16290 – Protective Devices and Instrument Transformers

P. Section 16315 – Dead Break Junction Equipment

Q. Section 16335 – Surge Protection

R. Section 16340 – Medium Voltage Switchgear Assemblies (60 Hz)

S. Section 16344 – DC Traction Power Switchgear Assemblies

T. Section 16348 – Negative and Drainage Switchboard

U. Section 16412 – DC Enclosed Switch Cabinets

V. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

W. Section 16920 – Stray Current Monitoring

X. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following documents for SEPTA's review and approval:

1. Welding, brazing and soldering procedures, including:
   a. Quality assurance measures.
   b. Inspection procedures.
   c. Defect repair procedures.
   d. Welding, brazing, and soldering procedure qualification records.
2. Submit welder certifications. Use only qualified welders in accordance with the requirements of the AWS and ASME B&PV Code Section IX.
3. Submit structural fasteners. Identify the fastener manufacturer, material grade and plating material finish. Hold the documentation for a period not less than the expiration of the warranty on the last item of equipment delivered.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. AMS-W-6858A, Welding, Resistance, Spot and Seam.
2. ANSI C80.1, American National Standard for Electric Rigid Steel Conduit (ERSC).
3. ANSI C80.3, American National Standard for Electrical Metallic Tubing - Steel (EMT-S).
4. ANSI/NEMA FB 1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
5. ASME Boiler and Pressure Vessel Code, Section IX, Welding and Brazing Qualifications.
6. ASME B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
7. ASME B1.13M, Metric Screw Threads (M Profile).
8. ASME B18.21.1, Lock Washers (Inch Series).
9. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
10. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
11. ASTM A 385/A 385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
12. ASTM B 633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
13. ASTM F 436, Standard Specification for Hardened Steel Washers.
14. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

15. AWS B2.1, Specification For Welding Procedure And Performance Qualification.
16. AWS B2.2, Standard For Brazing Procedure And Performance Qualification.
17. AWS C1.1, Recommended Practices For Resistance Welding.
18. AWS D1.1, Structural Welding Code – Steel.
19. AWS D1.2, Structural Welding Code – Aluminum.
20. AWS D1.3, Structural Welding Code – Sheet Steel.
21. AWS D1.6, Structural Welding Code – Stainless Steel.
22. FS QQ-P-416, Plating (Cadmium) Electrodeposited.
23. AWS Handbooks Volumes 1, 2, 3, 4 & 5.
24. MIL-P-23469, General Specification for Pin-Rivet, Grooved and Collar, Grooved Pin-Rivet, Swage-Locked (Lockpin).
25. MIL HDBK-132, Protective Finishes for Metal and Wood Surfaces.
26. NAMS-21044, Nut, Self-Locking, Hexagon, Regular Height, 250 degrees F, 125 ksi FTU and 60 ksi FTU.
27. SAE J429, Mechanical and Material Requirements for Externally Threaded Fasteners.

PART 2 - PRODUCTS

2.01 Threaded Fasteners

A. Screws, Bolts and Nuts:

1. Use carbon, alloy and martensitic steel fasteners plated with zinc in accordance with Federal Specification QQ-P-416, Class 2 or 3, Type II.
2. Use zinc plating in accordance with ASTM B 633, Type II SC2, SC3 or SC4 standards.
3. Any proposed alternate surface coating must be qualified by salt spray testing by an independent laboratory. In order to be qualified, the alternate coating must meet the same criteria as required by ASTM B 633, SC2, SC3 or SC4 as applicable.

B. Prevailing Torque Locknuts:

1. Use nylon insert type locknuts meeting ANSI or MAMS-21044 standards.
2. Use distorted thread locknuts where sufficient clearance to install nylon insert type locknuts is not available or where the locknut is exposed to temperatures above 200°F.

2.02 Washers and Lock Washers

A. Where high strength fasteners are applied, use hardened washers in accordance with ANSI or ASTM Standards.

B. Use lock washers, conforming to ANSI or ASTM Standards. If applicable, use prevailing torque nuts.

2.03 Rivets and Lock Pins

A. Use austenitic stainless steel or aluminum rivets and lock pins, as appropriate to the materials being joined.

B. Use swage-locking fasteners, Huckbolt-type fasteners, and lock pins conforming to Military Specification MIL-P-23469.

PART 3 - EXECUTION

3.01 Joining and Fastening

A. General:

1. Fit properly all joints, whether exposed or concealed. Hold gaps between joints to a dimension not larger than 10 percent of the thinner material being joined, or 0.005 inch, whichever is greater. Make gaps uniform in width. Manufacture edges of panels smooth and provide well finished appearance.

2. Repair excessive gaps at fayed surfaces with metal shims of the same material. Fasten the shims permanently (not with adhesives) to one (1) of the parts being joined.

3. Use isolating and moisture-proofing materials to prevent corrosion when joining parts of dissimilar metal.

4. Minimize the number of different sizes and types of fasteners used.

5. Use fasteners that are U.S. standard, meeting ASME B1.1 or ASME B1.13M.

6. For all fasteners exposed to view provide either bright finish or provide finish matching the surfaces being joined. Install all fasteners so that the fastener head is flush with the mating surface.

7. Connections to electrical and electronic heat producing apparatus:

   a. Take into account the thermal expansion of the components being fastened when selecting screws, bolts, nuts, flat washers and lock washers.

   b. For joining copper, stainless steel or high expansion alloys, use austenitic stainless steel fasteners.

   c. All critical bolts in any application and general-purpose bolts shall be sized to the design strengths for Grade 2 bolts and Class A nuts. The actual hardware used shall be a minimum Grade 5.

   d. Zinc-plated steel fasteners SAE J429, Grade 5 or Grade 8.

B. Threaded Fasteners:

1. Make all screws or bolts used to secure access panels to equipment enclosure captive to the panel in which they are used.

2. Use a reusable mechanical locking device for inaccessible bolts to prevent the bolt head from turning when the nut is being turned.

3. Self-tapping screws are only permitted where they will not be removed for normal maintenance more frequently than once in five (5) years. Use self-tapping screws manufactured of plated martensitic stainless steel.

4. Torque locknuts in accordance with the manufacturer recommendations or conduct tests to determine the appropriate installation torque. Provide at least two (2) screw threads visible beyond all nuts.

C. Washers and Lock Washers:

1. Use washers under the head of all bolts and under all nuts.

2. Lock washers shall not be used for fatigue applications where the fastener must be torqued and marked. If applicable, prevailing torque nuts shall be used for these applications.

D. Rivets and Lock Pins:

1. Machine smooth all rough surfaces of the collar end of the fasteners where accessible to maintenance personnel.

3.02 Welding, Brazing and Soldering

A. Clean the area in accordance with applicable parts of Section 2 in MIL HDBK-132.

B. Provide spacing of resistance and spot welds appropriate to the design. All welding practices shall be in accordance with requirements of AWS D1.1, AWS D1.2, AWS D1.3 and AWS Handbooks.

C. Resistance welding shall be in accordance with either AWS C1.1 or AMS-W-6858A. Requirements for statically loaded structures shall be applied.

D. Torch brazing - heating above 840°F - follow the recommendations contained in the AWS Welding Handbook, Volume 2. For brazing, use only personnel qualified in accordance with AWS B2.2.

E. Torch soldering - heating below 840°F - follow the recommendations contained in the AWS Welding Handbook, Volume 2.

F. Clean all welds exposed to view.

END OF SECTION

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SECTION 05120

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 Description

A. Furnish all labor, materials, tools and equipment, and perform all operations in connection with structural steel work, as indicated on the Contract Documents.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 03600 – Grout

C. Section 09910 – Paints and Coatings

1.03 Submittals

A. Submit product data and shop drawings under provisions of Section 01300.

B. Submit shop drawings:

1. Prepare shop detail drawings, bill of materials and erection plans for the material.
2. Provide the required details for the fabrication, shop assemblies and field installation of the members as shown on the Contract Drawings.
    a. Show member sizes and their lengths.
    b. Include details of cuts, copes, connections, cambers, drilling, fabrication and erection tolerances and other pertinent data.
    c. Show end preparations for welds. Include sizes, types and lengths of welds. Indicate welds by AWS symbols.
    d. Include sizes, types and lengths of connection bolts.
    e. Show field splices as specified on the Contract Drawings.
    f. Show lifting lugs or holes when required.
    g. A system of identification marking whereby each member for a particular elevation shall have the same prefix letter.
    h. Mark columns with the same designation shown on the Contract Drawing column schedule.
    i. Column base plates, if shipped loose, shall carry the same piecemark as their connecting columns.
    j. Use separate identifying letters for prefixing for independent structures.
    k. When shipment sequence is required, the sequence number shall prefix the member marking.
    l. Furnish erection bolts and nuts.
    m. Mark total weight on shop assembled members wand truss sections.
    n. Include shop primer.
    o. Furnish setting diagrams, template and directions for the installation of structural framing anchor bolts, bearing plates and other embedded items.

p. Mill columns to bear at bases and splices.

3. Design detail connections based on the loads and requirements specified on the Contract Drawings and the provisions specified in AISC manual.

4. Shop detail drawings, bill of materials and erection plans shall be completed and checked prior to submittal to SEPTA for review and comment.

5. The review by SEPTA will not relieve the Contractor's responsibility for correctness of the work.

6. SEPTA will have the right to use the Contractor's shop drawings, bill of materials and erection plans for subsequent work or any other work not covered by these Specifications.

C. Submit mill test reports:

1. Submit certified copies of reports for analyses and tests required by referenced ASTM specifications, including test reports for electrodes used in fabrication and mechanical tests for high strength threaded fasteners, shear connectors and unfinished bolts and nuts, and structural steel primer paint.

2. Submit results of nondestructive testing as applicable.

D. Submit manufacturer's specifications and installation recommendations:

1. Submit certified copies of manufacturer's specifications and installation recommendations.

E. Submit welding records and data:

1. Prior to commencing any work requiring welding, submit the procedure which will be used for pre-qualifying welders and welding procedures. For all procedures other than those set forth in Article 5.1 of AWS D1.1, submit a copy of procedure qualification test records.

2. Submit certified copy of qualification test record for each welder, welding operator and tacker who will be employed in the work.

3. Submit descriptive data for field welding equipment, including type and electrical power requirements.

1.04 Quality Assurance

A. Submit shop quality control manual prior to fabrication. The manual shall meet the applicable requirements of these Specifications.

B. Submit welding and repair welding procedures and procedure qualification test records. All welding procedure qualifications and welder performance qualifications shall be in accordance with AWS D1.1.

C. Submit heat treatment, cleaning, painting and preparation for shipment procedures.

D. Submit nondestructive procedures as applicable.

E. Meet the applicable provisions of the most recent issues of the following references:

1. AISC, Specification for Design, Fabrication and Erection of Structural Steel for Buildings.

2. AISC, Code of Standard Practice for Steel Buildings and Bridges.
3. ANSI B 18.2.1, Square and Hex Bolts and Screws inch Series Including Hex Cap Screw and Lag Screws Supplement.
4. ANSI B 18.2.2, Square and Hex Nuts.
5. ASTM A 6/A 6M, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
6. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
7. ASTM A 53/A 53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
8. ASTM A 108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
9. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
10. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
11. ASTM A 193/A 193M, Standard Specification or Alloy-Steel and Stainless Steel Bolting Materials for High Temperature or High Pressure Service and Other Special Purpose Applications.
12. ASTM A 283/A 283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.
13. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
14. ASTM A 500/A 500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
15. ASTM A 501/A 501M, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
16. ASTM A 563, Standard Specification for Carbon and Alloy Steel Nuts.
17. ASTM A 588/A 588M, Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi [345 MPa] Minimum Yield Strength, with Atmospheric Corrosion Resistance.
18. ASTM A 992/A 992M, Standard Specification for Structural Steel Shapes.
19. ASTM A 1085/A 1085M, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
20. ASTM F 436, Standard Specification for Hardened Steel Washers.
21. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPA) Minimum Tensile Strength, Inch and Metric Dimensions.
22. AWS A2.4, Standard Symbols for Welding, Brazing and Nondestructive Examination.
23. AWS A5.5, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.

24. AWS A5.1, Covered Carbon Steel Arc Welding Electrodes.
25. AWS A5.17, Carbon Steel Electrodes and Fluxes for Submerged Arc Welding.
26. AWS A5.20, Specification for Carbon Steel Electrodes for Flux Cored Arc Welding.
27. AWS D1.1, Structural Welding Code –Steel.
28. SSPC-SP 2, Hand Tool Cleaning.
29. SSPC-SP 3, Power Tool Cleaning.

1.05 Delivery, Storage and Handling

A. Perform shop inspection and shipment in accordance with requirements of Specifications.

B. All material shall be subject to inspection by SEPTA before released for shipment.

C. Fabricate and ship material in the sequence specified in the purchase order as required by the Contract erection schedule. Ship stairs, grating, floor plate, handrail and field bolts with the structural steel unless otherwise noted.

D. Load material carefully and brace it securely for shipment. Block plates for use of unloading slings. Small pieces shall be bundled or boxed. Ship bolts in kegs, however, small lots may have sizes separated in sacks and boxed. Mark all containers clearly for identification.

PART 2 - PRODUCTS

2.01 Materials

A. Unless otherwise specified on the Contract Drawings, design, detail and fabricate in accordance with AISC "Code of Standard Practice", the AISC "Specification for the Design, Fabrication and Erection of Structural Steel for Buildings" and AWS D1.1.

1. Rolled steel plates and bars to meet ASTM A 36/A 36M and ASTM A 588/A 588M.
2. W-shapes to meet ASTM A 992/A 992M.
3. Channels, Angles, M-shapes, and S-shapes to meet ASTM A 36/A 36M.
4. HSS tubes and pipes to meet ASTM A 1085/A 1085M.
5. Steel pipe to meet ASTM A 53/A 53M, grade B.
6. Structural tubing to meet ASTM A 501.
7. Anchor bolts to meet ASTM A 307, grade A, or ASTM A 36/A 36M.
8. Unfinished threaded fasteners to meet ASTM A 307, grade A.
9. Expansion bolts to meet ASTM A 193/A 193M; grade B7.
10. High strength bolts to meet ASTM F 3125/F 3125M.
11. Nuts to meet ASTM A 563.
12. Washers to meet ASTM F 436.
13. Checkered plate to meet ASTM A 283/A 283M.
14. Stud shear connector to meet ASTM A 108 and AWS D1.1.

15. Weld electrodes to meet E70XX per AWS A5.1 or A5.5.
16. Galvanizing to meet ASTM A 123/A 123M.
17. Prime paint to be "10-99 Tnemec Primer"; Or Approved Equal.
18. Non-shrink grout to be Five Star non-shrink cementitious grout; Or Approved Equal; for column base plate.
19. Plate assemblies, when required by the Contract Drawings, shall be furnished complete with stiffeners and all attachments.
    a. Fabricate and assemble plates of structural steel in accordance with ASTM A 36/A 36M unless otherwise noted on the Contract Drawings. Plate fabrication welding details, qualification and procedures shall meet AWS D1.1. Make careful visual examination for all welds to ensure that there is no slag, inclusions, craters, cracks or undercuts in accordance with AWS Specifications. Remove defects in accordance with AWS D1.1.
    b. Bevel plate edges for shop welds where shown and accurately cut void of ragged edges. Shop-weld rings, angles, stiffeners, etc., to their respective plates.
    c. When specified on the Contract Drawings, shop fit assemblies and pack and ship them in the largest practical sections to prevent distortion or damage during shipping.
20. Grating:
    a. Grating shall be of the rectangular skid resistant welded type having 3/16 inch bearing bars, of depth specified on the Contract Drawings, spaced 13/16 inch on centers, with cross bars spaced not more than 4 inches on center and welded into the bearing bars to form an anti-slip surface. All grating shall be hot dip galvanized after fabrication in accordance with ASTM A 123/A 123M. Grating shall be neatly cut and banded around openings.
    b. Grating panels shall be removable and bars of adjacent panels shall be in line. Grating fasteners shall consist of 1/4 inch diameter flux filled stainless steel welding studs with stainless steel, hexagonal nuts and 14 gauge hot dip galvanized "U" clips fitting between and hooking over the bearing bars. Four (4) clips shall be provided for panels under 10 feet long and six (6) clips shall be provided for panels 10 feet and longer. Fasteners shall be furnished with an excess of 5 percent over net requirements.

2.02 Fabrication

A. Fabricate and shop assemble work in accordance with AISC Specification for the Design, Fabrication and Erection of Structural Steel for buildings; Specification for Structural Joints using ASTM F 3125/F 3125M Bolts; Code of Standard Practice for Steel Buildings and Bridges, and as indicated on the Contract Documents and the approved shop drawings.

B. Unless noted on the Contract Drawings, use field connections with high strength bolted friction type connections for beam and bracing connections.

C. Miscellaneous:

1. Provide bolted erection seat angles for equal depth members framed to opposite sides of column webs. Do not use connections requiring the "Knifing" of beam web into the connection without specific approval of SEPTA.
2. Shop attach curb plates and angles to members unless otherwise noted on the Contract Drawings. Seal weld curb plates continuous on both sides at all vertical joints and where noted on the Contract Drawings.

3. Design compact bracing connections with minimum size gusset plates. Where practical, shop connect bracing gusset plates to beams or bracing members.
4. Make shearing accurate, and clean the cuts to be without drawn, ragged or split edges. Fabricate all copes, blocks and other re-entrant cuts with 1/2 inch minimum radius fillet.
5. Provide maximum shop assembly for all materials including, but not limited to, roof truss sections, walkways, hatch covers and frames. Shop stairs shall be assembled with stringers and treads attached.
6. Round off all structural steel sharp edges to hold paint more effectively.
7. Drill drain holes in structural steel as necessary to avoid the retention of liquids. Coat the holes to prevent corrosion.
8. Arrange bolt heads and nuts so as to not protrude into walkways.
9. All rolled material before being laid off or worked in any way shall be straight. If straightening or flattening is necessary, it shall be done by methods that will not injure the materials. After punching and before assembling, the material shall again be straightened if required by SEPTA. Sharp kinks and bends may be cause for rejection.
10. Fabricate shearing and clipping neatly and accurately. Finish all portions of the work exposed to view neatly.
11. If bolt holes have to be reamed to correct a misfit; use oversized bolts.
12. Stiffeners of plate girders carrying stress shall be faced on ends where the load is applied and brought to a true contact bearing with the flange; the other ends of the stiffeners shall be sheared square and brought to a tight fit with the flange. All other stiffeners shall be sheared square and brought to a tight fit with the flange to provide full bearing. Web splice plates and fillers under stiffeners shall be cut to fit within 1/8 inch of flange on each end. Stiffeners and splice plates shall not be crimped. Filler plates shall be used as required. When bolts carrying computed stress pass through fillers, the fillers shall be extended and bolted to distribute the total stress uniformly.

D. Welding:

1. Welding shall meet AISC Specification and the AWS D1.1. Welders, welding operators and weld procedures shall be qualified in accordance with AWS D1.1. Welding electrodes shall be AWS A5.1 low hydrogen Class E70 for manual shielded metal-arc welding, or AWS A5.17 F7X for submerged arc welding, or AWS A5.20, classification E70T-X for flux cored arc welding, unless otherwise specified on the Contract Drawings.
2. Welding details, qualifications and procedures for built-up girders and cover plates on columns and beams shall meet AWS D1.1. Make web and flange splices, pre-qualified butt welded joints unless otherwise noted on the Contract Drawings. Make splices of different thickness plates, tapered transition joints. Radiograph butt welds, when noted on the Contract Drawings.
3. Perform fillet welds to full size and of proper profile for the full length specified on the Contract Drawings. Make butt welds full penetration unless otherwise noted on the Contract Drawings. Follow preheat requirements of the welding specifications. Examine welds carefully to insure that there are no slag inclusions, craters, cracks or undercuts in accordance with AWS Specifications. Remove defects by chipping or grinding and then

re-weld. Care shall be taken in assembling and fitting. Control welding to minimize shrinkage stresses and distortion. Clamp or otherwise hold connection angles to insure close contact with beam webs during welding. Perform finished work with good quality and a neat appearance without warpage.

E. Bolting:

1. Make field connections friction type joints, assembled with high strength bolts, unless otherwise noted on the Contract Drawings, in accordance with AISC Specification for structural joints using ASTM F 3125/F 3125M bolts.
2. Use ASTM F 3125/F 3125M heavy hexagon structural bolts furnished with heavy semi-finished hexagon nuts of dimensions conforming to ANSI B18.2.2 and one (1) hardened washer per bolt. Bolting material shall be in accordance with ASTM F 3125/F 3125M.
3. Furnish bolts for connections to existing steel and for connections to members furnished by others.
4. Paint contact surfaces of joints except where specifically noted on the Contract Drawings that contact surfaces shall be free of paint.
5. ASTM A 307, grade A bolts may be used for girts, door and window framing connections and where noted on the Contract Drawings.
6. Provide an excess of 5 percent of net requirements for each size and type of bolt, together with a bolt summary list.
7. When erection fit up bolts are required, provide unfinished ASTM A 307 bolts in the amount of 15 percent of the net requirements of high strength field bolts. These bolts shall have square heads and be used, with hex nuts.

F. Shop Painting:

1. Proper shop painting is important as the steel will be subject to exterior exposure. Unless otherwise noted on the Contract Drawings, prepare all steel for painting after fabrication in accordance with surface preparation specification SSPC-SP 3 and shop paint with one (1) coat of prime paint meeting the manufacturer's instructions and recommendations, applied in accordance with paint application specification. Do not paint surfaces in contact with concrete and areas within 3 inches of field welds.
2. Do not add thinners or additives to the paint. The dry film thickness shall be not less than 2 1/2 mils or more than 3 1/2 mils. Paint shall be dry before steel is loaded for shipment. Make painted erection marks on members legible and durable. Apply special paints in accordance with the paint manufacturer's instructions.

PART 3 - EXECUTION

3.01 Erection

A. Provide surveys to establish permanent benchmarks necessary for the erection of structural steel. Check elevations of concrete surfaces, and locations of anchor bolts and similar items, before erection proceeds.

B. Anchor Bolts:

1. Furnish and install templates and other devices as needed for setting of bolts and other anchors which are to receive structural steel.
2. Install anchor bolts in templates and secure these templates to the forms for concrete after the installation of reinforcing steel.

C. Setting Bases and Bearing Plates:

1. Clean concrete bearing surfaces free from bond reducing materials and then roughen to improve bond to surface. Clean the bottom surface of base and bearing plates.
2. Set base plates and bearing plates for structural members in their proper positions and secure them with wedges or threaded fasteners.
3. Column base plates shall be finished over the area in contact with the column shaft in accordance with AISC Specification 1.21.3.

D. Assembly:

1. Clean the bearing surfaces and other surfaces which will be in permanent contact before assembly.
2. Set structural frames accurately to the lines and elevations indicated. Align and adjust the various members forming a part of a complete frame or structure before fastening. Splice only where indicated.
3. Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads.
4. Provide temporary guy lines to achieve alignment of the structures as erection proceeds.
5. Level and plumb individual members of the structure within AISC tolerances.
6. Perform adjustments to compensate for discrepancies in elevations and alignment. Immediately report errors in fabrication or deformation resulting from handling or transportation, which prevents the proper erection and fitting of parts, to SEPTA.
7. Establish required leveling and plumbing measurements at the mean operating temperature of the structure. Make allowances for the difference between temperature at time of erection and the mean temperature at which the structure will be when completed and in service.
8. Meet AISC Specifications for bearing, adequacy of temporary connections and alignment.
9. Tighten anchor bolts after the supporting members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with the edge of the base or bearing plate prior to grouting. Nuts on anchor bolts under base plates may be used in lieu of wedges or shims.

3.02 Non-Shrink Grout

A. Install grout in accordance with Section 03600.

3.03 Touch-Up

A. After erection, clean chips, skips and abrasions where paint has been removed, damaged or burned. Clean field bolts and field welds and coat as set forth under shop painting.

B. Clean areas where galvanized surfaces have been damaged as a result of handling and erection, or where field welding or bolting has occurred. Coat these areas with a field applied galvanizing compound.

3.04 Testing

A. Perform nondestructive testing, using magnetic particle testing method in accordance with AWS D1.1, for ten percent of shop welds.

3.05 Inspection

A. Inspect field-assembled bolted construction in accordance with AISC Specification for Structural Joints using ASTM F 3125/F 3125M bolts.

B. Inspect field welds by method selected by SEPTA from AWS D1.1.

END OF SECTION

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SECTION 05310

STEEL DECKING

PART 1 - GENERAL

1.01 Description

A. The Section includes:

1. Roof deck.
2. Composite floor deck.

1.02 Submittals

A. Submit product data for each type of deck, accessory and product indicated.

B. Submit shop drawings:

1. Include layout and types of deck panels, anchorage details, reinforcing channels, pans, cut deck openings, special jointing, accessories and attachments to other construction.

C. Submit welding certificates.

D. Submit product certificates for each type of steel deck.

E. Submit product test reports based on evaluation of comprehensive tests performed by a qualified testing agency, indicating that each of the following meets the requirements:

1. Power actuated mechanical fasteners.
2. Acoustical roof deck.

F. Submit evaluation reports for steel deck.

G. Submit field quality control reports.

1.03 Quality Assurance

A. Testing Agency to be qualified according to ASTM E 329 for testing indicated.

B. Qualify procedures and personnel according to AWS D1.3.

C. Meet the applicable provisions of the most recent issues of the following references:

1. American Iron and Steel Institute (AISI).
2. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
3. ASTM A 780/A 780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
4. ASTM E 119, Standard Test Methods for Fire Tests of Building Construction and Materials.
5. ASTM E 329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

6. AWS D1.3, Structural Welding Code - Sheet Steel.

1.04 Delivery, Storage and Handling

A. Protect steel deck from corrosion, deformation and other damage during delivery, storage and handling.

B. Stack steel deck on platforms or pallets and slope to provide drainage. Protect with a waterproof covering and ventilate to avoid condensation.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Meet the calculated structural characteristics of steel deck according to AISI's "North American Specification for the Design of Cold-Formed Steel Structural Members."

B. Fire resistance ratings to meet ASTM E 119; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Indicate design designations from UL's "Fire Resistance Directory" or from the listings of another qualified testing agency.

C. Provide steel roof deck evaluated by Factory Mutual and listed in its "Approval Guide, Building Materials" for Class 1 fire rating and Class 1-90 windstorm ratings.

2.02 Roof Deck

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Cordeck.
6. DACS, Inc.
7. Epic Metals Corporation.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
10. Nucor Corp.; Vulcraft Group.
11. Roof Deck, Inc.
12. Valley Joist; Subsidiary of EBSCO Industries, Inc.
13. Verco Manufacturing Co.
14. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
15. Or Approved Equal.

B. Fabricate roof deck panels, without top flange stiffening grooves, to meet "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 31, and with the following:

1. Galvanized steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), Grade 40 zinc coating.
2. Galvanized and shop primed steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), G60 zinc coating; cleaned, pretreated and primed with the manufacturer's standard baked on, rust inhibitive primer.
3. Finish to be exposed galvanized.
4. Provide deck profile as indicated on the Contract Drawings.
5. Provide cellular deck profile as indicated on the Contract Drawings, with bottom plate.
6. Provide profile depth as indicated on the Contract Drawings.
7. Provide design uncoated steel thickness as indicated on the Contract Drawings.
8. Provide span condition as indicated on the Contract Drawings.
9. Side laps to be overlapped or interlocking seam at the Contractor's option.

2.03 Composite Floor Deck

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Cordeck.
6. DACS, Inc.
7. Epic Metals Corporation.
8. Marlyn Steel Decks, Inc.
9. New Millennium Building Systems, LLC.
10. Roof Deck, Inc.
11. Verco Manufacturing Co.
12. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
13. Or Approved Equal.

B. Fabricate floor deck panels, with integrally embossed or raised pattern ribs and interlocking side laps, to meet "SDI Specifications and Commentary for Composite Steel Floor Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:

1. Galvanized steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), Grade 40, G60 zinc coating.
2. Provide profile depth as indicated on the Contract Drawings.
3. Provide design uncoated steel thickness as indicated on the Contract Drawings.
4. Provide span condition as indicated on the Contract Drawings.

2.04 Non-composite Form Deck

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
1. ASC Profiles, Inc.; a Blue Scope Steel company.
2. Canam United States; Canam Group Inc.
3. CMC Joist & Deck.
4. Consolidated Systems, Inc.; Metal Dek Group.
5. Cordeck.
6. DACS, Inc.
7. Marlyn Steel Decks, Inc.
8. New Millennium Building Systems, LLC.
9. Nucor Corp.; Vulcraft Group.
10. Roof Deck, Inc.
11. Valley Joist; Subsidiary of EBSCO Industries, Inc.
12. Verco Manufacturing Co.
13. Wheeling Corrugating Company; Div. of Wheeling-Pittsburgh Steel Corporation.
14. Or Approved Equal.

B. Fabricate ribbed steel sheet non-composite form deck panels to meet "SDI Specifications and Commentary for Non-composite Steel Form Deck," in SDI Publication No. 31, with the minimum section properties indicated, and with the following:
1. Galvanized steel sheet to meet ASTM A 653/A 653M, Structural Steel (SS), Grade 40, G60 zinc coating.
2. Provide profile depth as indicated on the Contract Drawings.
3. Provide design uncoated steel thickness as indicated on the Contract Drawings.
4. Provide span condition as indicated on the Contract Drawings.
5. Side laps to be overlapped or interlocking seam at the Contractor's option.

2.05 Accessories

A. Provide the manufacturer's standard accessory materials for deck that meet the requirements indicated.

B. Mechanical fasteners to be corrosion resistant, low velocity, power actuated or pneumatically driven carbon steel fasteners; or self-drilling, self-threading screws.

C. Side lap fasteners to be corrosion resistant, hexagonal washer head; self-drilling, carbon steel screws, No. 10 minimum diameter.

D. Flexible closure strips to be vulcanized, closed cell, synthetic rubber.

E. Miscellaneous sheet metal deck accessories to be steel sheet, minimum yield strength of 33,000 psi, not less than 0.0359 inch design uncoated thickness, of same material and finish as deck; of profile indicated or required for application.

F. Pour stops and girder fillers to be steel sheet, minimum yield strength of 33,000 psi, of same material and finish as deck, and of thickness and profile recommended by SDI Publication No. 31 for overhang and slab depth.

G. Column closures, end closures, Z-closures and cover plates to be steel sheet, of same material, finish and thickness as deck unless otherwise indicated.

H. Galvanizing repair paint to meet ASTM A 780/A 780M.

I. Repair paint to be the manufacturer's standard rust inhibitive primer of same color as primer.

PART 3 - EXECUTION

3.01 Examination

A. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Installation

A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 31, the manufacturer's written instructions and requirements in this Section.

B. Install temporary shoring before placing deck panels if required to meet deflection limitations.

C. Locate deck bundles to prevent overloading of supporting members.

D. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side lap interlocks.

1. Align cellular deck panels over full length of cell runs and align cells at ends of abutting panels.

E. Place deck panels flat and square and fasten to supporting frame without warp or deflection.

F. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to deck.

G. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of deck and support of other work.

H. Meet the AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.

I. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to the deck manufacturer's written instructions.

3.03 Roof Deck Installation

A. Fasten roof deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated or arc seam welds with an equal perimeter that is not less than 1 1/2 inches long, and as follows:

1. Weld diameter to be 3/4 inch, nominal.

2. Weld edge and interior ribs of deck units with a minimum of two (2) welds per deck unit at each support. Space welds 18 inches apart, maximum.

B. Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of 1/2 of the span or 18 inches for 1 1/2 inch deck and 36 inches for 3 inch deck, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon steel screws.

2. Fasten with a minimum of 1 1/2 inch long welds.

C. Install deck ends over supporting frame with a minimum end bearing of 1 1/2 inches, with end joints as follows:

1. End joints to be lapped 2 inches minimum or butted at the Contractor's option.

D. Install ridge and valley plates, finish strips, end closures and reinforcing channels according to the deck manufacturer's written instructions. Weld or mechanically fasten to substrate to provide a complete deck installation.

1. Weld cover plates at changes in direction of roof deck panels unless otherwise indicated.

E. Install flexible closure strips over partitions, walls and where indicated.

F. Install with adhesive according to the manufacturer's written instructions to ensure complete closure.

3.04 Floor Deck Installation

A. Fasten floor deck panels to steel supporting members by arc spot (puddle) welds of the surface diameter indicated and as follows:

1. Weld diameter to be 3/4 inch, nominal.

2. Weld edge ribs of panels at each support. Space additional welds an average of 12 inches apart, but not more than 18 inches apart.

B. Fasten side laps and perimeter edges of panels between supports, at intervals not exceeding the lesser of half of the span or 36 inches, and as follows:

1. Mechanically fasten with self-drilling, No. 10 diameter or larger, carbon steel screws.
2. Fasten with a minimum of 1 1/2 inch long welds.

C. Install deck ends over supporting frame with a minimum end bearing of 1 1/2 inches with end joints as follows:

1. End joints to be lapped or butted at the Contractor's option.

D. Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations unless otherwise indicated.

E. Weld steel sheet column closures, cell closures and Z-closures to deck, according to SDI recommendations, to provide tight fitting closures at open ends of ribs and sides of deck.

3.05 Field Quality Control

A. The Contractor will engage a qualified testing agency to perform tests and inspections.

B. Field welds will be subject to inspection.

C. Testing agency will report inspection results promptly and in writing to the Contractor and SEPTA.

D. Remove and replace work that does not meet the specified requirements.

E. Additional inspecting, at the Contractor's expense, will be performed to determine compliance of corrected work with specified requirements.

3.06 Protection

A. Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780/A 780M and the manufacturer's written instructions.

B. Provide final protection and maintain conditions to ensure that steel deck is without damage or deterioration at time of Substantial Completion.

END OF SECTION

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SECTION 05500

METAL FABRICATIONS

PART 1 - GENERAL

1.01 Description

A. This Section specifies items and assemblies fabricated from structural steel shapes and other materials as shown and specified.

B. Items specified:

1. Support for wall mounted items.
2. Shelf angles.
3. Caged roof access ladder with security door.
4. Painted cast iron rain water leaders.
5. Security cage.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Requirements

C. Section 04200 – Unit Masonry

D. Section 05120 – Structural Steel

E. Section 09910 – Paints and Coatings

F. Section 09960 – Painting of Steel

1.03 Submittals

A. Submit in accordance with Section 01300.

B. Submit shop drawings:

1. Each item specified, showing complete detail, location in the Project, material and size of components, method of joining various components and assemblies, finish, location, size and type of anchors.
2. Mark items requiring field assembly for erection identification and furnish erection drawings and instructions.
3. Provide templates and rough-in measurements as required.

C. Submit manufacturer's certificates:

1. Live load designs as specified.

D. Submit welding certificates.

E. Submit design calculations for specified live loads including dead loads.

F. Submit qualification data for a Professional Engineer licensed in the Commonwealth of Pennsylvania.

G. Submit setting drawings and instructions for installation of anchors to be preset into concrete and masonry work, and for the positioning of items having anchors to be built into concrete or masonry construction.

H. Submit analysis data; for ladders; including analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

1.04 Quality Assurance

A. Field welding is not permitted.

B. Qualify procedures and personnel according to AWS D1.1.

C. Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication.

D. Each manufactured product shall meet, as a minimum, the requirements specified, and shall be a standard commercial product of a manufacturer regularly presently manufacturing items of type specified.

E. Assemble products to the greatest extent possible before delivery to the site. No field welding will be permitted without the permission of the SEPTA Project Manager.

F. Include additional features, which are not specifically prohibited by this Specification, but which are a part of the manufacturer's standard commercial product.

G. Employ a Professional Engineer licensed in the Commonwealth of Pennsylvania competent in design and structural analysis to fabricate ladders and other metal fabrications in compliance with industry standards and local codes.

H. SEPTA reserves the right to shop inspect at any time during the fabrication and finishing processes.

I. SEPTA reserves the right to require NDE inspection from an independent testing agency, at no cost to SEPTA.

J. The Contractor must notify SEPTA five (5) days prior to beginning fabrication and finishing, to determine if SEPTA shall require a shop inspection prior to allowing the product to move forward to the next phase.

K. Field Visit and Measurements:

1. Any discrepancies between the Contact Drawings and what is in the field shall be brought to the attention of the SEPTA Project Manager. It is assumed that slight variation may exist and this is to be expected. Extras associated with discrepancies shall only be granted where these discrepancies can be proved to be a major consequence on the design and fabrication.

2. It is recommended that the fabricator visit the site prior to bidding on any fabrication in which the size of the project may require special on-site handling requirements or where the fabrication must fit into existing conditions.

L. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI A14.3, American National Standard (ASC) for Ladders - Fixed - Safety Requirements.
2. ASCE/SEI 7, Minimum Design Loads for Building and Other Structures.
3. ASME B18.2.2, Nuts for General Applications: Machine Screw Nuts, Square, Hex Flange, and Coupling Nuts (Inch Series).
4. ASME B18.6.1, Wood Screws (Inch Series).
5. ASTM A 27/A 27M, Standard Specification for Steel Castings, Carbon, for General Application.
6. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
7. ASTM A 47/A 47M, Standard Specification for Ferritic Malleable Iron Castings.
8. ASTM A 48/A 48M, Standard Specification for Gray Iron Castings.
9. ASTM A 53/A 53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
10. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
11. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
12. ASTM A 269/A 269M, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
13. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs and Threaded Rod 60,000 PSI Tensile Strength.
14. ASTM A 312/A 312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
15. ASTM A 380/A 380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
16. ASTM A 391/A 391M, Standard Specification for Grade 80 Alloy Steel Chain.
17. ASTM A 480/A 480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
18. ASTM A 484/A 484M, Standard Specification for General Requirements of Stainless Steel Bars, Billets, and Forgings.
19. ASTM A 500/A 500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
20. ASTM A 555/A 555M, Standard Specification for General Requirements for Stainless Steel Wire and Wire Rods.
21. ASTM A 563, Standard Specification for Carbon and Alloy Steel Nuts.
22. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

23. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate and Flat Bar.
24. ASTM A 780/A 780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
25. ASTM A 786/A 786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
26. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
27. ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Shapes, and Tubes.
28. ASTM B 456, Standard Specification for Electrodeposited Coatings of Copper Plus Nickel Plus Chromium and Nickel Plus Chromium.
29. ASTM B 632/B 632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
30. ASTM B 633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
31. ASTM C 1107/C 1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
32. ASTM D 1187/D 1187M, Standard Specification for Asphalt-Based Emulsions for Use as Protective Coatings for Metal.
33. ASTM D 3656/D 3656M, Standard Specification for Insect Screening and Louver Cloth Woven from Vinyl-Coated Glass Yarns.
34. ASTM E 488/E 488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
35. ASTM F 436, Standard Specification for Hardened Steel Washers.
36. ASTM F 468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use.
37. ASTM F 593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
38. ASTM F 594, Standard Specification for Stainless Steel Nuts.
39. ASTM F 1267, Standard Specification for Metal, Expanded, Steel.
40. ASTM F 1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
41. ASTM F 1667, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
42. ASTM F 1941/F 1941M, Standard Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric.
43. ASTM F 2329/F 2329M, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

44. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
45. AWS D1.1, Structural Welding Code - Steel.
46. AWS D1.2, Structural Welding Code - Aluminum.
47. AWS D1.3, Structural Welding Code - Sheet Steel.
48. FS RR-T-650E, Treads, Metallic and Nonmetallic, Nonskid.
49. MIL-M-17194C, Metal, Expanded, Steel.
50. NAAMM AMP 521, Pipe Railing Manual.
51. NAAMM AMP 500-505, Metal Finishes Manual.
52. NAAMM MBG 531, Metal Bar Grating Manual.
53. NAAMM MBG 532, Heavy Duty Metal Bar Grating Manual.
54. OSHA 1910.27, Fixed Ladders.
55. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel.
56. SSPC-SP 1, Solvent Cleaning.
57. SSPC-SP 2, Hand Tool Cleaning.
58. SSPC-SP 3, Power Tool Cleaning.
59. SSPC-SP 6, Commercial Blast Cleaning.

1.05 Delivery, Storage and Handling

A. Deliver materials in protective wrappings with each item labeled with installation location.

B. Deliver, store and handle all materials to prevent damage by breaking, water or moisture and contamination by foreign materials.

C. Store materials on a clean, dry surface or platform, off ground, covered, separate from each other and protected from deterioration and the elements. Bear fully along all supported edges on level and true structural supports. Ventilate to avoid condensation.

D. Handle all materials in a manner which will prevent undue stress on component parts, sealants and structural members. Do not rack, torque or cause load forces in an inappropriate manner. Lift panels from top only unless specifically instructed by the manufacturer.

1.06 Warranty

A. Ladder:

1. The manufacturer has responsibility for an extended corrective period for work of this Section for a period of five (5) years from date of Substantial Completion against all the conditions indicated below, and when notified in writing from SEPTA, the manufacturer shall promptly and without inconvenience and cost to SEPTA correct said deficiencies.
    a. Defects in materials and workmanship.

b. Deterioration of material and surface performance below minimum OSHA standards as certified by independent third party testing laboratory. Ordinary wear and tear, unusual abuse or neglect excepted.

c. Within the warranty period, the manufacturer shall, at its option, repair, replace or refund the purchase price of defective ladder.

2. The manufacturer shall be notified immediately of defective products, and be given a reasonable opportunity to inspect the goods prior to return. The manufacturer will not assume responsibility, or compensation, for unauthorized repairs or labor. The manufacturer makes no other warranty, expressed or implied, to the merchantability, fitness for a particular purpose, design, sale, installation, or use, of the ladder; and shall not be liable for incidental or consequential damages, losses of or expenses resulting from the use of ladder products.

PART 2 - PRODUCTS

2.01 Design Criteria

A. Engage a qualified Professional Engineer licensed in the Commonwealth of Pennsylvania, as defined in Section 01400 to design ladders, including attachment to building construction.

B. Decorative formed metal items, including anchors and connections, shall withstand the effects of gravity loads and the following loads and stresses without exceeding the allowable design working stress of materials involved and without exhibiting permanent deformation in any components:

1. Wind loads on exterior items to be as indicated on the Contract Drawings.

C. Aluminum ladders shall withstand the effects of loads and stresses within limits and under conditions specified in ANSI A14.3.

D. Exterior decorative formed metal items, including anchors and connections, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. Component importance factor to be 1.0.

E. Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects.

1. Temperature change to be 120°F ambient; 180°F material surfaces.

2.02 Metals

A. Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed work, provide materials without seam marks, roller marks, rolled trade names or blemishes.

B. Steel Plates, shapes and bars to meet ASTM A 36/A 36M.

1. Rolled steel floor plate to meet ASTM A 36/A 36M.

C. Steel tubing to meet ASTM A 500/A 500M, cold formed steel tubing.

D. Steel pipe to meet ASTM A 53/A 53M standard weight (schedule 40) unless otherwise indicated.

1. Galvanized for exterior locations.
2. Type S, Grade A unless specified otherwise.
3. NPS (inside diameter) as shown.

E. Cast iron to be either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

2.03 Hardware

A. Rough Hardware:

1. Furnish rough hardware with a standard plating, applied after punching, forming and assembly of parts; galvanized, cadmium plated or zinc coated by electro-galvanizing process. Galvanized G90 where specified.
2. Use G90 galvanized coating on ferrous metal for exterior work unless non-ferrous metal or stainless is used.

2.04 Fasteners

A. Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc plated fasteners with coating meeting ASTM B 633 or ASTM F 1941/F 1941M, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade and class required.

1. Provide stainless steel fasteners for fastening aluminum.
2. Provide stainless steel fasteners for fastening stainless steel.
3. Provide stainless steel fasteners for fastening nickel silver.
4. Provide bronze fasteners for fastening bronze.

B. Steel bolts and nuts to be regular hexagon head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Steel bolts and nuts to be regular hexagon head bolts, ASTM F 3125/F 3125M, Type 3; with hex nuts, ASTM A 563, Grade C3; and, where indicated, flat washers.

D. Stainless steel bolts and nuts to be regular hexagon head annealed stainless-steel bolts, ASTM F 593; with hex nuts, ASTM F 594; and, where indicated, flat washers; Alloy Group 1 (A1).

E. Anchor bolts to meet ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

1. Hot dip galvanize or provide mechanically deposited, zinc coating where item being fastened is indicated to be galvanized.

F. Anchors to be capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

G. Cast-in-place anchors in concrete to be either threaded type or wedge type unless otherwise indicated; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or

ASTM A 27/A 27M cast steel. Provide bolts, washers and shims as needed, all hot dip galvanized per ASTM F 2329/F 2329M.

H. Post installed anchors to be chemical anchors.

1. Material for interior locations to be carbon steel components zinc plated to meet ASTM B 633 or ASTM F 1941/F 1941M, Class Fe/Zn 5, unless otherwise indicated.

2. Material for exterior locations and where stainless steel is indicated to be Alloy Group 1 (A1) stainless steel bolts, ASTM F 593, and nuts, ASTM F 594.

3. Blind bolts to be Type HB – Hollo Bolt; Or Approved Equal.

2.05 Miscellaneous Materials

A. Provide primers that meet Section 09910.

B. Primer formulated for exterior use over zinc coated metal and compatible with finish paint systems indicated.

C. Galvanizing repair paint to be high zinc dust content paint meeting SSPC-Paint 20 and compatible with paints specified to be used over it.

D. Bituminous paint to be cold applied asphalt emulsion meeting ASTM D 1187/D 1187M.

E. Non-shrink, nonmetallic grout to be factory packaged, non-staining, noncorrosive, nongaseous grout meeting ASTM C 1107/C 1107M. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

2.06 General Fabrication

A. Material:

1. Use material as specified. Use material of commercial quality and suitable for intended purpose for material that is not named or its standard of quality not specified.

2. Use material free of defects which could affect the appearance or service ability of the finished product.

B. Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

C. Cut, drill and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form bent metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

E. Form exposed work with accurate angles and surfaces and straight edges.

F. Weld corners and seams continuously to meet the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing. Weld in accordance with AWS.
5. Welds shall show good fusion, be free from cracks and porosity, and accomplish secure and rigid joints in proper alignment.
6. Where exposed in the finished work, continuous weld for the full length of the members joined and have depressed areas filled and protruding welds finished smooth and flush with adjacent surfaces.
7. Finish welded joints to match finish of adjacent surface.

G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

1. Miter or butt members at corners.
2. Where frames members are butted at corners, cut leg of frame member perpendicular to surface, as required for clearance.

H. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

I. Cut, reinforce, drill and tap metal fabrications as indicated to receive finish hardware, screws and similar items.

1. Accurately cut, machine and fit joints, corners, copes and miters.
2. Fit removable members to be easily removed.
3. Design and construct field connections in the most practical place for appearance and ease of installation.
4. Fit pieces together as required.
5. Fabricate connections for ease of assembly and disassembly without use of special tools.
6. Joints firm when assembled.
7. Conceal joining, fitting and welding on exposed work as far as practical.
8. Do not show rivets and screws prominently on the exposed face.
9. The fit of components and the alignment of holes shall eliminate the need to modify component or to use exceptional force in the assembly of item and eliminate the need to use other than common tools.

J. Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

1. Use methods for fastening or anchoring metal fabrications to building construction as shown or specified.

2. Where fasteners and anchors are not shown, design the type, size, location and spacing to resist the loads imposed without deformation of the members or causing failure of the anchor or fastener, and suit the sequence of installation.
3. Use material and finish of the fasteners compatible with the kinds of materials which are fastened together and their location in the finished work.
4. Fasteners for securing metal fabrications to new construction only, may be by use of threaded or wedge type inserts or by anchors for welding to the metal fabrication for installation before the concrete is placed or as masonry is laid.
5. Fasteners for securing metal fabrication to existing construction or new construction may be expansion bolts, toggle bolts, power actuated drive pins, welding, self-drilling and tapping screws or bolts, except where otherwise specified.

K. Where units are indicated to be cast into concrete or built into masonry, equip with integrally welded steel strap anchors, 1/8 inch by 1 1/2 inches, with a minimum 6 inch embedment and 2 inch hook, not less than 8 inches from ends and corners of units and 24 inches on center, unless otherwise indicated.

L. Size:

1. Size and thickness of members as shown.
2. When size and thickness is not specified or shown for an individual part, use size and thickness not less than that used for the same component on similar standard commercial items or in accordance with established shop methods.

M. Connections

1. Except as otherwise specified, connections may be made by welding, riveting or bolting.
2. Field riveting will not be approved.
3. Design size, number and placement of fasteners, to develop a joint strength of not less than the design value.
4. Size and shape welds to develop the full design strength of the parts connected by welds and to transmit imposed stresses without permanent deformation or failure when subject to service loadings.
5. Use rivets and bolts of material selected to prevent corrosion (electrolysis) at bimetallic contacts. Plated or coated material will not be approved.
6. Use stainless steel connectors for removable member's machine screws or bolts.

N. Workmanship

1. General:
    a. Fabricate items to design shown.
    b. Furnish members in longest lengths commercially available within the limits shown and specified.
    c. Fabricate straight, true, free from warp and twist, and where applicable square and in same plane.
    d. Provide holes, sinkages and reinforcement shown and required for fasteners and anchorage items.

e. Provide openings, cut outs and tapped holes for attachment and clearances required for work of other trades.

f. Prepare members for the installation and fitting of hardware.

g. Cut openings in gratings and floor plates for the passage of ducts, sumps, pipes, conduits and similar items. Provide reinforcement to support cut edges.

h. Fabricate surfaces and edges free from sharp edges, burrs and projections which may cause injury.

O. Finish:

1. Finish exposed surfaces in accordance with NAAMM Metal Finishes Manual.

2. Steel and iron to meet NAAMM AMP 504.

a. Zinc coated (galvanized) to meet ASTM A 123/A 123M, G90 unless noted otherwise.

b. Surfaces exposed in the finished work:

1) Finish smooth rough surfaces and remove projections.

2) Fill holes, dents and similar voids and depressions with epoxy type patching compound.

c. Shop Prime Painting:

3) Surfaces of Ferrous Metal:

a) Items not specified to have other coatings.

b) Galvanized surfaces specified to have prime paint.

c) Remove all loose mill scale, rust and paint, by hand or power tool cleaning as defined in SSPC-SP 2 and SSPC-SP 3.

d) Clean of oil, grease, soil and other detrimental matter by use of solvents or cleaning compounds as defined in SSPC-SP 1.

e) After cleaning and finishing apply one (1) coat of primer as specified in Section 09910.

4) Non-ferrous metals to meet NAAMM 500 series.

P. Protection:

1. Spot prime all abraded and damaged areas of zinc coating which expose the bare metal using zinc rich paint on hot dip zinc coat items and zinc dust primer on all other zinc coated items.

2.07 Miscellaneous Framing and Supports

A. Provide steel framing and supports not specified in other Sections as needed to complete the work.

B. Fabricate units from steel shapes, plates and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes and profiles indicated and as necessary to receive adjacent construction.

1. Fabricate units from slotted channel framing where indicated.

2. Furnish inserts for units installed after concrete is placed.

C. Galvanize miscellaneous framing and supports where indicated.

D. Prime miscellaneous framing and supports with primer specified in Section 09910.

2.08 Shelf Angles

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4 inch bolts, spaced not more than 6 inches from ends and 24 inches on center, unless otherwise indicated.

1. Provide mitered and welded units at corners.

2. Provide open joints in shelf angles at expansion and control joints. Make open joint approximately 2 inches larger than expansion or control joint.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete.

C. Galvanize and prime all shelf angles located in exterior walls.

D. Prime shelf angles located in exterior walls with primer specified in Section 09910.

2.09 Loose Bearing and Leveling Plates

A. Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction. Drill plates to receive anchor bolts and for grouting.

B. Galvanize plates.

C. Prime plates with zinc rich primer. Refer to Section 09910.

2.10 Steel Weld Plates and Angles

A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the work. Provide each unit with no fewer than two (2) integrally welded steel strap anchors for embedding in concrete.

2.11 Metal Ladders

A. General:

1. Meet ANSI A14.3.

B. Manufacturers:

1. The basis of design is O'Keeffe's, Inc.; 325 Newhall St. San Francisco, CA 94124, Tel: (888) 653-3333, http://www.okeeffes.com.

2. ACL Industries, Inc.

3. ALACO Ladder Co.

4. Or Approved Equal.

C. Fixed Cage Ladder:

1. Low Parapet Access with Roofover Rail Extensions:

a. Model 532 as manufactured by O'Keeffe's Inc.; Or Approved Equal.

b. Security door.

D. Clear anodic finish to be AA-M10C22A41 mechanical finish as fabricated. Architectural Class I, clear coating 0.018 mm or thicker.

E. Material:

1. Aluminum sheet to be Alloy 5005-H34 to meet ASTM B 209.
2. Aluminum extrusions to be Alloy 6063-T6 to meet ASTM B 221.

F. Fabrication:

1. Rungs to be not less than 1 1/4 inches in section and 18 3/8 inches long, formed from tubular aluminum extrusions. Squared and deeply serrated on all sides.
   a. Rungs shall withstand a 1,500 pound load without deformation or failure.
2. Channel side rails to be not less than 1/8 inch wall thickness by 3 inches wide.
3. Heavy duty tubular side rails to be assembled from two (2) interlocking aluminum extrusions no less than 1/8 inch wall thickness by 3 inches wide. Construction shall be self-locking stainless steel fasteners, full penetration TIG welds and clean, smooth and burr free surfaces.
4. Roof rail extension to be not less than 3 feet 6 inches above the landing and shall be fitted with deeply serrated, square, tubular grab rails.
5. Security doors to be formed 1/8 inch thick aluminum sheet. Security panels shall extend on both sides, perpendicular to the door face, to within 2 inches of the wall. Security door shall be furnished with continuous aluminum piano hinge and heavy duty forged steel locking hasps.
6. Ladder safety post to be retractable hand hold and tie off.
7. Safety Cage:
   a. Fabricate ladder safety cages to comply with the authority having jurisdiction. Assemble by welding. Spacing of primary hoops, secondary hoops and vertical bars shall not exceed that required by code.
   b. Safety cage hoops and vertical bars to be 3/16 inch by 2 inches aluminum bar.

2.12 Rain Leader

A. Plain round complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.

B. Material to be cast iron.

2.13 Security Cage

A. Three (3) sided enclosure with ceiling and swing door.

1. Frame shall be 2 inches by 2 inches by 14 gauge tube steel.
2. Infill shall be steel expanded metal.
   a. MIL-M-17194C, ASTM F 1267, Type II, standard (raised) surface.
   b. 3/4 inch diamond pattern.
   c. 9 gauge.

2.14 Finishes

A. Finish metal fabrications after assembly.

B. Finish exposed surfaces to remove tool and die marks and stretch lines, and to blend into surrounding surface.

2.15 Steel and Iron Finishes

A. Hot dip galvanize items as indicated to meet ASTM A 153/A 153M for steel and iron hardware and ASTM A 123/A 123M for other steel and iron products.

1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

B. After galvanizing, thoroughly clean railings of grease, dirt, oil, flux and other foreign matter, and treat with metallic phosphate process.

C. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed on fireproofing, or masonry, or unless otherwise indicated.

1. Shop prime with primers specified in Section 09910.

D. Prepare surfaces for shop priming to meet the requirements indicated below:

1. Exterior items to meet SSPC-SP 6.
2. Items indicated to receive zinc-rich primer to meet SSPC-SP 6.
3. Items indicated to receive primers specified in Section 09960 to meet SSPC-SP 6.
4. Other items to meet SSPC-SP 3.

E. Apply shop primer to comply with SSPC-PA 1 for shop painting.

PART 3 - EXECUTION

3.01 Examination and Inspection

A. SEPTA reserves the right to shop inspect at any time during the fabrication and finishing process.

B. The Contractor must notify SEPTA five (5) days prior to beginning fabrication, galvanizing and painting, to determine if SEPTA shall require a shop inspection prior to allowing the product to move forward to the next phase.

3.02 Installation

A. Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment and elevation; with edges and surfaces level, plumb, true and free of rack and twist, set parallel or perpendicular as required to line and plane of surface and measured from established lines and levels.

B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut or abrade surfaces of exterior units that have been hot dip galvanized after fabrication and are for bolted or screwed field connections.

C. Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag screws, wood screws and other connectors.

1. Provide temporary bracing for such items until concrete or masonry is set.
2. Place in accordance with setting drawings and instructions.
3. Build strap anchors into masonry as work progresses.

D. Set frames of gratings, covers, corner guards, trap doors and similar items flush with finish floor or wall surface and, where applicable, flush with side of opening.

E. Field weld in accordance with AWS.

1. Design and finish as specified for shop welding.
2. Use continuous weld unless specified otherwise.

F. Install anchoring devices and fasteners as shown and as necessary for securing metal fabrications to building construction as specified. Expansion anchors should be used where shown on the Contract Drawings and elsewhere except where shown otherwise. Power actuated drive pins may be used except for removable items and where members would be deformed or substrate damaged by their use.

G. Spot prime all abraded and damaged areas of zinc coating as specified and all abraded and damaged areas of shop prime coat with same kind of paint used for shop priming.

H. Isolate aluminum from dissimilar metals and from contact with concrete and masonry materials as required to prevent electrolysis and corrosion.

3.03 Installation of Miscellaneous Framing and Supports

A. Install framing and supports to meet the requirements of items being supported, including the manufacturers' written instructions and requirements indicated on shop drawings.

B. Anchorage to Structure:

1. Secure angles and clips to structure as shown or as required.
2. Secure supports to mid height of concrete beams when inserts do not exist with expansion anchors and to slabs, with expansion anchors unless shown otherwise.
3. Secure steel plate and steel angles to slabs or masonry walls with expansion anchors unless shown or specified otherwise.

3.04 Installing Bearing and Leveling Plates

A. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces. Clean bottom surface of plates.

B. Set bearing and leveling plates on wedges, shims or leveling nuts. After bearing members have been positioned and plumbed, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with non-shrink grout. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.05 Clean and Adjusting

A. Immediately after erection, clean field welds, bolted connections and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to meet SSPC-PA 1 for touching up shop painted surfaces.

1. Apply by brush or spray to provide a minimum 2.0 mil dry film thickness.

B. Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint are specified in Section 09910.

C. Clean field welds, bolted connections and abraded areas and repair galvanizing to meet ASTM A 780/A 780M.

D. Clean after installation exposed pre-finished and plated items and items fabricated from stainless steel, aluminum and copper alloys, as recommended by the metal manufacture and protected from damage until completion of the Contract.

E. Clean after installation exposed pre-finished and plated items and items fabricated from stainless steel, as recommended by the metal manufacturer and protect from damage until completion of the Contract.

F. If any surface staining becomes apparent, stainless steel must be cleaned and repassivated by experienced personnel. If this action is deemed necessary by the SEPTA Project Manager, the Contractor shall submit their proposed process and a mock-up to SEPTA for approval prior to start of work.

G. Only approved stainless steel cleaners shall be used. Strong unapproved acids such as muriatic or cleaners containing chlorine shall not be used.

END OF SECTION

SECTION 05511

METAL GRATING STAIRS

PART 1 - GENERAL

1.01 Description

A. Section includes industrial type, straight run stairs with steel grating treads and railings attached to metal grating stairs.

1.02 Related Sections

A. Section 01400 – Quality Requirements

B. Section 05520 – Handrails and Railings

C. Section 09910 – Paints and Coatings

1.03 Submittals

A. Submit product data for metal grating stairs and the following:

1. Paint products.

2. Grout.

B. Submit shop drawings including plans, elevations, sections, details and attachments.

C. Submit delegated design submittal for stairs, including analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

D. Submit welding certificates.

E. Submit paint compatibility certificates from manufacturers of topcoats applied over shop primers, certifying that shop primers are compatible with topcoat.

1.04 Quality Assurance

A. Installer qualifications to be fabricator of products.

B. Qualify procedures and personnel according to AWS D1.1.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.

2. ASTM A 47/A 47M, Standard Specification for Ferritic Malleable Iron Castings.

3. ASTM A 48/A 48M, Standard Specification for Gray Iron Castings.

4. ASTM A 283/A 283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

5. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.

6. ASTM A 510/A 510M, Standard Specification for General Requirements for Wire Rods and Coarse Round Wire, Carbon Steel, and Alloy Steel.
7. ASTM A 563, Standard Specification for Carbon and Alloy Steel Nuts.
8. ASTM A 786/A 786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
9. ASTM A 1011/A 1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
10. ASTM A 1018/A 1018M, Standard Specification for Steel, Sheet and Strip, Heavy-Thickness Coils, Hot-Rolled, Carbon, Commercial, Drawing, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
11. ASTM B 633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
12. ASTM C 1107/C 1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
13. ASTM E 488/E 488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
14. ASTM F 1554, Standard Specification for Anchors Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
15. ASTM F 1941/F 1941M, Standard Specification for Electrodeposited Coatings on Mechanical Fasteners, Inch and Metric.
16. AWS D1.1 Structural Welding Code - Steel.
17. NAAMM AMP 510, Metal Stairs Manual.
18. NAAMM MBG 531, Metal Bar Grating Manual.
19. National Ornamental and Miscellaneous Metals Association (NOMMA).
20. SSPC-PA 1, Shop, Field and Maintenance Painting of Steel.
21. SSPC-SP 6 Commercial Blast Cleaning.

1.05 Delivery, Storage and Handling

A. Refer to Section 01400.

B. Meet the manufacturer’s ordering instructions and lead time requirements to avoid construction delays.

C. Deliver materials in the manufacturer’s original unopened, undamaged containers with identification labels intact.

D. Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.

E. Store materials and accessories off ground, under cover, and protected from weather and construction activities.

1.06 Warranty

A. All components shall be warranted for five (5) years against frame failure, mill scale, rusting, corrosion, rust stains, chipping, pealing, and/or paint discoloration and/or fading.

1.07 Coordination

A. Coordinate selection of shop primers with topcoats to be applied over them. Meet the paint and coating manufacturers' written instructions to ensure that shop primers and topcoats are compatible with one another.

B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Engage a Professional Engineer licensed in the Commonwealth of Pennsylvania, as defined in Section 01400, to design stairs.

B. Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Uniform Load to be 100 lbf/sq. ft.
2. Concentrated load to be 300 lbf applied on an area of 4 sq. in.
3. Uniform and concentrated loads need not be assumed to act concurrently.
4. Stair framing to be capable of withstanding stresses resulting from railing loads in addition to loads specified above.
5. Limit deflection of treads, platforms and framing members to L/360.

2.02 Metals

A. Provide materials with smooth, flat surfaces unless otherwise indicated. For components exposed to view in the completed work, provide materials without seam marks, roller marks, rolled trade names or blemishes.

B. Steel plates, shapes, and bars to meet ASTM A 36/A 36M.

C. Rolled steel floor plate to meet ASTM A 786/A 786M, rolled from plate meeting ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

D. Steel bars for grating treads to meet ASTM A 36/A 36M or steel strip, ASTM A 1011/A 1011M or ASTM A 1018/A 1018M.

E. Wire rod for grating crossbars to meet ASTM A 510/A 510M.

F. Cast iron; either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

G. Cast abrasive nosings to be cast iron, with an integral abrasive, as cast finish consisting of aluminum oxide, silicon carbide or a combination of both.

2.03 Fasteners

A. Provide zinc plated fasteners with coating meeting ASTM B 633 or ASTM F 1941/F 1941M, Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade and class required.

B. Bolts and nuts to be regular hexagon head bolts, ASTM A 307, Grade; with hex nuts, ASTM A 563; and, where indicated, flat washers.

C. Anchor bolts to be ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563; and, where indicated, flat washers.

D. Post installed anchors to be torque controlled expansion anchors or adhesive anchors capable of sustaining, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and four (4) times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for interior locations to be carbon steel components zinc plated to meet ASTM B 633 or ASTM F 1941/F 1941M, Class Fe/Zn 5, unless otherwise indicated.

2.04 Miscellaneous Materials

A. Provide primers that meet Section 09910.

B. Non-shrink, nonmetallic grout to be factory packaged, non-staining, noncorrosive, nongaseous grout meeting ASTM C 1107/C 1107M. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

2.05 Fabrication

A. Provide complete stair assemblies, including metal framing, hangers, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.

1. Join components by welding unless otherwise indicated.

2. Use connections that maintain structural value of joined pieces.

B. Form exposed work with accurate angles and surfaces and straight edges.

C. Weld connections to meet the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. At exposed connections, finish exposed welds to meet NOMMA's "Voluntary Joint Finish Standards" for Type 4 welds: good quality, uniform undressed weld with minimal splatter.

D. Fabricate joints that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

2.06 Steel Framed Stairs

A. Meet the "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, Industrial Class, unless more stringent requirements are indicated.

B. Stair Framing:

1. Fabricate stringers of steel channels.
   a. Provide closures for exposed ends of channel stringers.
2. Construct platforms of steel channel headers and miscellaneous framing members as needed to meet the performance requirements.
3. Weld stringers to headers; weld framing members to stringers and headers.

C. Form treads and platforms to configurations shown from metal bar grating stairs; fabricate to meet NAAMM MBG 531.

1. Fabricate treads and platforms from welded steel grating with openings in gratings no more than 5/16 inch in least dimension.
2. Surface to be serrated.
3. Finish to be painted.
4. Fabricate grating treads with cast abrasive nosing and with steel angle or steel plate carrier at each end for stringer connections. Secure treads to stringers with bolts.
5. Fabricate grating platforms with nosing matching that on grating treads. Provide toe plates at open sided edges of grating platforms. Weld grating to platform framing.

2.07 Stair Railings

A. Meet the applicable requirements in Section 05520.

2.08 Finishes

A. Finish metal stairs after assembly.

1. Fill vent and drain holes that are exposed in the finished work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. Prepare uncoated ferrous metal surfaces to meet the minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed products:

1. Interior stairs to meet SSPC-SP 6.

C. Apply shop primer to uncoated surfaces of metal stair components, except those to be embedded in concrete or masonry unless otherwise indicated. Meet SSPC-PA 1 for shop painting.

1. Stripe paint corners, crevices, bolts, welds and sharp edges.

D. Apply finish coat. Refer to Section 09910.

PART 3 - EXECUTION

3.01 Installation

A. Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through bolts, lag bolts and other connectors.

B. Perform cutting, drilling and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.

3.02 Installing Metal Stairs with Grouted Baseplates

A. Clean concrete and masonry bearing surfaces of bond reducing materials and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel stair baseplates on wedges, shims or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims, but if protruding, cut off flush with edge of bearing plate before packing with grout.

1. Use nonmetallic, non-shrink grout unless otherwise indicated.

2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 Adjusting and Cleaning

A. Cleaning and touchup painting of bolted connections and abraded areas of shop paint are specified in Section 09910.

END OF SECTION

SECTION 05520

HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.01 Description

A. This Section includes stainless steel pipe railings.

1.02 Related Sections

A. Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

1.03 Submittals

A. Submit product data for the following:

1. Grout, anchoring cement and paint products.

B. Submit shop drawings including plans, elevations, sections, details and attachments to other work.

1. For installed products indicated to meet the design loads, include structural analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

C. Submit welding certificates.

D. Submit qualification data for a Professional Engineer licensed in the Commonwealth of Pennsylvania.

E. Submit product test reports based on evaluation of comprehensive tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

1.04 Quality Assurance

A. Obtain each type of railing through one (1) source from a single manufacturer.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
2. ASTM A 580/A 580M, Standard Specification for Stainless Steel Wire.
3. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
4. ASTM A 743/A 743M, Standard Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
5. ASTM D 1187/D 1187M, Standard Specification for Asphalt-Base Emulsions for Use as Protective Coatings for Metal.
6. ASTM E 488/E 488M, Standard Test Methods for Strength of Anchors in Concrete Elements.

7. ASTM E 894, Standard Test Method for Anchorage of Permanent Metal Railing Systems and Rails for Buildings.
8. ASTM E 935, Standard Test Methods for Performance of Permanent Metal Railing Systems and Rails for Buildings.
9. AWS D1.6, Structural Welding Code - Stainless Steel.
10. National Association of Architectural Metal Manufacturers (NAAMM).

1.05 Performance Requirements

A. Engineer railings to withstand structural loads indicated, determine allowable design working stresses of railing materials based on the following:
   1. Stainless steel to meet 60 percent of minimum yield strength.

B. Provide railings capable of withstanding the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
   1. Handrails:
      a. Uniform load of 50 lbf/ ft. applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   2. Top Rails of Guards:
      a. Uniform load of 50 lbf/ ft. applied in any direction.
      b. Concentrated load of 200 lbf applied in any direction.
      c. Uniform and concentrated loads need not be assumed to act concurrently.
   3. Infill of Guards:
      a. Concentrated load of 50 lbf applied horizontally on an area of 1 square foot.
      b. Infill load and other loads need not be assumed to act concurrently.

C. Provide exterior railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
   1. Temperature change (range) to be 120°F, ambient; 180°F, material surfaces.

D. Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.06 Delivery, Storage and Handling

A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.07 Project Conditions

A. Verify actual locations of walls and other construction contiguous with railings by field measurements before fabrication and indicate measurements on shop drawings.

1. Where field measurements cannot be made without delaying the work, establish dimensions and proceed with fabricating railings without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
2. Provide allowance for trimming and fitting at site.

1.08 Coordination and Scheduling

A. Coordinate installation of anchorages for railings. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

B. Schedule installation so wall attachments are made only to completed walls.

C. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.01 Metals

A. Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations or blemishes.

B. Brackets, flanges and anchors to be cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.02 Stainless Steel

A. Tubing to meet ASTM A 554, Grade MT 304.

B. Castings to meet ASTM A 743/A 743M, Grade CF 8 or CF 20.

C. Plate and sheet to meet ASTM A 666, Type 304.

D. Woven wire mesh to be intermediate crimp, square pattern, 2 inch woven wire mesh, made from 0.135 inch nominal diameter wire meeting ASTM A 580/A 580M, Type 304.

2.03 Fasteners

A. Provide the following:

1. Type 304 stainless steel fasteners for stainless steel railings.

B. Select fasteners of type, grade and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless otherwise indicated.
2. Provide square or hex socket flat head machine screws for exposed fasteners, unless otherwise indicated.

D. Provide cast-in-place anchors, fabricated from corrosion resistant materials with capability to sustain, without failure, a load equal to six (6) times the load imposed when installed in unit masonry and equal to four (4) times the load imposed when installed in concrete, as determined by testing per ASTM E 488/E 488M conducted by a qualified independent testing agency.

2.04 Miscellaneous Materials

A. Welding rods and bare electrodes to be selected according to AWS specifications for metal alloy welded.

B. Bituminous paint to be cold applied asphalt emulsion that meets ASTM D 1187/D 1187M.

C. Non-shrink, nonmetallic grout to be factory packaged, non-staining, noncorrosive, nongaseous grout meeting ASTM C 1107. Provide grout specifically recommended by the manufacturer for interior and exterior applications.

1. At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by the manufacturer for exterior use.

2.05 Fabrication

A. Fabricate railings to meet the requirements indicated for design, dimensions, member sizes and spacing, details, finish and anchorage, but not less than that required to support structural loads.

B. Assemble railings in the shop to the greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

C. Cut, drill and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

D. Form work true to line and level with accurate angles and surfaces.

E. Fabricate connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

F. Cut, reinforce, drill and tap as indicated to receive finish hardware, screws and similar items.

G. Fabricate railings with welded connections, unless otherwise indicated.

H. At welded connection cope components at connections to provide close fit or use fittings designed for this purpose. Weld all around at connections, including at fittings.

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusions without undercut or overlap.

3. Remove flux immediately.

4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

I. At non-welded connections connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is the manufacturer's standard splicing method.

J. Close exposed ends of railing members with prefabricated end fittings.

K. Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work, unless otherwise indicated.

L. Provide inserts and other anchorage devices for connecting railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

M. For removable railing posts, fabricate slip fit sockets from steel tube or pipe whose inner diameter is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.

N. Fabricate infill panels from woven wire mesh crimped into 1 inch by 1/2 inch by 1/8 inch metal channel frames. Make wire mesh and frames from same metal as railings in which they are installed.

1. Wire mesh is 2 inch by 2 inch square pattern.

O. Where indicated, provide toe boards at railings around openings and at edge of open sided floors and platforms. Fabricate to dimensions and details indicated.

2.06 Finishes

A. Meet NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.07 Stainless Steel Finishes

A. Remove tool and die marks and stretch lines or blend into finish.

B. Wire mesh shall have standard mill finish.

C. Bright directional polish #4 mill finish for tubing and standard mill finish for wire mesh.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.01 Installation

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling and fitting required for installing railings. Set railings accurately in location, alignment and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut or abrade surfaces of railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Adjust railings before anchoring to ensure matching alignment at abutting joints.

D. Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in place construction.

3.02 Railing Connections

A. At non-welded connections use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.

B. At welded connections use fully welded joints for permanently connecting railing components. Meet the requirements for welded connections in Article 2.05 in this Section whether welding is performed in the shop or in the field.

3.03 Anchoring Posts

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with non-shrink, nonmetallic grout, mixed and placed to meet the anchoring material manufacturer's written instructions.

B. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8 inch buildup, sloped away from post.

C. Anchor posts to metal surfaces with oval flanges, angle type or floor type as required by conditions, connected to posts and to metal supporting members as follows:

1. For stainless steel pipe railings, weld flanges to post and bolt to supporting surfaces.

D. Install removable railing sections, where indicated, in slip fit metal sockets cast in concrete.

3.04 Anchoring Railing Ends

A. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces and welded to railing ends.

3.05 Adjusting and Cleaning

A. Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

3.06 Protection

A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by the railing manufacturer. Remove protective coverings at time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit or provide new units.

END OF SECTION

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SECTION 05610

MISCELLANEOUS METALS

PART 1 - GENERAL

1.01 Description

A. This Section specifies furnishing and installing all miscellaneous metal works.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 05120 – Structural Steel

C. Section 09910 – Paints and Coatings

1.03 Submittals

A. Submit shop drawings of metal fabrications proposed to be used shall be submitted in accordance with Section 01300.

B. Submit shop drawings for the fabrication and assembly of all items and assemblies. They shall show anchorage, accessory items, and adjacent materials and conditions.

1.04 Quality Assurance

A. Materials and workmanship to be furnished under this Specification, including all accessories, shall meet the Commonwealth of Pennsylvania Building Code (International Building Code).

B. Welding processes and welding operators shall be qualified in accordance with AWS Standard Qualification Procedure.

C. Field measurement shall be taken prior to preparation of shop drawings and fabrication, where possible, to ensure proper fitting of the work. Allowance for fitting and trimming shall be made wherever the taking of field measurements before fabrication might delay the work.

D. Items shall be pre-assembled in the shop to the greatest extent possible. Units shall be field assembled or re-assembled only to the extent necessary. Units shall be clearly marked for reassembly and installation coordinated.

E. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
2. ASTM A 108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
3. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
4. ASTM A 283/A 283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

5. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
6. ASTM A 526/A 526M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Commercial Quality.
7. ASTM A 575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
8. ASTM A 568/A 568M, Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
9. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. ASTM A 992/A 992M, Standard Specification for Structural Steel Shapes.
11. ASTM A 1008/A 1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
12. ASTM A 1011/A 1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
13. ASTM A 1085/A 1085M, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
14. ASTM B 26/B 26M, Standard Specification for Aluminum-Alloy Sand Castings.
15. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. ASTM B 429/B 429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
18. ASTM C 1396/C 1396M, Standard Specification for Gypsum Board.
19. American Welding Society (AWS).
20. International Building Code (IBC).
21. National Association of Architectural Metal Manufacturers (NAAMM).
22. SSPC-SP 1, Solvent Cleaning.
23. SSPC-SP2, Hand Tool Cleaning.
24. SSPC-SP 3, Power Tool Cleaning.
25. SSPC-SP 7, Brush-off Blast Cleaning.

PART 2 - PRODUCTS

2.01 General

A. Only materials which are smooth and free of surface blemishes shall be used for the fabrication of miscellaneous metal work which will be exposed to view.

B. Blemishes shall be removed by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.

2.02 Materials

A. Steel plate, channels, M-shapes, S-shapes, and bars to meet ASTM A 36/A 36M.

B. Steel W-shapes to meet ASTM A 992/A 992M.

C. Steel plates to be bent or cold formed to meet ASTM A 283/A 283M, Grade C.

D. Hot rolled carbon steel bars to meet ASTM A 575.

E. Cold-finished steel bars to meet ASTM A 108.

F. Hot rolled carbon steel sheets and strips to meet ASTM A 568/A 568M and ASTM A 1011/A 1011M.

G. Cold rolled carbon steel sheets to meet ASTM A 1008/A 1008M.

H. Galvanized carbon steel sheets to meet ASTM A 526/A 526M; with 1.25-ounce commercial zinc coat that meets ASTM A 653/A 653M.

I. Steel bar grating to meet the requirements of the NAAMM "Metal Bar Grating Manual."

J. Extruded aluminum pipe and tube of Schedule 40 size to meet ASTM B 429/B 429M, 6064-T6.

K. Aluminum plate bar and sheet to meet ASTM B 209, 6061-T6 or ASTM B 221, 6063-T6.

L. Aluminum casting to meet ASTM B 26/B 26M, ANSI 356-Tb.

M. Two (2) coats of bituminous paint shall be applied on one (1) or both surfaces wherever dissimilar metals, or metal and masonry, would otherwise be in contact to separate metals. Gasketed fasteners shall be used where required to eliminate the possibility of corrosive or electrolytic action.

2.03 Fasteners

A. For securing aluminum plate cover placed across brick opening for roof drain leaders, use 1 inch by 1/4 inch raw plugs (nail-in type) with one (1) piece drive anchors; Or Approved Equal. All other masonry anchorage devices shall be expansion shield type with threaded fasteners.

B. Toggle bolts shall be tumble wing type; type, class and style as required.

C. Zinc coated fasteners, with ASTM A 153/A 153M; zinc coating (hot dip) on iron and steel hardware shall be used for exterior use or where built into exterior walls. Fasteners shall be selected for the type, grade and class required for the installation of miscellaneous metal items.

D. Standard bolts and nuts shall be ASTM A 307; carbon steel, externally and internally threaded standard fasteners, grade A, regular hexagon head.

E. Lag bolts shall be square head type.

F. Machine screws shall be cadmium plated steel.

G. Plain washers, screws (machine, slotted or cross recessed and round) shall be general assembly grade carbon steel.

H. Lock washers shall be helical spring type carbon steel.

I. Clip angles, brackets and flanges shall be of same material to be fastened.

J. Grout shall be that specifically recommended by manufacturer for interior and exterior applications of type specified and shall meet ASTM C 1396/C 1396M.

2.04 Miscellaneous Framing, Supports and Lintels

A. Miscellaneous units shall be fabricated to the size, shapes and profiles shown or, if not shown, of the required dimensions to receive other work to be retained by the framing.

B. Items shall be fabricated from structural steel shapes, plates and steel bars, of all welded construction using mitered corners, welded brackets and splice plates and a minimum number of joints for field connection. Unit shall be cut, drilled, and tapped to receive hardware and similar items to be anchored to the work.

C. Units shall be equipped with integrally welded anchor straps, for casting into poured concrete or building into masonry wherever required.

D. Miscellaneous framing, supports and lintels shall include, but are not limited to:

1. Miscellaneous clips and angles.
2. Frames for gratings.
3. Closure and support angles.
4. Loose lintels and lintels assemblies.
5. Loose bearing and leveling plates.

2.05 Cast Abrasive Nosings

A. Nosings for concrete steps shall be aluminum, with non-slip abrasive finish of size and configuration shown on the Contract Drawings, with cast on bolt anchor, 1/4 inch diameter by 1 inch deep.

B. Pattern of abrasive surface shall be checkered.

2.06 Miscellaneous Metal Fabrications

A. Miscellaneous metal fabrications shall be fabricated to the sizes, shapes and profile shown.

B. Except as otherwise shown, items shall be fabricated from carbon steel sheets, be of all welded construction using mitered corners, with a minimum number of joints for field connection.

C. Units shall be equipped with integrally welded anchor straps for building into masonry wherever required.

D. Miscellaneous metal fabrications shall include, but are not limited to:

1. Closure trims.

2.07 Steel Bar Gratings

A. Steel bar gratings shall be Irving Grating, type CM-2, galvanized; Or Approved Equal; by SEPTA, with bearing bars, 1 1/4 inch by 3/16 inch on center.

B. Steel bar gratings shall be welded to steel support beams.

2.08 Shop Painting

A. Miscellaneous metal work surfaces and edges, except those members or portions of members to be embedded in masonry, are to be field painted unless otherwise indicated.

B. Rust, scale and other deleterious materials shall be removed before the shop coat of paint is applied. Heavy rust and loose mill scale shall be cleaned in accordance with SSPC-SP 2, SSPC-SP 3 or SSPC-SP 7. Oil, grease and similar contaminants shall be removed in accordance with SSPC-SP 1.

C. One (1) shop coat of metal primer paint shall be applied to fabricated metal items and two (2) coats of paint to surfaces which are inaccessible after assembly or erection. Color of second coat shall be changed to distinguish it from the first coat.

D. Metal primer paint shall be brushed or sprayed on, in accordance with the manufacturer's instructions, at a rate to provide a uniform dry film thickness of 4.0 mils for each coat immediately after surface preparation. Methods which will result in full coverage of joints, corners, edges and all exposed surfaces shall be used for applying paint.

PART 3 - EXECUTION

3.01 General

A. The Contractor shall furnish and coordinate anchorage setting drawings, diagrams, templates, instructions and other directions for installation of anchorages, such as sleeves, anchor bolts and miscellaneous items having integral anchors which are to be imbedded in masonry construction.

B. Delivery of items to the Project site shall be coordinated with work of other trades to avoid delays.

C. Work shall be accurately set in location, alignment and elevation; plumb, level, true and free or rack; measured from established lines and levels.

D. Exposed connections shall fit accurately together to form tight, hairline joints. Weld connections, which are not to be left as exposed joints, but cannot be shop welded because of shipping limitations, shall be welded in the field.

E. Field welding, where approved by SEPTA, shall meet the AWS Code for procedures for Manual Shielded Metal Arc Welding, appearance and quality of welds made and methods used in correcting welding work.

F. Exposed joints shall be ground smooth and cleaned and painted in accordance with Section 09910.

3.02 Setting Fabrications

A. Bottom surfaces of units shall be cleaned, set, positioned and plumbed.

B. Grout shall be packed solidly between units and masonry to ensure that no voids remain.

C. Non-removable units shall be welded to supporting members of frameworks.

3.03 Adjust and Clean

A. Field welds, bolted connections and abraded areas of shop paint shall be cleaned, and exposed areas shall be painted with same paint used for shop painting. Paint shall be applied by brush to provide a minimum thickness of 4.0 mils.

END OF SECTION

SECTION 05900

METAL RESTORATION AND CLEANING

PART 1 - GENERAL

1.01 Description

A. Provide all labor, materials, tools, equipment and services necessary for cleaning, repair and reinstalling existing metal as indicated. Clean metal only where cleaning is indicated.

1.02 Related Sections

A. Section 02070 – Selective Demolition

B. Section 05500 – Metal Fabrications

1.03 Submittals

A. Submit manufacturer's product data for each product proposed for use in the work. Include instructions for handling, storage and application of each product.

B. Submit shop drawings including floor plans/elevations, locating each metal piece and identifying each with a sequential number which corresponds to that metal piece. Do not use the same number for more than one (1) piece. Indicate the size of each piece either on the plan or in the schedule.

C. Submit qualification data for metal refinishing specialist.

D. Submit preconstruction test reports for chemical cleaning of metal.

E. Submit quality control submittals:

1. Submit signed certification that materials are in accordance with the specified requirements.

F. Submit photographs of each metal piece as it exists in place prior to dismantling. Show surface on which metal piece is mounted so that it can be identified, and label each photograph with space name and metal piece number.

1.04 Quality Assurance

A. A qualified metal cleaning specialist shall be experienced in using mechanical and chemical methods on the types of metal surfaces indicated.

1.05 Delivery, Storage and Handling

A. Delivery:

1. Schedule delivery of materials at the site at such time as required for proper coordination of work. Receive materials in the manufacturer's unopened packages and bearing the manufacturer's label.

B. Storage and Handling:

1. Store materials in a dry and well ventilated place, adequately protected from damage and exposure to the elements.

PART 2 - PRODUCTS

2.01 Materials

A. Cleaning Materials:

1. Surfactant is a non-ionic surface active agent composed of an anhydrous mixture of alkylaryl polyether alcohols.
   a. Source:
      1) Triton X-100 by Rohm and Haas Company; Or Approved Equal. Triton X-100 is available from Fisher Scientific Company, 201-796-7100; J. T. Baker Chemical Co., 201-859-2151; and various photographic supply stores.
      2) Equivalent products by other manufacturers will only be considered for use after safety and effectiveness have been demonstrated through description of chemical and physical properties and effects; and comparison testing at site.
2. Ethanol to be industrial grade, denatured ethanol.
3. Water to be clean, potable, and free of acids and other deleterious substances.
4. Brushes to be medium stiffness nylon bristle, natural bristle or stiff animal hair brushes selected for maximum cleaning efficiency but with least potential for surface injury to material being cleaned.

B. Color to match cleaned existing finish of representative metal pieces designated by SEPTA.

PART 3 - EXECUTION

3.01 Preparation

A. Protect surrounding surfaces from liquids used in cleaning. Continuously collect and dispose of liquids and other waste.

1. Cover adjacent surfaces with materials that are proven to resist chemical solutions being used unless products being used will not damage adjacent surfaces. Use protective materials that are waterproof and UV resistant. Apply masking agents to meet the manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. When no longer needed, promptly remove masking to prevent adhesive staining.
2. Dispose of runoff from operations by legal means and in a manner that prevents soil erosion, undermining of paving and foundations, damage to landscaping and water penetration into building interiors.

3.02 Cleaning

A. Remove all loose dirt and dust with soft bristle brushes.

B. Wash with a surfactant solution:

1. Prepare a 2 percent solution of surfactant (2 1/2 fluid ounces to one gallon of warm water).
2. Pre-wet area to be cleaned with warm water.
3. Wash surfaces with surfactant solution applied to a soft line free cloth. Thoroughly wash all surfaces, including recesses and crevices. Use small soft brushes or cotton swabs to reach into narrow crevices. Control and collect run-off of solution; do not allow it to contact other surfaces.
4. Rinse surfaces with ethanol applied to a soft lint free cloth. Thoroughly rinse all surfaces, including recesses and crevices. Control and collect ethanol; do not allow it to contact other surfaces.
5. Remove dirt built-up in crevices with acetone applied to cotton swabs after the initial surfactant washing and rinsing.
6. Repeat washing and rinsing procedures as necessary to remove all dirt and surfactant residue.

3.03 Removal and Reinstallation of Metal Pieces

A. Perform removal work in a systematic manner and use such methods as required to complete the work indicated on the Contract Drawings and as needed for completion of the work and the Contract objectives in accordance with the requirements of the Contract Specification. Removal of metal pieces shall not damage surrounding metal pieces not affected by Contract scope.

B. Neatly cut openings and holes plumb, square and true to dimensions required. Use cutting methods least likely to damage metal to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces. Temporarily cover openings to remain.

C. Neatly trim and cut metal slats as needed as per Contract scope.

D. Reinstall metal slats to match existing installation. Reinstallation of metal pieces shall not damage surrounding metal pieces not affected by Contract scope.

E. Clean metal pieces of dirt and extraneous material.

3.04 Adjusting and Cleaning

A. Touch-up scratches and other defects with same paint as used for refinishing. Remove, strip, polish, refinish, if touch-up work is unacceptable to the SEPTA Project Manager, until completed work is acceptable.

B. Wipe completed work carefully with a soft cloth to remove fingerprints and dirt and leave in perfect condition.

END OF SECTION

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SECTION 06105

MISCELLANEOUS CARPENTRY

PART 1 - GENERAL

1.01 Description

A. This Section includes the following:

1. Rooftop equipment bases and support curbs.
2. Wood blocking, cants and nailers.
3. Plywood backing panels.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

1.03 Submittals

A. Submit product data for each type of process and factory fabricated product. Indicate component materials and dimensions and include construction and application details.

1. Include data for wood preservative treatment from the chemical treatment manufacturer and certification by treating plant that treated materials meet the requirements. Indicate type of preservative used and net amount of preservative retained.
2. Include data for fire retardant treatment from the chemical treatment manufacturer and certification by treating plant that treated materials meet the requirements. Include physical properties of treated materials based on testing by a qualified independent testing agency.
3. For products receiving a waterborne treatment, include statement that moisture content of treated materials was reduced to levels specified before shipment to Project site.
4. Include copies of warranties from the chemical treatment manufacturers for each type of treatment.

B. Submit research/evaluation reports for the following, showing compliance with building code in effect for the Contract:

1. Preservative treated wood.
2. Power driven fasteners.
3. Powder actuated fasteners.
4. Expansion anchors.

1.04 Quality Assurance

A. Testing agency providing classification marking for fire-retardant-treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

B. Meet the applicable provisions of the most recent issues of the following references:

1. American Forest and Paper Association (AF&PA).
2. American Lumber Standard Committee (ALCS).
3. ASME B18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
4. ASME B18.6.1, Wood Screws (Inch Series).
5. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
6. ASTM A 307, Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60,000 PSI Tensile Strength.
7. ASTM A 563, Standard Specification for Carbon and Alloy Steel Nuts.
8. ASTM B 633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
9. ASTM C 954, Standard Specification for Steel Drill Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Steel Studs from 0.033 in. (0.84 mm) to 0.112in. (2.8 mm) in Thickness.
10. ASTM E 488/E 488M, Standard Test Methods for Strength of Anchors in Concrete Elements.
11. ASTM F 593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
12. ASTM F 594, Standard Specification for Stainless Steel Nuts.
13. ASTM F 1667, Standard Specification for Driven Fasteners: Nails, Spikes, and Staples.
14. AWPA C2, Lumber, Timber, Bridge Ties and Mine Ties – Preservative Treatment by Pressure Processes.
15. AWPA C20, Structural Lumber – Fire-Retardant Treatment by Pressure Processes.
16. AWPA C27, Plywood – Fire-Retardant Treatment by Pressure Processes.
17. AWPA C31, Lumber Used Out of Contact with the Ground and Continuously Protected From Liquid Water – Treatment by Pressure Processes.
18. AWPA M4, Standard for the Care of Preservative – Treated Wood Products.
19. DOC PS 1, Structural Plywood.
20. DOC PS 20, American Softwood Lumber Standard.
21. Environmental Protection Agency (EPA).
22. International Building Code (IBC).

23. NES NER-272, Power-Driven Fasteners.

1.05 Delivery, Storage and Handling

A. Stack lumber flat with spacers between each bundle to provide air circulation. Provide for air circulation around stacks and under coverings.

B. Deliver interior wood materials that are to be exposed to view only after building is enclosed and weatherproof, wet work other than painting is dry, and HVAC system is operating and maintaining temperature and humidity at occupancy levels.

1.06 Definitions

A. Lumber of 2 inches nominal or greater but less than 5 inches nominal in least dimension.

B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NeLMA is the Northeastern Lumber Manufacturers' Association.
2. NHLA is the National Hardwood Lumber Association.
3. NLGA is the National Lumber Grades Authority.
4. SPIB is the Southern Pine Inspection Bureau.
5. WCLIB is the West Coast Lumber Inspection Bureau.
6. WWPA is the Western Wood Products Association.

1.07 Quality Assurance

A. Testing agency providing classification marking for fire retardant treated material, an inspection agency acceptable to authorities having jurisdiction that periodically performs inspections to verify that the material bearing the classification marking is representative of the material tested.

PART 2 - PRODUCTS

2.01 Wood Products

A. Lumber to be DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, provide lumber that meets the applicable rules of any rules writing agency certified by the ALSC Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.

1. Factory mark each piece of lumber with grade stamp of grading agency.
2. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry lumber.

2.02 Wood Preservative Treated Materials

A. Preservative treatment by pressure process to meet AWPA C2, except that lumber that is not in contact with the ground and is continuously protected from liquid water may be treated according to AWPA C31 with inorganic boron (SBX).

1. Preservative chemicals to be acceptable to authorities having jurisdiction and containing no arsenic or chromium.

B. Kiln dry lumber after treatment to a maximum moisture content of 19 percent. Do not use material that is warped or does not meet the requirements for untreated material.

C. Mark lumber with treatment quality mark of an inspection agency approved by the ALSC Board of Review.

1. For exposed lumber indicated to receive a stained or natural finish, mark end or back of each piece or omit marking and provide certificates of treatment compliance issued by inspection agency.

D. Treat items indicated on the Contract Drawings and the following:

1. Wood cants, nailers, curbs, equipment support bases, blocking, stripping and similar members in connection with roofing, flashing, vapor barriers and waterproofing.

2. Wood sills, sleepers, blocking and similar concealed members in contact with masonry or concrete.

2.03 Miscellaneous Lumber

A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:

1. Blocking.

2. Nailers.

3. Cants.

B. For items of dimension lumber size, provide construction or No. 2 grade lumber with 19 percent maximum moisture content and any of the following species:

1. Hem-fir (north); NLGA.

2. Mixed southern pine; SPIB.

3. Spruce-pine-fir; NLGA.

4. Spruce-pine-fir (south); NeLMA, WCLIB, or WWPA.

5. Northern species; NLGA.

6. Eastern softwoods; NeLMA.

C. For exposed boards, provide lumber with 15 percent maximum moisture content and any of the following species and grades:

1. Eastern white pine, Idaho white, lodgepole, ponderosa or sugar pine; premium or 2 common (sterling) grade; NeLMA, NLGA, WCLIB or WWPA.

2. Mixed southern pine, No. 1 grade; SPIB.

3. Hem-fir or hem-fir (north), select merchantable or No. 1 common grade; NLGA, WCLIB or WWPA.
4. Spruce-pine-fir (south) or spruce-pine-fir, select merchantable or No. 1 common grade; NeLMA, NLGA, WCLIB or WWPA.

D. For concealed boards, provide lumber with 19 percent maximum moisture content and any of the following species and grades:

1. Mixed southern pine, No. 2 grade; SPIB.
2. Hem-fir or hem-fir (north), construction or 2 common grade; NLGA, WCLIB or WWPA.
3. Spruce-pine-fir (south) or spruce-pine-fir, construction or 2 common grade; NeLMA, NLGA, WCLIB or WWPA.

E. For blocking not used for attachment of other construction utility, stud or No. 3 grade lumber of any species may be used provided that it is cut and selected to eliminate defects that will interfere with its attachment and purpose.

F. For blocking and nailers used for attachment of other construction, select and cut lumber to eliminate knots and other defects that will interfere with attachment of other work.

G. For furring strips for installing plywood or hardboard paneling, select boards with no knots capable of producing bent over nails and damage to paneling.

H. For wood shims, nailers, cants, blocking and all wood items for roofing use pressure treated wood with ASTM A 153/A 153M hot dipped galvanized fasteners.

2.04 Plywood Backing Panels

A. Telephone and electrical equipment backing panels to be DOC PS 1, exposure 1, C-D plugged, fire retardant treated, in thickness indicated or, if not indicated, not less than 1/2 inch nominal thickness.

2.05 Fasteners

A. Provide fasteners of size and type indicated that meet the requirements specified in this Article for material and manufacture.

1. Where carpentry is exposed to weather, in ground contact, pressure preservative treated, or in area of high relative humidity, provide fasteners of Type 304 stainless steel.

B. Nails, brads and staples to meet ASTM F 1667.

C. Power driven fasteners to meet NES NER-272.

D. Wood screws to meet ASME B18.6.1.

E. Screws for fastening to cold formed metal framing to meet ASTM C 954, except with wafer heads and reamer wings, length as recommended by the screw manufacturer for material being fastened.

F. Lag bolts to meet ASME B18.2.1.

G. Steel bolts to meet ASTM A 307, Grade A; with ASTM A 563 hex nuts and, where indicated, flat washers.

H. Expansion anchors to be an anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six (6) times the load imposed when installed in unit masonry assemblies and equal to four (4) times the load imposed when installed in concrete as determined by testing per ASTM E 488/E 488M conducted by a qualified independent testing and inspecting agency.

1. Carbon steel components, zinc plated to meet ASTM B 633, Class Fe/Zn 5.
2. Stainless steel with bolts and nuts to meet ASTM F 593 and ASTM F 594, Alloy Group 1 or 2.

PART 3 - EXECUTION

3.01 Installation

A. Set carpentry to required levels and lines, with members plumb, true to line, cut and fitted. Fit carpentry to other construction; scribe and cope as needed for accurate fit. Locate nailers, blocking and similar supports to meet the requirements for attaching other construction.

B. Framing standard to meet AF&PA's "Details for Conventional Wood Frame Construction," unless otherwise indicated.

C. Do not splice structural members between supports, unless otherwise indicated.

D. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items and trim.

1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches on center.

E. Sort and select lumber so that natural characteristics will not interfere with installation or with fastening other materials to lumber. Do not use materials with defects that interfere with function of member or pieces that are too small to use with minimum number of joints or optimum joint arrangement.

F. Meet AWPA M4 for applying field treatment to cut surfaces of preservative treated lumber.

1. Use inorganic boron for items that are continuously protected from liquid water.
2. Use copper naphthenate for items not continuously protected from liquid water.

G. Securely attach carpentry work to substrate by anchoring and fastening as indicated, meeting the following:

1. NES NER-272 for power driven fasteners.
2. Table 2304.9.1, "Fastening Schedule," in IBC.

H. Use common wire nails, unless otherwise indicated. Select fasteners of size that will not fully penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting wood; do not countersink nail heads, unless otherwise indicated.

3.02 Wood Blocking and Nailer Installation

A. Install where indicated and where required for attaching other work. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.

B. Attach items to substrates to support applied loading. Recess bolts and nuts flush with surfaces, unless otherwise indicated.

3.03 Protection

A. Protect rough carpentry from weather. If, despite protection, rough carpentry becomes wet, apply EPA registered borate treatment. Apply borate solution by spraying to meet EPA registered label.

END OF SECTION

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SECTION 06610

GLASS FIBER FABRICATIONS

PART 1 - GENERAL

1.01 Description

A. This section covers fiberglass reinforced plastic fabrications, assemblies and appurtenant system components.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01600 - Materials and Equipment

C. Section 05500 - Metal Fabrications

1.03 Submittals

A. Submit material manufacturer's published product descriptive data indicating following items:

1. Minimum physical properties data and applicable descriptive test data for each product.
2. Include pertinent installation instructions for prefabricated products.
3. Submit certification that products meet the specified test data and/or referenced standards.

B. Submit shop drawings in accordance with Section 01300, demonstrating compliance with the Specifications.

1. Clearly identify fiberglass items on shop drawings and be complete as to detail of product and location in the Contract.
2. Indicate size of members, joining methods, location, and type of anchors, and necessary installation reference measurements.
3. Indicate fabricated part numbers and their locations in the assembly.
4. Indicate mechanical properties of structural members.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
2. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
3. 29 CFR 1910.23, Guarding Floor and Wall Openings and Holes.
4. 29 CFR 1910.24, Fixed Industrial Stairs.

5. Occupational Safety and Health Administration (OSHA).

1.05 Delivery, Storage and Handling

A. Deliver, store and handle prefinished products in a manner that prevents material damage, deterioration or contamination from elements.

B. Provide protective wrapping on prefinished products, if required, to prevent damage until the Contract is ready for final inspection.

C. See Section 01600 for general handling, storage and protection requirements.

1.06 System Description

A. Design Requirements:

1. The manufacturer's design to meet OSHA 29 CFR 1910.23, OSHA 29 CFR 1910.24 and all other applicable OSHA requirements.

PART 2 - PRODUCTS

2.01 Fiberglass Gratings

A. Fiberglass reinforced plastic pultruded bar type grating. Individual "T" or "I" bar shaped bearing bars assembled and bonded with tie bar components into a one (1) piece panel of grating with a flush top tie bar design. Material to have Class 1 fire retardance rating of 25 or less per ASTM E 84, meet self-extinguishing requirements of ASTM D 635 and be corrosion resistant.

1. Bearing bars to be continuous glass fiber core wrapped by continuous glass mat and permanently bonded together with thermosetting resin plus synthetic surfacing veil.
2. Tie bar system to be two (2) part mechanical locking pultruded cross rod with cross rod top flush with bearing bar top.
3. Clip assemblies to be Type 316 stainless steel saddle and plate clips, bolts, nuts and washers as recommended by the manufacturer.
4. Resin system to be fire retardant vinyl ester.
5. UV resistant synthetic veil on all exposed surfaces.
6. Provide grating with bearing bar and tie bar top surface covered with permanently bonded quartz/epoxy nonskid surface.
7. Color to be gray.
8. Design Data:
    a. "T" or "I" bar top width to be 0.6 inch.
    b. Open space between bars to be 0.4 inch.
    c. Depth to be 1 1/2 inches.
9. Manufacturers:
    a. Fibergrate Composite Structures; Saf-T-Span, I-4015.
    b. Seasafe, Inc.; Safegrate.

c. Or Approved Equal.

2.02 Fabrication

A. Do not proceed with shop fabrication until approved shop drawings are received by the manufacturer.

1. Provide prefabricated sections with required couplings, fasteners, holes, clips and adhesives required to field assemble system.
2. Tag each component or panel part with the manufacturer's drawing and part numbers for ease of installation.
3. Factory seal shop cut edges and holes with compatible resin system.
4. Use Fiberglass Reinforced Plastic (FRP) dowels or stainless steel fasteners for all connections.

B. Insofar as possible, fit and shop assemble FRP fabrications, ready for installation.

C. Fabricate in accordance with details, approved shop drawings and reference standards.

D. Fabricate work square, plumb, straight and true.

PART 3 - EXECUTION

3.01 Examination

A. Inspect all items prior to placement. Repair or replace damaged items as directed by SEPTA.

B. Inspect installed work of other trades and verify such work is complete to point where this work can properly commence.

3.02 Installation

A. Install fiberglass items in accordance with the manufacturer's installation instructions and approved shop drawings.

B. Seal all edges cut during installation with compatible resin system.

END OF SECTION

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SECTION 07190

WATER REPELLENTS

PART 1 - GENERAL

1.01 Description

A. Section includes penetrating, MPI approved water repellent treatments for the following vertical and horizontal surfaces:

1. Cast-in-place concrete.
2. Clay brick masonry.

1.02 Related Sections

A. Section 04200 – Unit Masonry

1.03 Submittals

A. For each type of product indicated, submit manufacturer's printed statement of VOC content, manufacturer's recommended number of coats for each type of substrate and spreading rate for each separate coat, printout of current "MPI Approved Products List" for each product category specified in Article 2.01 of this Section that specifies water repellents approved by MPI, with the proposed product highlighted.

B. Submit a 12 inch by 12 inch sample for each type of water repellent and substrate indicated with specified water repellent treatment applied to half of each sample.

C. Submit qualification data for applicator.

D. Submit product certificates for each type of water repellent.

E. Submit preconstruction test reports for water repellent treated substrates.

F. Submit field quality control reports.

G. Submit sample warranty.

1.04 Quality Assurance

A. An employer of workers trained and approved by the manufacturer for water repellent application.

B. Meet MPI standards indicated and provide water repellents listed in its "MPI Approved Products List."

C. Prepare mockups of each required water repellent on each type of substrate required to demonstrate aesthetic effects, and to set quality standards for materials and execution.

D. Locate mockups in locations that enable viewing under same conditions as the completed work.

1. Size to be 10 square feet each.

E. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.

F. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

G. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM C 67, Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile.
2. ASTM C 642, Standard Test Method for Density, Absorption, and Voids in Hardened Concrete.
3. ASTM D 1653, Standard Test Methods for Water Vapor Transmission of Organic Coating Films.
4. ASTM D 5703, Standard Practice for Preparatory Surface Cleaning for Clay Brick Masonry.
5. ASTM E 96/E 96M, Standard Test Methods for Water Vapor Transmission of Materials.
6. ASTM E 514/E 514M, Standard Test Method for Water Penetration and Leakage Through Masonry.
7. ASTM E 1857, Standard Guide for Selection of Cleaning Techniques for Masonry, Concrete, and Stucco Surfaces.
8. ASTM G 154, Standard Practice for Operating Fluorescent Ultraviolet (UV) Lamp Apparatus for Exposure of Nonmetallic Materials.
9. Master Painters Institute (MPI).
10. National Cooperative Highway Research Program (NCHRP).

1.05 Preconstruction Testing

A. Engage a qualified testing agency to perform preconstruction testing of water repellents on field mockups.

1. In addition to verifying performance requirements, use mockups to verify the manufacturer's written instructions for application procedure and optimum rates of product application to substrates.
2. Propose changes to materials and methods to suit the Contract.
3. Notify SEPTA seven (7) days in advance of the dates and times when mockups will be tested.

1.06 Field Conditions

A. Proceed with application only when the following existing and forecasted weather and substrate conditions permit water repellents to be applied according to the manufacturers' written instructions and warranty requirements:

1. Concrete surfaces and mortar have cured for not less than twenty-eight (28) days.

2. Building has been closed in for not less than thirty (30) days before treating wall assemblies.
3. Ambient temperature is above 40°F and below 100°F and will remain so for twenty-four (24) hours.
4. Substrate is not frozen and substrate surface temperature is above 40°F and below 100°F.
5. Rain or snow is not predicted within twenty-four (24) hours.
6. Not less than twenty-four (24) hours have passed since surfaces were last wet.
7. Windy conditions do not exist that might cause water repellent to be blown onto vegetation or surfaces not intended to be treated.

1.07 Warranty

A. The manufacturer's standard form in which the manufacturer agrees to repair or replace materials that fail to maintain water repellency specified in Article 2.01 in this Section within specified warranty period.
   1. Warranty period to be five (5) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Water repellents shall meet the following performance requirements as determined by preconstruction testing on substrates representing those indicated for this Contract.

B. Minimum 80 percent reduction of water absorption after twenty-four (24) hours for treated compared to untreated specimens when tested according to the following:
   1. Cast-in-place concrete to meet ASTM C 642.
   2. Clay brick to meet ASTM C 67.

C. Water-vapor transmission to meet one (1) or both of the following:
   1. Maximum 10 percent reduction water vapor transmission of treated compared to untreated specimens, according to ASTM E 96/E 96M.
   2. Minimum 80 percent water vapor transmission of treated compared to untreated specimens, according to ASTM D 1653.

D. Water penetration and leakage through masonry to be a minimum 90 percent reduction in leakage rate of treated compared to untreated specimens, according to ASTM E 514/E 514M.

E. Maximum 5 percent loss of water repellent performance after two thousand and five hundred (2500) hours of weathering according to ASTM G 154 compared to water repellent treated specimens before weathering.

F. Chloride-ion intrusion in concrete to meet NCHRP Report 244, Series II tests.
   1. Reduction of water absorption to be 80 percent.

2. Reduction in chloride content to be 80 percent.

2.02 Penetrating Water Repellents

A. Silane, penetrating water repellent to be clear, containing 20 percent or more solids of alkyltrialkoxysilanes; with alcohol, mineral spirits, water or other proprietary solvent carrier; and with 400 g/L or less of VOCs.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas and conditions, with the applicator present, for compliance with requirements and conditions affecting performance of the work.

1. Verify that surfaces are clean and dry according to the water repellent manufacturer's requirements. Check moisture content in three (3) representative locations by method recommended by the manufacturer.

2. Verify that there is no efflorescence or other removable residues that would be trapped beneath the application of water repellent.

3. Verify that required repairs are complete, cured and dry before applying water repellent.

B. Test pH level according to the water-repellent manufacturer's written instructions to ensure chemical bond to silica-containing or siliceous minerals.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation

A. Allow concrete and other cementitious materials to age before application of water repellent, according to the repellent manufacturer's written instructions.

B. Before application of water repellent, clean substrate of substances that could impair penetration or performance of product according to the water repellent manufacturer's written instructions and as follows:

1. Remove oil, curing compounds, laitance and other substances that inhibit penetration or performance of water repellents on cast-in-place concrete according to ASTM E 1857.

2. Clay brick masonry to meet ASTM D 5703.

C. Protect adjoining work, including mortar and sealant bond surfaces, from spillage or blow-over of water repellent. Cover adjoining and nearby surfaces of aluminum and glass if there is the possibility of water repellent being deposited on surfaces. Cover live vegetation.

D. Do not apply water repellent until pointing mortar for joints adjacent to surfaces receiving water repellent treatment has been installed and cured.

E. Do not apply water repellent until sealants for joints adjacent to surfaces receiving water repellent treatment have been installed and cured.

1. Water repellent work may precede sealant application only if sealant adhesion and compatibility have been tested and verified using substrate, water repellent and sealant materials identical to those required.

3.03 Application

A. Engage a factory authorized service representative to inspect the substrate before application of water repellent and to instruct the applicator on the product and application method to be used.

B. Apply coating of water repellent on surfaces to be treated using 15 psi pressure spray with a fan type spray nozzle, roller or brush to the point of saturation. Apply coating in dual passes of uniform, overlapping strokes. Remove excess material; do not allow material to puddle beyond saturation. Meet the manufacturer's written instructions for application procedure unless otherwise indicated.

C. Apply a second saturation coating, repeating first application. Meet the manufacturer's written instructions for limitations on drying time between coats and after rainstorm wetting of surfaces between coats. Consult the manufacturer's technical representative if written instructions are not applicable to Project conditions.

3.04 Field Quality Control

A. SEPTA reserves the right to invoke the following procedure at any time and as often as SEPTA deems necessary during the period when water repellent is being applied:

1. The Contractor will engage the services of a qualified testing agency to sample water repellent material being used. Samples of material delivered to Project site will be taken, identified, sealed and certified in presence of the Contractor.

2. Testing agency will perform tests for compliance of water repellent material with product requirements.

3. SEPTA may direct the Contractor to stop applying water repellents if test results show material being used does not meet the product requirements. The Contractor shall remove noncomplying material from Project site, pay for testing and correct deficiency of surfaces treated with rejected materials, as approved by SEPTA.

B. In the presence of SEPTA, hose down a dry, repellent treated surface to verify complete and uniform product application. A change in surface color will indicate incomplete application.

1. Notify SEPTA seven (7) days in advance of the dates and times when surfaces will be tested.

2. Reapply water repellent until coverage test indicates complete coverage.

3.05 Cleaning

A. Immediately clean water repellent from adjoining surfaces and surfaces soiled or damaged by water repellent application as work progresses. Correct damage to work of other trades caused by water repellent application, as approved by SEPTA.

B. Meet the manufacturer's written cleaning instructions.

END OF SECTION

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SECTION 07210

BUILDING INSULATION

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of the building insulation as follows:

1. Perimeter insulation under slabs-on-grade.
2. Cavity wall insulation.
3. Concealed building insulation.
4. Vapor retarders.
5. Polyisocyanurate foam plastic insulation board.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 04200 - Unit Masonry

E. Section 07500 - Membrane Roofing

F. Section 07620 - Sheet Metal Flashing and Trim

1.03 Submittals

A. Submit product data for each type of product indicated.

B. Submit product test reports based on evaluation of comprehensive tests performed by a qualified testing agency for insulation products.

C. Submit manufacturer's catalog cut, data sheets and installation instructions.

D. Submit evaluation reports for foam plastic insulation board from ICC-ES.

E. All submittals are to be in accordance with Section 01300.

1.04 Quality Assurance

A. Obtain each type of building insulation through one (1) source from a single manufacturer.

B. Provide insulation and related materials with the fire test response characteristics indicated, as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.

1. Surface burning characteristics to meet ASTM E 84.
2. Fire resistance ratings to meet ASTM E 119.

3. Combustion characteristics to meet ASTM E 136.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E 119, Standard Test Methods for Fire Tests of Building Construction and Materials.
3. ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
4. ASTM C 1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
5. International Building Code (IBC).
6. International Energy Conservation Code (IEEC).
7. NFPA 285, Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components.
8. All other applicable local codes.

1.05 Delivery, Storage and Handling

A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with the manufacturer's written instructions for handling, storing, and protecting during installation.

B. Protect foam plastic insulation board as follows:

1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
2. Protect against ignition at all times. Do not deliver foam plastic insulation board materials to Project site until just before installation time.
3. Quickly complete installation and concealment of foam plastic insulation board in each area of construction.

PART 2 - PRODUCTS

2.01 Materials

A. Provide insulating materials that meet the requirements and the referenced standards.

1. Sizes of performed units to fit applications indicated; selected from the manufacturer's standard thickness, widths and lengths.

B. Miscellaneous materials to be galvanized metal clips, zinc coated wires, adhesives and devices for anchoring insulation as recommended by the insulation manufacturer.

2.02 Polyisocyanurate Foam Plastic Insulation Board

A. Polyisocyanurate foam plastic insulation board, foil faced to meet ASTM C 1289, Type I, Class 2.

1. Fire propagation characteristics shall pass NFPA 285 testing as part of an approved assembly.

2.03 Manufacturers

A. Subject to compliance with the requirements, provide products by one (1) of the following manufacturers:

1. Foam Plastic Insulation Board:
   a. Dow/Styrofoam Cavity Mate SE.
   b. Owens Corning.
   c. Or Approved Equal.

2.04 Insulation Fasteners

A. Subject to compliance with the requirements, provided by one (1) of the following manufacturers:

1. Adhesively Attached, Spindle Type Anchors:
   a. AGM Industries, Inc.; Series T TACTOO Insul-Hangers.
   b. Eckel Industries of Canada Limited; Stic-Klip Type N Fasteners.
   c. Gemco; Spindle Type.
   d. Or Approved Equal.
2. Insulation Retaining Washers:
   a. AGM Industries, Inc.; RC150.
   b. AGM Industries, Inc.; SC150.
   c. Gemco; Dome-Cap.
   d. Gemco; R-150.
   e. Gemco, S-150.
   f. Or Approved Equal.
3. Insulation Standoff:
   a. Gemco; Clutch Clip.
   b. Or Approved Equal.
4. Anchor Adhesives:
   a. AGM Industries, Inc.; TACTOO Adhesive.
   b. Eckel Industries of Canada Limited; Stic-Klip Type S Adhesive.
   c. Gemco; Tuff Bond Hanger Adhesive.
   d. Or Approved Equal.

B. Adhesively attached, spindle type anchors to be plate welded to projecting spindle; capable of holding insulation of specified thickness securely in position with self-locking washer in place.

1. Plate to be perforated galvanized carbon steel sheet, 0.030 inches thick by 2 inches square.
2. Spindle to be copper coated, low carbon steel, fully annealed, 0.105 inches in diameter, length to suit depth of insulation indicated.

C. Insulation retaining washers to be self-locking washers formed from 0.016 inch thick galvanized steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1 1/2 inches square or in diameter.

1. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
    a. Crawlspaces.
    b. Ceiling plenums.
    c. Attic spaces.
    d. Where indicated.

D. Insulation standoff to be a spacer fabricated from galvanized mild steel for fitting over spindle of insulation anchor to maintain air space of dimension indicated between face of insulation and substrate to which anchor is attached.

1. Air space to be 1 inch.

E. Anchor adhesive to be a product with demonstrated capability to bond insulation anchors securely to substrates without damaging insulation, fasteners, or substrates.

2.05 Accessories

A. Adhesive of Bonding Insulation:

1. Product compatible with insulation and air and water barrier materials, and with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates and conditions, with the installer present, for compliance with the requirements for Sections in which substrates and related work are specified and other conditions affecting performance.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation

A. Transmit submittals required by this Section.

B. Furnish products as indicated.

C. Ensure that substrates are in suitable condition to receive the work.

D. Clean substrates of substances that are harmful to insulations or vapor retarders, including removing projections capable of puncturing insulation or vapor retarders that interfere with insulation attachment.

3.03 General Installation

A. Place rigid insulation with all edges in contact.

B. Carefully cut and fit insulation around pipes, conduits and other obstructions. If water piping is located on inside of insulated exterior walls, coordinate location of piping to ensure that it is placed on warm side of insulation and insulation encapsulates piping.

C. Do not compress insulation in excess of 10 percent.

D. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.

E. Comply with the insulation manufacturer's written instructions applicable to products and application.

F. Extend insulation to envelop entire area to be insulated. Fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.

G. Provide sizes to fit applications and selected from the manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units unless multiple layers are otherwise shown or required to make up total thickness or to achieve R-value.

3.04 Installation of General Building Insulation

A. Apply insulation to substrates by method indicated, meeting the manufacturer's written instructions. If no specific method is indicated, bound units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.

B. Set vapor retarder faced units with vapor retarder to warm side of construction, unless otherwise indicated. Do not obstruct ventilation spaces, except for firestopping.

1. Tape joints and ruptures in vapor retarder and seal each continuous area of insulation to surrounding construction to ensure airtight installation.

C. Install board insulation on concrete substrates by adhesively attached, spindle type insulation anchors as follows:

1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to the anchor manufacturer's written instructions. Space anchors according to the insulation manufacturer's written instructions for insulation type, thickness and application indicated.

2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.

3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation retaining washers, taking care not to compress insulation below indicated thickness.

4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.05 Installation of Vapor Retarders

A. Extend vapor retarder to extremities if areas are required to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as indicated. Extend vapor retarder to cover miscellaneous voids in insulated substrates, including those filled with loose fiber insulation.

B. Seal vertical joints in vapor retarders over framing by lapping not less than two (2) wall studs. Fasten vapor retarders to framing at top, end and bottom edges; at perimeter of wall openings; and at lap joints. Space fasteners 16 inches on center.

C. Seal overlapping joints in vapor retarders with adhesives or vapor retarder tape according to the vapor retarder manufacturer's instructions. Seal butt joints and fastener penetrations with vapor retarder tape. Locate all joints over framing members or other solid substrates.

D. Firmly attach vapor retarders to substrates with mechanical fasteners or adhesives as recommended by the vapor retarder manufacturer.

E. Seal joints caused by pipes, conduits, electrical boxes and similar items penetrating vapor retarders with vapor retarder tape to create an airtight seal between penetrating objects and vapor retarder.

F. Repair any tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor retarder tape or another layer of vapor retarder.

3.06 Protection

A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation and vapor retarders are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION

SECTION 07500

MEMBRANE ROOFING

PART 1 - GENERAL

1.01 Description

A. The work of this Section includes the physical requirements and methods of installation for a cold applied SBS modified bituminous roofing system. The Contractor shall be responsible for a complete, watertight, warranted, and inspected system. This system shall include but not necessarily be limited to the following:

1. SBS modified mineral cap sheet.
2. Polyester and glass-fiber felt base sheets.
3. Flashing materials.
4. Adhesives.

B. The Contractor shall be responsible for all materials, labor, equipment, and storage.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 01060 – Regulatory Requirements and Safety

C. Section 06105 – Miscellaneous Carpentry

D. Section 07620 – Sheet Metal Flashing and Trim

E. Section 07720 – Roof Accessories

F. Section 07841 – Penetration Fire Stopping

G. Section 07842 – Joint Fire Stopping

H. Section 07900 – Joint Sealers

1.03 Contractor Responsibilities

A. General:

1. Install cold applied SBS modified roofing system to be waterproof, withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing.
2. Provide installed roofing membrane and base flashings that remain watertight; do not permit the passage of water; and resist specified uplift pressures, thermally induced movement, and exposure to weather without failure.

B. Material Compatibility:

1. Provide roofing materials that are compatible with one another under conditions of service and application required, as demonstrated by the roofing manufacturer based on testing and field experience.

C. Provide manufacturer warranty for entire roofing system, including flashing and adhesives.

D. FM Global (FMG) Listing:

1. Provide roofing membrane, base flashing, and component materials that comply with requirements in FMG 4450 and FMG 4470 as part of a roofing system and that are listed in FMG's "Approval Guide" for Class 1 or noncombustible construction as applicable. Identify materials with FMG markings.
   a. Fire/windstorm classification shall be Class 1A-90.
   b. Hail resistance shall be SH.

1.04 Submittals

A. Submit product data for each type of product indicated.

B. Submit shop drawings for roofing system including plans, elevations, sections, details, and attachments to other work, including:

1. Base and counter flashings, cants, and membrane terminations.
2. Roof deck repairs.
3. Gutter and drain fabrication/installation.

C. Samples for Verification:

1. Provide catalog cuts and two (2) 12 inch by 12 inch samples for each of the following products:
   a. Base ply sheet.
   b. Mineral granule surface roofing membrane cap sheet of color specified.
   c. Flashing material.
   d. Two (2) fasteners of each type, length, and finish.

D. Manufacturer Certificates:

1. Certify that materials are manufactured in the United States and conform to the requirements specified herein, are chemically and physically compatible with each other, and are suitable for inclusion within the total roofing system specified herein.
2. Signed by the roofing manufacturer certifying that the roofing system complies with the requirements specified in this Section.
   a. Submit evidence of meeting performance requirements.

E. Installer Certificates:

1. Signed by the roofing system manufacturer certifying that the installer is approved, authorized, or licensed by the roofing system manufacturer to install the roofing system.

F. Qualification Data:

1. Provide qualification data for the installer, the manufacturer, and the infrared scanning company.

G. Product Test Reports:

1. Provide product test reports based on evaluation of comprehensive tests performed by the manufacturer and witnessed by a qualified testing agency, for components of the roofing system.

H. Research/Evaluation Reports and Safety Data Sheets (SDSs):

1. Provide research/evaluation reports and SDSs for components of the roofing system.

I. Maintenance Data:

1. Provide maintenance data for the roofing system to include maintenance manuals.

J. Warranties:

1. Provide special warranties specified in this Section.

K. Inspection Report:

1. Provide a copy of the roofing system manufacturer's inspection report of the completed roofing system installation.

1.05 Quality Assurance

A. Manufacturer Qualifications:

1. Company specializing in manufacturing the products specified in this Section with not less than twelve (12) years of documented experience and have ISO 9001 certification.
   a. Manufacturer shall have FMG approval for roofing system identical to that used for this Project.

B. Installer Qualifications:

1. A qualified firm that is approved, authorized, or licensed by the roofing system manufacturer to install the manufacturer's product and that is eligible to receive the manufacturer's warranty.

C. Technical Inspector Qualifications:

1. The Contractor will engage a qualified manufacturer's technical representative inspector for the entire length of the roof project every workday on a daily basis. The manufacturer's technical representative inspector will be required to be on the job site from the start of the workday to the completion of the workday. The manufacturer's technical representative inspector shall perform roof inspections and tests and prepare daily inspection and test reports. The manufacturer's technical representative inspector shall not be provided by an outside third party but from the manufacturer of the roofing system to be installed.

D. Testing Agency Qualifications:

1. An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E 548.

E. Infrared scan must be made to the completed roof prior to application of final surfacing. Infrared scanner must be approved by the manufacturer issuing the warranty. Cost of this survey must be included in the Contractor's base bid.

F. Products:

1. The products below must meet the following minimum physical properties:

a. Roofing Membrane Cap Sheet:

Property	Typical Value	Test Method
Elongation @ 0°F +/- 3.6°F	5.1% MD; 5.1% XMD	ASTM D 5147/D 5147M; ASTM D 6162/D 6162M
Elongation @ 73.4°F +/- 3.6°F	3.5% MD; 3.5% XMD	ASTM D 5147/D 5147M; ASTM D 6162/D 6162M
Tensile Strength @ 0°F +/- 3.6°F	325 lbf/in MD; 325 lbf/in XMD	ASTM D 5147/D 5147M; ASTM D 6162/D 6162M
Tensile Strength @ 73.4°F +/- 3.6°F	310 lbf/in MD; 310 lbf/in XMD	ASTM D 5147/D 5147M; ASTM D 6162/D 6162M
Tear Strength @ 73.4°F +/- 3.6°F	500 lbf/in MD; 500 lbf/in XMD	ASTM D 5147/D 5147M; ASTM D 6162/D 6162M
Thickness	2.667mm	ASTM D 5147/D 5147M; ASTM D 6162/D 6162M
Granule Color	White	-

b. Roofing Membrane Base Ply Sheets:

Property	Typical Value	Test Method
Pliability, 2 Inch Radius Bend	No Failures	ASTM D 1490
Surfacing and Stabilizer	60% Max	ASTM D 4601/D 4601M
Asphalt	10 lb/100 ft^2	ASTM D 228/D 228M or ASTM D 5147/D 5147M
Weight	31 lb/100 ft^2 Min	ASTM D 228/D 228M or ASTM D 5147/D 5147M
Tensile Strength	229 lbf/in MD; 258 lbf/in XMD	ASTM D 4073/D 4073M; ASTM D 5147/D 5147M
Tear Strength	370 lbf/in MD; 370 lbf/in XMD	ASTM D 4073/D 4073M; ASTM D 5147/D 5147M
Elongation	6.0% MD; 4.1% XMD	ASTM D 4601/D 4601M; ASTM D 5147/D 5147M

c. Flashing Adhesive:

Property	Typical Value	Test Method
Asbestos Content	None	-
Viscosity @ 77EF	160,000 – 200,000 cP Min	-
Density @ 77EF	8.6 lb/gal Min	ASTM D 1475
Flash Point	80°F	ASTM D 93
Volatile Organic Compound (VOC)	300 g/L Max	-

d. Asphalt Materials Interply Adhesive:

Property	Typical Value	Test Method
Nonvolatile Matter	70%	ASTM D 4479/ D 4479M

Density @ 77EF	7.89 lb/gal	ASTM D 1475
Asbestos Content	None	EPA 600/R-93/116
Viscosity @ 77EF	40,000 – 200,000 cP	ASTM D 2196
Asphalt Content, Min	42%	ASTM D 4479/D 4479M or ASTM D 6511/D 6511M

e. Glass Fiber Fabric:

Property	Typical Value	Test Method
Weight	9.0 lb/100 ft^2	ASTM D 146/ D 146M; ASTM D 1668/D 1668M
Moisture Based on Net Weight	None	ASTM D 146/ D 146M; ASTM D 1668/D 1668M
Average Tensile Strength @ 70EF	65 lbf/in Warp Threads 75 lbf/in Filling Threads	ASTM D 1668/D 1668M

f. Cold Applied Insulation Adhesive:

Property	Typical Value	Test Method
Asbestos Content	None	ASTM D 3960
Viscosity @ 77EF	70,000 cP	ASTM D 2556
Density @ 77EF	8.5 lb/gal	ASTM D 1875
Tensile Strength @ 77EF	200 psi	ASTM D 412
Elongation @ 77EF	1,200 psi	ASTM D 412
Adhesion Strength in Shear @ 77EF	80 psi	ASTM D 816
Average T-Peel Strength @ 77EF	15 lbf	ASTM D 1876
Low Temp Flexibility	Pass @ -60EF	ASTM D 816

G. Source Limitations:

1. Obtain components for the roofing system approved by the roofing system manufacturer.

H. Fire Test Response Characteristics:

1. Provide roofing materials with the fire test response characteristics indicated as determined by testing identical products per test method below by UL, FMG, or another testing and inspecting agency acceptable to authorities having jurisdiction. Materials shall be identified with appropriate markings of applicable testing and inspecting agency.
   a. Exterior Fire Test Exposure:
      1) Class A; ASTM E 108, for application and roof slopes indicated.
   b. Fire Resistance Ratings:
      1) ASTM E 119, for fire resistance rated roof assemblies of which the roofing system is a part.

I. Pre-Installation Conference:

1. Convene a pre-roofing conference approximately two (2) weeks before scheduled commencement of SBS modified bituminous roofing system installation and associated work. Review methods and procedures related to existing roof demolition, roof deck

construction and/or repair and installation of the new roofing system and associated work including but not limited to the following:

a. Meet with SEPTA, the Architect, SEPTA's insurer if applicable, testing and inspecting agency representative, all subcontractors, demolition contractor, roofing installer, roofing system manufacturer's representative, deck installer, and installers whose work interfaces with or affects roofing including installers of roof accessories and roof mounted equipment.
b. Review and finalize the Contractor's proposal for staging, storage, phasing, and protection.
c. Review methods and procedures related to roofing installation, including the manufacturer's written instructions.
d. Review and finalize construction schedule and verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
e. Examine deck substrate conditions and finishes for compliance with requirements, including flatness, pitch, and fastening.
f. Review structural loading limitations of roof deck during and after roofing.
g. Review base flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect the roofing system.
h. Review governing regulations and requirements for insurance and certificates if applicable.
i. Review temporary protection requirements for the roofing system during and after installation.
j. Review procedures to test flow of existing and/or new roof leaders during and after roofing installation.
k. Review roof observation and repair procedures after roofing installation.

J. Immediately correct roof leakage during construction. If the Contractor does not respond within twenty-four (24) hours, SEPTA has a right to hire a qualified contractor and back charge the original Contractor.

K. Final Moisture Analysis:

1. Compliance with dampness and moisture controls will be verified upon completion of the work by an infrared scan provided by the roofing manufacturer.

L. Insurance Certification:

1. Assist SEPTA in preparation and submittal of the roof installation acceptance certification as may be necessary in connection with fire and extended coverage insurance on roofing and associated work.

M. Meet the applicable provisions of the most recent issues of the following references:

1. Asphalt Roofing Manufacturers Association (ARMA).
2. ASTM D 41/D 41M, Standard Specification for Asphalt Primer Used in Roofing, Damproofing, and Waterproofing.
3. ASTM D 93, Standard Test Methods for Flash Point by Pensky-Martens Closed Cup Tester.
4. ASTM D 146/D 146M, Standard Test Methods for Sampling and Testing Bitumen-Saturated Felts and Woven Fabrics for Roofing and Waterproofing.
5. ASTM D 228/ D 228M, Standard Test Methods for Sampling, Testing, and Analysis of Asphalt Roll Roofing, Cap Sheets, and Shingles Used in Roofing and Waterproofing.

6. ASTM D 412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers – Tension.
7. ASTM D 816, Standard Test Methods for Rubber Cements.
8. ASTM D 1475, Standard Test Method for Density of Liquid Coatings, Ink, and Related Products.
9. ASTM D 1490, Standard Test Method for Nonvolatile Content of Urea-Formaldehyde Resin Solutions.
10. ASTM D 1668/D 1668M, Standard Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing.
11. ASTM D 1875, Standard Test Method for Density of Adhesives in Fluid Form.
12. ASTM D 1876, Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
13. ASTM D 2196, Standard Test Methods for Rheological Properties of Non-Newtonian Materials by Rotational Viscometer.
14. ASTM D 2556, Standard Test Method for Apparent Viscosity of Adhesives Having Shear-Rate-Dependent Flow Properties Using Rotational Viscometry.
15. ASTM D 3617/D 3617M, Standard Practice for Sampling and Analysis of Built-Up Roof Systems During Application.
16. ASTM D 3960, Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings.
17. ASTM D 4073/D 4073M, Standard Test Method for Tensile Tear Strength of Bituminous Roofing Membranes.
18. ASTM D 4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
19. ASTM D 4479/ D 4479M, Standard Specification for Asphalt Roof Coatings – Asbestos Free.
20. ASTM D 4586/D 4586M, Standard Specification for Asphalt Roof Cement – Asbestos Free.
21. ASTM D 4601/D 4601M, Standard Specification for Asphalt-Coated Glass Fiber Base Sheet Used in Roofing.
22. ASTM D 5147/D 5147M, Standard Test Methods for Sampling and Testing Modified Bituminous Sheet Material.
23. ASTM D 6162/D 6162M, Standard Specification for Styrene Butadiene Styrene (SBS) Modified Bituminous Sheet Materials Using a Combination of Polyester and Glass Fiber Reinforcements.
24. ASTM D 6511/D 6511M, Standard Test Methods for Solvent Bearing Bituminous Compounds.
25. ASTM E 108, Standard Test Methods for Fire Tests of Roof Coverings.
26. ASTM E 119, Standard Test Methods for Fire Tests of Building Construction and Materials.

27. ASTM E 548, Standard Guide for General Criteria Used for Evaluating Laboratory Competence.
28. EPA 600/R-93/116, Test Method for the Determination of Asbestos in Bulk Building Materials.
29. FMG 4450, Approval Standard for Class 1 Insulated Steel Deck Roofs.
30. FMG 4470, Approval Standard for Single Ply, Polymer-Modified Bitumen Sheet, Built-Up Roof and Liquid Applied Roof Assemblies.
31. National Roofing Contractors Association (NRCA).

1.06 Project Conditions

A. All work shall be performed in accordance with rules, regulations, procedures, and safe practices of SEPTA, the Commonwealth of Pennsylvania, Occupational Safety and Health Administration (OSHA), and all other governmental agencies having jurisdiction over the work.

B. Proceed with roofing work only when existing and forecasted weather conditions will permit unit of work to be installed in accordance with the manufacturer's recommendations and warranty requirements.

C. Do not apply roofing insulation or membrane to damp or frozen deck surface.

D. Do not expose materials vulnerable to water or sun damage in quantities greater than can be weatherproofed during the same day.

1.07 Delivery, Storage and Handling

A. The Contractor shall store equipment and materials at the job site in accordance with instructions of the SEPTA Project Manager and in conformance with applicable regulatory provisions. The Contractor shall not store unnecessary items at the job site.

B. Deliver roofing materials to job site in original containers with seals unbroken and labeled with the manufacturer's name, product brand name and type, date of manufacture, and directions for storage.

C. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by the roofing system manufacturer. Protect stored liquid material from direct sunlight.

1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

D. Store and handle roofing sheets in a dry, well ventilated, weather tight place to ensure no possibility of significant moisture exposure. Store rolls of felt and other sheet materials on pallets or other raised surfaces. Stand all roll materials on end. Cover roll materials with a canvas tarpaulin or other breathable material; not polyethylene.

E. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with the insulation manufacturer's written instructions for handling, storing, and protecting during installation.

F. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

G. Do not leave unused materials on the roof overnight or when roof work is not in progress unless protected from weather and other sources.

1.08 Manufacturer's Inspections

A. When the Project is in progress, the roofing system manufacturer will provide the following:

1. Keep SEPTA informed as to the progress and quality of the work as observed.
2. Provide a technical inspector to be on the job site full time for the duration of the work.
3. Report to SEPTA in writing any failure or refusal of the Contractor to correct unacceptable practices called to the Contractor's attention.
4. Provide verification that the roof slopes positively to drains/gutters and that there are no low areas that may cause ponding.

B. When the Project is complete, the roofing system manufacturer will provide the following:

1. Infrared scan of the Project upon completion of the work to confirm that the roof has been installed free of dampness and moisture. At the discretion of the manufacturer and approved by SEPTA; large roof areas separated by dividers, completed sections can be scanned prior to completion of the entire roof installation. Cost of the scan shall be included in the Contractor's base bid.
2. Confirm after completion that the manufacturer has observed no application procedures in conflict with the Specifications other than those that may have been previously reported and corrected.

1.09 Sequencing and Scheduling

A. Sequence installation of SBS modified bituminous sheet roofing with related units of work specified in other Sections to ensure that the roof assemblies including roof accessories, flashing, trim, and joint sealers are protected against damage from affects of weather, corrosion, and adjacent construction activity.

B. Fully complete all SBS modified bituminous membrane roofing field assembly work each day. Staged construction will not be accepted.

1.10 Warranty

A. Special Warranty:

1. Manufacturer's standard form, without monetary limitation, in which the manufacturer agrees to repair or replace components of the roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks.
   a. Special warranty includes roofing membrane, base flashings, roofing membrane accessories, roof insulation, fasteners, cover boards, substrate boards, walkway products and other components of the roofing system.
   b. Warranty Period:
      1) Fifteen (15) years from date of Substantial Completion, with the option to extend for ten (10) additional years.

c. The manufacturer will be responsible for providing an infrared scan of the roof upon completion of the work.

d. The manufacturer will be responsible for inspecting the roof each year to determine if any maintenance or repairs need to be done to maintain the warranty. The manufacturer will inform SEPTA of any necessary maintenance and inspect upon SEPTA's completion of the work.

e. If the manufacturer fails to perform the yearly inspection and the roof develops a leak that year, the manufacturer shall hold SEPTA harmless and honor the full roof warranty.

B. Special Project Warranty:

1. Submit the roofing installer's warranty, on warranty form at end of this Section, signed by the installer, covering work of this Section, including all components of the roofing system such as roofing membrane, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:

a. One (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Subject to compliance with requirements, provide warrantied systems by one (1) of the following:

1. The Garland Company, Inc.
3800 East 91st Street
Cleveland, OH 44105
Fax: 216-641-0633
Phone: 216-641-7500
Toll Free: 800-321-9336

2. Tremco, Inc.
3735 Green Road
Beachwood, OH 44122
Phone: 216-292-5000
Toll Free: 800-562-2728

3. Johns Manville Roofing
717 17th Street
Denver, CO 80202
Phone: 303-978-2000
Toll Free: 800-654-3103

4. Or Approved Equal.

B. The following requirements apply for product selection:

1. Available Products:

a. Subject to compliance with requirements, products that may be incorporated into the work include, but are not limited to, the products specified.

2. Available Manufacturers:

a. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the manufacturers specified.

3. Any item or material submitted as a substitution to the manufacturer specified must comply in all respects as to the quality and performance of the brand name specified and the manufacturer shall provide all services specified. SEPTA shall be the sole judge as to whether or not an item submitted as a substitute is truly equal.

4. Substitutions and Or Approved Equals must be submitted for review a minimum of five (5) working days prior to the bid opening. Sufficient information to evaluate the substitution must be supplied or the substitution will be rejected. It shall be at the Contractor's risk to submit a substitution after being awarded the Contract. If after evaluating the substitution SEPTA determines the substitution is not equal to the specified product then it shall be the Contractor's responsibility to make good on the specified product at no extra cost to SEPTA.

2.02 SBS Modified Asphalt Sheet Materials

A. Roofing Membrane Cap Sheet:

1. ASTM D 6162/D 6162M, Grade C, Type I, II, or III composite polyester and glass fiber reinforced, SBS modified asphalt sheet; asbestos free; light colored; granular surface; suitable for application method specified.

a. The following products are acceptable. Other products may be considered but must meet or exceed all ASTM tests for elongation, tear strength, tensile strength, and thickness.

1) Garland StressPly Plus Membrane.

2) Tremco POWERply 300 FR Granular.

3) Johns Manville DynaMax FR Plus.

4) Or Approved Equal.

B. Roofing Membrane Base Ply Sheets:

1. ASTM D 4601/D 4601M, Type II, asphalt impregnated, asbestos free, polyester and glass fiber felt.

a. The following products are acceptable. Other products may be considered but must meet or exceed all ASTM tests for pliability, weight, breaking strength, and asphalt content.

1) Garland HPR Tri-Base Premium.

2) Tremco BURmastic Modified Premium Composite Ply.

3) Johns Manville Glas DynaMax S Plus.

4) Or Approved Equal.

2.03 Flashing Materials

A. One (1) layer of base ply material and one (1) layer of cap sheet material.

B. Cold Applied Flashing Adhesive:

1. Roofing system manufacturer's standard asphalt-based, one (1) or two (2) part, asbestos free, cold applied adhesive specially formulated for compatibility and use with membrane felt ply sheets.

a. The following products are acceptable. Other products may be considered but must meet or exceed all ASTM tests for density, viscosity, and flash point.

1) Garland Weatherking Flashing Adhesive.
2) Tremco POWERPly Rubberized Cold Adhesive.
3) Johns Manville MBR Flashing Cement.
4) Or Approved Equal.

C. Flashing Reinforcement:

1. Manufacturer's standard fiberglass or stitch bonded polyester scrim.
   a. The following products are acceptable. Other products may be considered but must meet or exceed all ASTM tests for density, viscosity, and flash point.
      1) Garland HPR Garmesh.
      2) Tremco BURmesh.
      3) Johns Manville PermaFlash Scrim.
      4) Or Approved Equal.

2.04 Asphalt Materials

A. Asphalt Primer:

1. ASTM D 41/D 41M.

B. Membrane Interply Adhesive:

1. The following products are acceptable. Other products may be considered but must meet or exceed all ASTM tests for density, viscosity, and nonvolatile matter.
   a. Garland Weatherking.
   b. Tremco POWERPly Standard Cold Adhesive.
   c. Johns Manville MBR Bonding Adhesive.
   d. Or Approved Equal.

2.05 Auxiliary Materials

A. General:

1. Auxiliary materials recommended by the roofing system manufacturer for intended use and compatible with built-up roofing.

B. Asphalt Roofing Cement:

1. ASTM D 4586/D 4586M, asbestos free, of consistency required by the roofing system manufacturer for application.

C. Mastic Sealant:

1. Polyisobutylene, plain or modified bitumen, nonhardening, nonmigrating, nonskinning, and nondrying.

D. Fasteners:

1. Factory coated steel fasteners and metal or plastic plates meeting corrosion resistance provisions in FMG 4470; designed for fastening roofing membrane components to substrate; tested by the manufacturer for required pullout strength; and acceptable to the roofing system manufacturer.

E. Metal Flashing Sheet:

1. Refer to Section 07620.

F. Walkway Pads:

1. Mineral granule surfaced, reinforced asphaltic composition, slip resisting pads manufactured as a traffic pad for foot traffic and acceptable to the built-up roofing manufacturer, 1/2 inch thick minimum.
   a. Pad size shall be 48 inches by 30 inches.

G. Miscellaneous Accessories:

1. Provide miscellaneous accessories recommended by the roofing system manufacturer.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas, and conditions, with the installer present, for compliance with the following requirements and other conditions affecting performance of the roofing system:

1. Verify that roof openings and penetrations are in place and set and braced and roof drains are securely clamped in place.
2. Verify that cants, blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in applicable roof deck sections.
4. Verify that roof positively slopes to drain.
5. Verify that concrete curing compounds that will impair adhesion of roofing components to roof deck have been removed.
6. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
   a. Test for moisture by pouring 1 pint of hot roofing asphalt on deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if test sample foams or can be easily and cleanly stripped after cooling.
7. Verify that deck is securely fastened with no projecting fasteners and with no adjacent units in excess of 1/16 inch out of plane relative to adjoining deck.
8. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation

A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to the roofing system manufacturer's written instructions. Remove sharp projections.

B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof drain plugs when no work is taking place or when rain is forecast.

C. Prime surface of concrete deck with asphalt primer at a rate of 3/4 gallon per 100 square feet and allow primer to dry.

3.03 General Roofing Membrane Installation

A. Install roofing membrane system according to the roofing system manufacturer's written instructions and applicable recommendations of ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing".

1. Install the roofing system according to applicable specification plate classifications in NRCA's "The NRCA Roofing and Waterproofing Manual" and requirements in this Section.

B. Start installation of roofing membrane in presence of the roofing system manufacturer's technical personnel.

C. Where the roof slope exceeds 3/4 inch per 12 inches; 1:18; install roofing membrane sheets parallel to slope.

1. Backnail roofing membrane sheets to substrate according to the roofing system manufacturer's written instructions.

D. Cooperate with testing and inspecting agencies engaged or required to perform services for installing roofing system.

E. Coordinate installing roofing system so insulation and other components of the roofing membrane system not permanently exposed are not subjected to precipitation or left uncovered at the end of the workday or when rain is forecast.

1. Provide tie-offs at end of each day's work to cover exposed roofing membrane sheets and insulation with a course of coated felt set in roofing cement or hot roofing asphalt with joints and edges sealed.

2. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of the roofing system.

3. Remove and discard temporary seals before beginning work on adjoining roofing.

F. Substrate Joint Penetrations:

1. Prevent roofing asphalt from penetrating substrate joints, entering building, or damaging roofing system components or adjacent building construction.

3.04 Membrane Installation

A. Install two (2) plies of membrane base ply sheets according to the roofing system manufacturer's written instructions starting at low point of roofing system. Align base ply sheets without stretching. Shingle side laps of base ply sheets uniformly to ensure required number of base ply sheets covers substrate at any point. Shingle direction to shed water. Extend base ply sheets over and terminate beyond cants.

B. Install SBS modified bituminous roofing membrane cap sheet according to the roofing manufacturer's written instructions, starting at low point of roofing system. Extend roofing membrane sheets over and terminate beyond cants and as follows:

1. Adhere to substrate in cold applied adhesive.

2. Unroll roofing membrane sheets and allow them to relax for minimum time period required by the manufacturer.

C. Laps:

1. Accurately align roofing membrane sheets, without stretching, and maintain uniform side and end laps. Stagger end laps. Completely bond and seal laps, leaving no voids.
   a. Repair tears and voids in laps and lapped seams not completely sealed.
   b. Apply roofing granules to cover exuded bead at laps while bead is hot and/or liquid.

D. Install roofing membrane sheets so side and end laps shed water.

3.05 Flashing and Stripping Installation

A. First install base flashing consisting of a base ply and a cap sheet over cant strips and other sloping and vertical surfaces, at roof edges, and at penetrations through roof, and secure at substrates according to the roofing system manufacturer's written instructions and as follows:

1. Prime substrates with asphalt primer if required by the roofing system manufacturer.

2. Flashing Sheet Application:
   a. Adhere flashing sheet to substrate in cold adhesive applied at a rate required by the roofing system manufacturer.

B. Extend base flashing up walls or parapets a minimum of 8 inches above roofing membrane and a maximum of 24 inches up the vertical surface. Extend base flashing a minimum of 8 inches onto field of roofing membrane. Extend base flashing up and over parapets and roof curbs covering top.

C. Mechanically fasten top of base flashing securely at terminations and perimeter of roofing.

1. Seal top termination of base flashing with a strip of glass fiber fabric set in asphalt roofing cement.

D. Install stripping, according to the roofing system manufacturer's written instructions, where metal flanges and edgings are set on roof membrane.

E. Built-Up Stripping:

1. Install stripping of not less than two (2) roofing membrane base ply sheets, setting each ply in a continuous coating of cold applied asphalt and extend onto roofing membrane 4 inches and 6 inches, respectively.

F. Strip in base of flashing to roof system and vertical flashing laps, using a three (3) course application of glass fiber set in flashing adhesive and covered with approved mastic.

G. Roof Drains:

1. Set 30 inch by 30 inch metal flashing in bed of asphalt roofing cement on completed roofing membrane. Cover metal flashing with stripping and extend a minimum of 4 inches beyond edge of metal flashing onto field of roofing membrane. Clamp roofing membrane, metal flashing, and stripping into roof drain clamping ring.
   a. Install flashing sheet stripping by same method as installing base flashing.
   b. Install stripping of not less than two (2) roofing membrane ply sheets, each set in a continuous coating of asphalt roofing cement.

3.06 Aggregate Surfacing and Walkway Pads

A. Apply surfacing materials in the quantities specified; 500 pounds per square for aggregate, 400 pounds per square for slag. Uniformly embed aggregate in a flood coat of bitumen at a rate of 60 to 70 pounds per square coverage after felt flashings, tests, repairs, and corrective actions have been completed and approved.

B. Aggregate shall be dry and placed in a manner required to form a compact, embedded overlay. To aid in proper embedment, lightly roll aggregate provided that there is no damage to the roofing membrane.

C. Walkway Pads:

1. Install walkway pads using units of size indicated or, if not indicated, of the manufacturer's standard size according to the walkway pad manufacturer's written instructions.
    a. Provide 2 inches between adjacent pads and sweep away loose aggregate surfacing and set walkway pads in additional flood coat of hot roofing asphalt.

3.07 Field Quality Control

A. Testing Agency:

1. The Contractor will engage a qualified independent testing and inspecting agency to perform roof tests and inspections and to prepare test reports.

B. Test Cuts:

1. Test specimens will be removed to evaluate problems observed during quality assurance inspections of roofing membrane as follows:
    a. Approximate quantities of components within roofing membrane will be determined according to ASTM D 3617/D 3617M.
    b. Test specimens will be examined for interply voids to ASTM D 3617/D 3617M and to comply with criteria established in Appendix 3 of ARMA/NRCA's "Quality Control Guidelines for the Application of Polymer Modified Bitumen Roofing".

C. Upon completion of work, the Contractor shall flood roof and verify with the SEPTA Project Manager that entire roof flows adequately to drains.

D. Final Roof Inspection:

1. The roofing system manufacturer's technical personnel shall inspect roofing installation on completion and submit report to SEPTA.
    a. Notify SEPTA forty-eight (48) hours in advance of date and time of inspection.

E. Infrared scan shall be completed at the end of the Project.

F. Repair or remove and replace components of the roofing system where test results or inspections indicate that they do not comply with specified requirements.

G. Additional testing and inspecting, at the Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.08 Protection and Cleaning

A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to SEPTA.

B. Correct deficiencies in or remove roofing system that does not comply with the requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by the manufacturer of affected construction.

3.09 Roofing Installer's Warranty Sample

WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following Project:

Owner: <Insert name of Owner>.

Address: <Insert address>.

Building Name/Type: <Insert information>.

Address: <Insert address>.

Area of Work: <Insert information>.

Acceptance Date: _____.

Warranty Period: <Insert time>.

Expiration Date: _____.

AND WHEREAS the Roofing Installer has contracted (either directly with the Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period.

NOW THEREFORE the Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

This Warranty is made subject to the following terms and conditions:

Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:

lightning; peak gust wind speed; fire; failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration and decomposition; faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work; vapor condensation on bottom of roofing; and activity on roofing by others, including

construction contractors, maintenance personnel, other persons and animals, whether authorized or unauthorized by the Owner.

When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by the Owner or by another responsible party so designated.

Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.

During Warranty Period, if the Owner allows alteration of work by anyone other than the Roofing Installer, including cutting, patching and maintenance in connection with penetrations, attachment of other work and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If the Owner engages the Roofing Installer to perform said alterations, Warranty shall not become null and void unless the Roofing Installer, before starting said work, shall have notified the Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

The Owner shall promptly notify the Roofing Installer of observed, known or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for the Roofing Installer to inspect work and to examine evidence of such leaks, defects or deterioration.

This Warranty is recognized to be the only warranty of the Roofing Installer on said work and shall not operate to restrict or cut off the Owner from other remedies and resources lawfully available to the Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve the Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a Contract directly with the Owner or a subcontract with the Owner's Contractor.

IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

Authorized Signature: _____.

Name: _____.

Title: _____.

END OF SECTION

SECTION 07590

PREPARATION FOR RE-ROOFING

PART 1 - GENERAL

1.01 Description

A. The work of this Section includes the complete tear off of a roofing assembly, the removal of base flashings and the removal and storage of mechanical equipment. Also covered is the repair and preparation of the existing roof deck to receive the new roof system and equipment specified elsewhere:

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 07500 – Membrane Roofing

C. Section 07620 – Sheet Metal Flashing and Trim

D. Section 07720 – Roof Accessories

1.03 Materials Ownership

A. Except for items or materials indicated to be reused, reinstalled, or otherwise indicated to remain SEPTA's property, demolished materials shall become the Contractor's property and shall be removed from the job site.

1.04 Definitions

A. Roofing Terminology:

1. Refer to ASTM D 1079 and glossary in NRCA's "The NRCA Roofing and Waterproofing Manual" for definition of terms related to roofing work in this Section.

B. Existing Membrane Roofing System:

1. EPDM roofing membrane, roof insulation, surfacing, and components and accessories between roof deck and roofing membrane.

C. Roof Tear Off:

1. Removal of existing membrane roofing system from roof deck.

D. Remove:

1. Detach items from existing construction and legally dispose of them offsite unless indicated to be removed and reinstalled.

E. Existing to Remain:

1. Existing items of construction that are not indicated to be removed.

1.05 Submittals

A. Submit product data for each type of product indicated.

B. Submit fastener pull out test report.

C. Submit photographs that show existing conditions of adjoining construction and site improvements, including exterior and interior finish surfaces, that might be misconstrued as having been damaged by re-roofing operations. Submit photographs before work begins.

1.06 Quality Assurance

A. Regulatory Requirements:

1. Comply with governing EPA notification regulations before beginning membrane roofing removal. Comply with hauling and disposal regulations of authorities having jurisdiction.

B. Re-Roofing Conference:

1. Conduct re-roofing conference at job site.
    a. Meet with SEPTA and SEPTA's insurer if applicable; testing and inspecting agency representative; roofing system manufacturer’s representative; roof deck installer; roofing installer including project manager, superintendent, and foreman; and installers whose work interfaces with or affects re-roofing including installers of roof accessories and roof mounted equipment.
    b. Review methods and procedures related to roofing system tear off and replacement including, but not limited to, the following:
        1) Re-roofing preparation, including membrane roofing system manufacturer’s written instructions.
        2) Temporary protection requirements for existing roofing system that is to remain during and after installation.
        3) Existing roof drains and roof drainage during each stage of re-roofing, and roof drain plugging and plug removal requirements.
        4) Construction schedule and availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
        5) Condition and acceptance of existing roof deck for reuse.
        6) Structural loading limitations of roof deck during re-roofing.
        7) Base flashings, special roofing details, drainage, penetrations, equipment curbs, and condition of other construction that will affect re-roofing.
        8) Shutdown and sealing of air intakes.
        9) Governing regulations and requirements for insurance and certificates if applicable.
        10) Existing conditions that may require notification of SEPTA before proceeding.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM D 1079, Standard Terminology Relating to Roofing and Waterproofing.
2. ASTM D 4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
3. Environmental Protection Agency (EPA).
4. Factory Mutual Group (FMG)

5. National Roofing Contractors Association (NRCA).

1.07 Project Conditions

A. SEPTA will occupy portions of building immediately below re-roofing area. Conduct re-roofing so SEPTA's operations will not be disrupted. Provide SEPTA with not less than seventy-two (72) hours' notice of activities that may affect SEPTA's operations.

1. Coordinate work activities daily with SEPTA so SEPTA can place protective dust or water leakage covers over sensitive equipment or furnishings, shut down HVAC and fire alarm or detection equipment if needed, and evacuate occupants from below the work area.

2. Before working over structurally impaired areas of roof deck, notify SEPTA to evacuate occupants from below the affected area. Verify that occupants below the work area have been evacuated before proceeding with work over the impaired roof deck area.

B. Protect building to be re-roofed, adjacent buildings, walkways, site improvements, exterior plantings, and landscaping from damage or soiling from re-roofing operations.

C. Limit construction loads on roof to rooftop equipment wheel loads and 50 lbs./sq. ft. for uniformly distributed loads.

D. Weather Limitations:

1. Proceed with re-roofing preparation only when existing and forecasted weather conditions permit work to proceed without water entering existing roofing system or building.

E. Hazardous Materials:

1. The roof was tested for asbestos and results indicated no asbestos was found. The report is available for the Contractor upon request.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation

A. Coordinate with SEPTA to shut down air intake equipment in the vicinity of the work. Cover air intake louvers before proceeding with re-roofing work that could affect indoor air quality or activate smoke detectors.

B. During removal operations, have sufficient and suitable materials onsite to facilitate rapid installation of temporary protection in the event of unexpected rain.

C. Maintain roof drains in functioning condition to ensure roof drainage at end of each workday. Prevent debris from entering or blocking roof drains and conductors. Use roof drain plugs specifically designed for this purpose. Remove roof drain plugs at end of each workday, when no work is taking place, or when rain is forecast.

1. If roof drains are temporarily blocked or unserviceable due to roofing system removal or partial installation of new membrane roofing system, provide alternative drainage method to remove water and eliminate ponding. Do not permit water to enter into or under existing membrane roofing system components that are to remain.

D. Verify that rooftop utilities and service piping have been shut off before beginning the work.

3.02 Roof Tear Off

A. General:

1. Notify SEPTA each day of extent of roof tear off proposed for that day and obtain authorization to proceed.
2. Remove aggregate ballast from roofing membrane.
3. Remove protection mat and insulation from protected roofing membrane and discard.
4. Roof Tear Off:
   a. Remove existing roofing membrane and other membrane roofing system components down to the roof deck.
      1) Remove cover boards roof insulation and substrate boards.
      2) Remove bitumen and felts completely from roof decks.
      3) Remove excess asphalt from roof deck.
      4) Remove fasteners from roof deck.

3.03 Roof Deck Preparation

A. Inspect roof deck after tearing off of membrane roofing system.

B. Verify that gypsum substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263 or by pouring 1 pint of hot roofing asphalt on roof deck at start of each day's work and at start of each roof area or plane. Do not proceed with roofing work if moisture condenses under the plastic sheet or if asphalt test sample foams or can be easily and cleanly stripped after cooling.

C. If broken or loose fasteners that secure roof deck panels to one another or to structure are observed or if roof deck appears or feels inadequately attached, immediately notify SEPTA. Do not proceed with installation until directed by SEPTA.

D. If roof deck surface is not suitable for receiving new roofing or if structural integrity of roof deck is suspect, immediately notify SEPTA. Do not proceed with installation until directed by SEPTA.

E. Provide additional roof deck securement as indicated on the Contract Drawings.

F. Replace roof deck as indicated on the Contract Drawings.

3.04 Existing Base Flashings

A. Remove existing base flashings around parapets, curbs, walls, and penetrations.

1. Clean substrates of contaminants such as asphalt, sheet materials, dirt, and debris.

3.05 Fastener Pull Out Testing

A. Retain independent testing and inspecting agency to conduct fastener pull out tests according to FMG and submit test report to the roofing membrane manufacturer before installing new membrane roofing system.

1. Obtain the roofing membrane manufacturer's approval to proceed with specified fastening pattern. The roofing membrane manufacturer may furnish revised fastening pattern commensurate with pull out test results.

3.06 Disposal

A. Collect demolished materials and place in containers. Promptly dispose of demolished materials. Do not allow demolished materials to accumulate onsite.

1. Storage or sale of demolished items or materials onsite is not permitted.

B. Transport and legally dispose of demolished materials off SEPTA's property.

END OF SECTION

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SECTION 07620

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 Description

A. Section includes the following sheet metal flashing and trim items:

1. Manufactured through wall flashing with counterflashing.
2. Manufactured reglets with counterflashing.
3. Formed roof drainage sheet metal fabrications.
4. Formed low slope roof sheet metal fabrications.
5. Synthetic underlayment to prevent corrosion between sheet metal and pressure treated wood.

1.02 Related Sections

A. Section 05500 – Metal Fabrications

B. Section 06105 – Miscellaneous Carpentry

C. Section 07500 – Membrane Roofing

D. Section 07720 – Roof Accessories

E. Section 07841 – Penetration Fire Stopping

F. Section 07842 – Joint Fire Stopping

G. Section 07900 – Joint Sealers

1.03 Submittals

A. Product Data:

1. Submit product data for each type of product.
   a. Include construction details, material descriptions, dimension of individual components and profiles, and finishes for each manufactured product and accessory.

B. Shop Drawings:

1. Submit shop drawings for sheet metal flashing and trim.
   a. Include plans, elevations, sections, and attachment details.
   b. Detail fabrication and installation layouts, expansion joint locations, and keyed details. Distinguish between shop and field assembled work.
   c. Include identification of material, thickness, weight, and finish for each item and location in this Project.
   d. Include details for forming, including profiles, shapes, seams, and dimensions.
   e. Include details for joining, supporting, and securing, including layout, and spacing of fasteners, cleats, clips, and other attachments. Include pattern of seams.

f. Include details of termination points and assemblies.
g. Include details of expansion joints and expansion joint covers, including showing direction of expansion and contraction from fixed points.
h. Include details of roof penetration flashing.
i. Include details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashing as applicable.
j. Include details of special conditions.
k. Include details of connections to adjoining work.
l. Detail formed flashing and trim at scale of not less than 1 1/2 inches per 12 inches.

C. Samples for Initial Selection:

1. Submit samples for each type of sheet metal and accessory indicated with factory applied finishes.

D. Samples for Verification:

1. Submit samples for each type of exposed finish.
   a. Sheet Metal Flashing:
      1) 12 inches long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
   b. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications:
      1) 12 inches long and in required profile. Include fasteners and other exposed accessories.
   c. Anodized Aluminum Samples:
      1) Samples to show full range to be expected for each color required.

E. Qualification Data:

1. Submit qualification data for fabricator.

F. Product Certificates:

1. Submit product certificates for each type of coping and roof edge flashing that is FM Approvals approved.

G. Product Test Reports:

1. Submit product test report for each product for tests performed by a qualified testing agency.

H. Sample Warranty:

1. Submit sample warranty for special warranty.

1.04 Closeout Submittals

A. Maintenance Data:

1. Submit maintenance data for sheet metal flashing and trim, and its accessories, to include in maintenance manuals.

1.05 Quality Assurance

A. Fabricator Qualifications:

1. Employ skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
    a. For copings and roof edge flashings that are FM Approvals approved, shop shall be listed as able to fabricate required details as tested and approved.

B. Meet the "Architectural Sheet Metal Manual", as published by the Sheet Metal and Air Conditioning Design Builder National Association, Inc. (SMACNA) and these Specifications. Conform to dimensions and profiles shown unless more stringent requirements are indicated.

C. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leak-proof, secure, and noncorrosive installation.

D. Underlayment is required for separation of sheet metal and pressure treated wood regardless of any manufacturers printed literature or statement indicating underlayment is not required.

E. Exposed fasteners shall not be acceptable.

F. Meet the applicable provisions of the most recent issues of the following references:

1. AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
2. ASTM A 240/A 240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
3. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
4. ASTM B 32, Standard Specification for Solder Metal.
5. ASTM B 209/B 209M, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
6. ASTM B 370, Standard Specification for Copper Sheet and Strip for Building Construction.
7. ASTM C920, Standard Specification for Elastomeric Joint Sealants.
8. ASTM D 226/D 226M, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
9. ASTM D 2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
10. ASTM D 4214, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
11. ASTM D 4586/D 4586M, Standard Specification for Asphalt Roof Cement, Asbestos Free.
12. Factory Mutual (FM)
13. Metal Construction Association (MCA).

14. National Roofing Contracts Association (NRCA).
15. Sheet Metal and Air Condition Contractors Association (SMACNA).

1.06 Delivery, Storage and Handling

A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.07 Coordination

A. Coordinate sheet metal flashing and trim layout and seams with sizes and locations of penetrations to be flashed, and joints and seams in adjacent materials.

B. Coordinate sheet metal flashing and trim installation with adjoining roofing and wall materials, joints, and seams to provide leak-proof, secure, and noncorrosive installation

1.08 Pre-installation Meetings

A. Pre-installation Conference:

1. Conduct a pre-installation conference at the job site.
   a. Review construction schedule. Verify availability of materials, installer's personnel, equipment, and facilities needed to make progress and avoid delays.
   b. Review special roof details, roof drainage, roof penetration flashing, equipment curbs, and condition of other construction that affect sheet metal flashing and trim.
   c. Review requirements for insurance and certificates if applicable.
   d. Review sheet metal flashing observation and repair procedures after flashing installation.

1.09 Warranty

A. Special Warranty on Finishes:

1. The manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory applied finishes within specified warranty period.
   a. Exposed metal finish deterioration includes, but is not limited to, the following:
      1) Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   b. Finish warranty period to be ten (10) years for date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. General:

1. Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.

B. Sheet Metal Standard for Flashing and Trim:

1. Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.

C. Sheet Metal Standard for Copper:

1. Comply with CDA's "Copper in Architecture Handbook." Conform to dimensions and profiles shown unless more stringent requirements are indicated.

D. FM Approvals Listing:

1. Manufacture and install roof edge flashings that are listed in FM Approvals “RoofNav” and approved for windstorm classification, Class 1-90. Identify materials with name of fabricator and design approved by FM Approvals.

E. Thermal Movements:

1. Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime sky heat loss.
    a. Temperature change to be 120°F, ambient; 180°F, material surfaces.

2.02 Sheet Metals

A. General:

1. Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.

B. Copper Sheet:

1. ASTM B 370 cold rolled copper sheet, H00 or H01 temper.

C. Aluminum Sheet:

1. ASTM B 209/B 209M, alloy as standard with manufacturer for finish required, with temper as required to suit forming operations and performance required; with smooth, flat surface.
    a. Exposed Coil Coated Finish:
        1) Two (2) Coat Fluoropolymer:
            a) AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with the coating and resin manufacturer’s written instructions.
    b. Color:
        1) As selected by SEPTA from the manufacturer’s full range.

c. Concealed Finish:
1) Pretreat with the manufacturer's standard white or light colored acrylic or polyester backer finish, consisting of prime coat and wash coat with minimum total dry film thickness of 0.5 mil.

D. Stainless Steel Sheet:
1. ASTM A 240/A 240M or ASTM A 666, Type 316, dead soft, fully annealed; with smooth, flat surface.
a. Finish:
1) 2D; dull, cold rolled.

2.03 Parapet Scuppers

A. Fabricate scuppers to dimensions required, with closure flange trim to exterior, 4 inch wide wall flanges to interior, and base extending 4 inches beyond cant or tapered strip into field of roof. Fabricate from the following materials:
1. Galvanized steel to be 0.028 inch thick.

2.04 Underlayment Materials

A. Felt:
1. ASTM S 226/D 226M, Type II; No. 30; asphalt saturated organic felt; nonperforated.

2.05 Miscellaneous Materials

A. General:
1. Provide materials and types of fasteners, solder, protective coatings, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and as recommended by the manufacturer of primary sheet metal or manufactured item unless otherwise indicated.

B. Fasteners:
1. Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads and recommended by the manufacturer of primary sheet metal or manufactured item.
a. General:
1) Blind fasteners or self-drilling screws, gasketed, with hex washer head.
a) Exposed Fasteners:
i. Heads matching color of sheet metal using plastic caps or factory applied coating. Provide metal backed EPDM or PVC sealing washers under heads of exposed fasteners bearing on weather side of metal.
b) Blind Fasteners:
i. High strength aluminum or stainless steel rivets suitable for metal being fastened.
c) Spikes and Ferrules:
i. Same material as gutter, with spike and ferrule matching internal gutter width.
b. Fasteners for Copper Sheet:
1) Copper or passivated Series 300 stainless steel.

c. Fasteners for Aluminum Sheet:
   1) Series 300 stainless steel.
d. Fasteners for Stainless Steel Sheet:
   1) Series 300 stainless steel.

C. Solder:

1. For Copper:
   a. ASTM B 32, Grade Sn50, 50 percent tin and 50 percent lead with maximum lead content of 0.2 percent.
2. For Stainless Steel:
   a. ASTM B 32, with acid flux of type recommended by the stainless steel manufacturer.

D. Sealant Tape:

1. Pressure sensitive, 100 percent solids, polyisobutylene compound sealant tape with release paper backing. Provide permanently elastic, non-sag, nontoxic, non-staining tape 1/2 inch wide and 1/8 inch thick.

E. Elastomeric Sealant:

1. ASTM C 920, elastomeric polyurethane polymer sealant, of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.

F. Epoxy Seam Sealer:

1. Two (2) part, noncorrosive, aluminum seam cementing compound, recommended by the aluminum manufacturer for exterior nonmoving joints, including riveted joints.

G. Bituminous Coating:

1. Cold applied asphalt emulsion according to ASTM D 1187/D 1187M.

H. Asphalt Roofing Cement:

1. ASTM D 4586/D 4586M, asbestos free, of consistency required for application.

2.06 Manufactured Sheet Metal Flashing and Trim

A. Reglets:

1. Units of type, material, and profile required, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with factory mitered and welded corners and junctions and with interlocking counterflashing on exterior face, of same material as reglet.

   a. Material:
      1) Copper, 16 ounce per square foot.
   b. Masonry Type:
      1) Provide with offset top flange for embedment in masonry mortar joint.
   c. Accessories:
      1) Flexible Flashing Retainer:

a) Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where the Contract Drawings show reglet without metal counterflashing.

2) Counterflashing Wind Restraint Clips:

a) Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing's lower edge.

d. Finish:

1) Mill.

2.07 General Fabrication

A. General:

1. Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.

a. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.

b. Obtain field measurements for accurate fit before shop fabrication.

c. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.

d. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

B. Fabrication Tolerances:

1. Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet on slope and location lines indicated on the Contract Drawings and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

2. Fabricate sheet metal flashing and trim that is capable of installation to tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

C. Expansion Provisions:

1. Form metal for thermal expansion of exposed flashing and trim.

a. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with butyl sealant concealed within joints.

b. Use lapped expansion joints only where indicated on the Contract Drawings.

D. Sealant Joints:

1. Where movable, non-expansion type joints are required, form metal to provide for proper installation of elastomeric sealant according to cited sheet metal standard.

E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.

F. Fabricate cleats and attachment devices of sizes as recommended by cited sheet metal standard and by FM Global Property Loss Prevention Data Sheet 1-49 for application, but not less than thickness of metal being secured.

G. Seams:

1. Fabricate nonmoving seams with flat lock seams. Tin edges to be seamed, form seams, and solder.

H. Seams for Aluminum:

1. Fabricate nonmoving seams with flat lock seams. Form seams and seal with epoxy seam sealer.

I. Do not use graphite pencils to mark metal surfaces.

2.08 Roof Drainage Sheet Metal Fabrications

A. Hanging Gutters:

1. Fabricate to cross section required, complete with end pieces, outlet tubes, and other accessories as required. Fabricate in minimum 28 feet long sections. Furnish flat stock gutter brackets and flat stock gutter spacers and straps fabricated from same metal as gutters, of size recommended by cited sheet metal standard but with thickness not less than twice the gutter thickness. Fabricate expansion joints, expansion joint covers, and gutter accessories from same metal as gutters.
    a. Gutter Profile:
        1) Style E according to cited sheet metal standard.
    b. Expansion Joints:
        1) Butt type with cover plate.
    c. Accessories:
        1) Wire ball downspout strainer.
    d. Gutter with Girth up to 15 Inches:
        1) Fabricate from the Following Materials:
            a) Aluminum that is 0.032 inches thick.

B. Downspouts:

1. Fabricate rectangular downspouts to dimensions indicated, complete with mitered elbows. Furnish with metal hangers from same material as downspouts and anchors. Shop fabricate elbows.
    a. Fabricated Hanger Style:
        1) Figure 1-35B according to SMACNA's "Architectural Sheet Metal Manual."
    b. Fabricate from the Following Materials:
        1) Aluminum that is 0.024 inches thick.

2.09 Low Slope Roof Sheet Metal Fabrications

A. Roof Edge Flashing (Gravel Stop):

1. Fabricate in minimum 96 inch long, but not exceeding 12 foot long sections. Furnish with 6 inch wide joint cover plates.
    a. Joint Style:
        1) Butted with expansion space and 6 inch wide, concealed backup.

b. Fabricate from the Following Materials:
   1) Aluminum that is 0.050 inches thick.

B. Roof Penetration Flashing:
   1. Fabricate from the Following Materials:
      a. Stainless steel that is 0.019 inches thick.
      b. Lead that is 2.5 pounds thick.

C. Roof Drain Flashing:
   1. Fabricate from the Following Materials:
      a. Stainless steel that is 0.016 inches thick.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas, and conditions, with installer present, for compliance with requirements for installation tolerances, substrate, and other conditions affecting performance of the work.
   1. Verify compliance with requirements for installation tolerances of substrates.
   2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
   3. Verify that air or water resistant barriers have been installed over sheathing or backing substrate to prevent air infiltration or water penetration.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Underlayment Installation

A. Felt Underlayment:
   1. Install felt underlayment, wrinkle free, using adhesive to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply shingle fashion to shed water, with lapped joints of not less than 2 inches.

3.03 Installation

A. General:
   1. Anchor sheet metal flashing and trim and other components of the work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
      a. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure to solder, welds, and sealant.
      b. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.

c. Space cleats not more than 12 inches apart. Attached each cleat with at least two (2) fasteners. Bend taps over fasteners.

d. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.

e. Torch cutting of sheet metal flashing and trim is not permitted.

f. Do not use graphite pencils to mark metal surfaces.

B. Metal Protection:

1. Where dissimilar metals contact each other, or where metal contacts pressure treated wood or other corrosive substrates, protect against galvanic action or corrosion by painting contact surfaces with bituminous coating or by other permanent separation as recommended by the sheet metal manufacturer or cited sheet metal standard.

a. Coat concealed side of uncoated aluminum and stainless steel sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.

b. Underlayment:

1) Where installing sheet metal flashing and trim directly on cementitious or wood substrates, install underlayment and cover with a slip sheet.

C. Expansion Provisions:

1. Provide for thermal expansion of exposed flashing and trim. Space movement joints at maximum of 10 feet with no joints within 24 inches of corner or intersection.

a. Form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with sealant concealed within joints.

b. Use lapped expansion joints only where indicated on the Contract Drawings.

D. Fasteners:

1. Use fastener sizes that penetrate wood blocking or sheathing not less than 1 1/4 inches for nails and not less than 3/4 inch for wood screws.

E. Conceal fasteners and expansion provisions where possible in exposed work and locate to minimize possibility of leakage. Cover and seal fasteners and anchors as required for a tight installation.

F. Seal joints as required for watertight construction.

1. Use sealant filled joints unless otherwise indicated. Embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is between 40°F and 70°F, set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant type joints at temperatures below 40°F.

2. Prepare joints and apply sealants to comply with the requirements in Section 07900.

G. Solder Joints:

1. Clean surfaces to be soldered, removing oils and foreign matter. Pre-tin edges of sheets with solder to width of 1 1/2 inches; however, reduce pre-tinning where pre-tinned surface would show in completed work.

a. Do not solder sheet.

b. Do not use torches for soldering.

c. Heat surfaces to receive solder, and flow solder into joint. Fill joint completely. Completely remove flux and spatter from exposed surfaces.

d. Stainless Steel Soldering:

1) Tin edges of uncoated sheets, using solder for stainless steel and acid flux. Promptly remove acid flux residue from metal after tinning and soldering. Comply with the solder manufacturer's recommended methods for cleaning and neutralization.

e. Copper Soldering:

1) Tin edges of uncoated sheet, using solder for copper.

3.04 Roof Drainage System Installation

A. General:

1. Install sheet metal roof drainage items to produce complete roof drainage system according to cited sheet metal standard unless otherwise indicated. Coordinate installation of roof perimeter flashing with installation of roof drainage system.

B. Hanging Gutters:

1. Gutter sections shall be seamless between ends and expansion joints. Provide for thermal expansion. Attach gutters at eave or fascia to firmly anchor them in position. Provide end closures and seal watertight with sealant. Slope to downspouts.

a. Fasten gutter spacers to front and back of gutter.

b. Anchor and loosely lock back edge of gutter to continuous cleat, eave, or apron flashing.

c. Anchor gutter and gutter brackets spaced not more than 24 inches apart to roof deck, unless otherwise indicated, and loosely lock to front gutter bead.

d. Install gutter with expansion joints at locations indicated, but not exceeding 50 feet apart. Install expansion joint caps.

C. Downspouts:

1. Join sections with 1 1/2 inch telescoping joints.

a. Provide hangers with fasteners designed to hold downspouts securely to walls. Locate hangers at top and bottom and at approximately 60 inches on center.

b. Provide elbows at base of downspout to direct water away from building.

c. Connect downspouts to underground drainage system.

D. Expansion Joint Covers:

1. Install expansion joint covers at locations and of configuration indicated. Lap joints minimum of 4 inches in direction of water flow.

3.05 Roof Flashing Installation

A. General:

1. Install sheet metal flashing and trim to comply with the performance requirements, the sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.

B. Roof Edge Flashing:

1. Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at staggered 3 inch centers.

2. Anchor to resist uplift and outward forces according to recommendations in FM Global Property Loss Prevention Data Sheet 1-49 for FM Approvals listing for required windstorm classification.

C. Pipe or Post Counterflashing:

1. Install counterflashing umbrella with close fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches over base flashing. Install stainless steel draw band and tighten.

D. Counterflashing:

1. Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches. Secure in a waterproof manner by means of snap-in installation and sealant or lead wedges and sealant other otherwise indicated.

E. Roof Penetration Flashing:

1. Coordinate installation of roof penetration flashing with installation of roofing and other items penetrating roof. Seal with butyl sealant and clamp flashing to pipes that penetrate roof.

3.06 Erection Tolerances

A. Installation Tolerances:

1. Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet on slope and location lines indicated on the Contract Drawings and within 1/8 inch offset of adjoining faces and of alignment of matching profiles.

2. Shim and align sheet metal flashing and trim within installed tolerances specified in MCA's "Guide Specification for Residential Metal Roofing."

3.07 Cleaning and Protection

A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.

B. Clean and neutralize flux materials. Clean off excess solder.

C. Clean off excess sealants.

D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in the manufacturer's written installation instructions. On completion of sheet metal flashing and trim installation, remove unused materials and clean finished surfaces as recommended by the sheet metal flashing and trim manufacturer. Maintain sheet metal flashing and trim in clean condition during construction.

E. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION

SECTION 07720

ROOF ACCESSORIES

PART 1 - GENERAL

1.01 Description

A. Section includes the following roof accessory items:

1. Roof curbs.
2. Roof Hatches.
3. Equipment supports.
4. Preformed flashing sleeves.

1.02 Related Sections

A. Section 05500 – Metal Fabrications

B. Section 05520 – Handrails and Railings

C. Section 07500 – Membrane Roofing

D. Section 07620 – Sheet Metal Flashing and Trim

E. Section 09910 – Paints and Coatings

F. Section 15700 – Heating, Ventilating and Air Conditioning Equipment

G. Section 16070 – Hangers, Anchors and Supports

1.03 Submittals

A. Submit product data for each type of roof accessory.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Submit shop drawings for roof accessories.

1. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant and field assembled work.

C. Submit samples for each exposed product and for each color and texture specified, prepared on samples of size to adequately show color.

D. Submit delegated design submittal for roof curbs and equipment supports indicated to meet the performance requirements and design criteria, including analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

1. Detail mounting, securing and flashing of roof-mounted items to roof structure. Indicate coordinating requirements with roof membrane system.

2. Detail fabrication and attachment of wind restraints. Show anchorage details and indicate quantity, diameter and depth of penetration of anchors.

E. Submit coordination roof plans, drawn to scale, and coordinating penetrations and roof mounted items. Show the following:

1. Size and location of roof accessories specified in this Section.
2. Method of attaching roof accessories to roof or building structure.
3. Other roof mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
4. Required clearances.

F. Submit sample warranties for the manufacturer's special warranties.

G. Closeout Submittals:

1. Submit operations and maintenance data for roof accessories to include in operation and maintenance manuals.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.
2. AAMA 621, Voluntary Specification for High Performance Organic Coatings on Coil Coated Architectural Hot Dipped Galvanized (HDG) and Zing-Aluminum Coated Steel Substrates.
3. AAMA 2603, Voluntary Specification, Performance Requirements and Test Procedures for Pigmented Organic Coatings on Aluminum Extrusions and Panels.
4. AAMA 2605, Voluntary Specification, Performance Requirements and Test Procedures for Superior Performing Organic Coatings on Aluminum Extrusions and Panels.
5. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
6. ASTM A 53/A 53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
7. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
8. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
9. ASTM A 240/A 240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
10. ASTM A 500/A 500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

12. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
13. ASTM A 755/A 755M, Standard Specification for Steel Sheet, Metallic Coated by the Hot-Dip Process and Prepainted by the Coil-Coating Process for Exterior Exposed Building Products.
14. ASTM A 780/A 780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
15. ASTM A 792/A 792M, Standard Specification for Steel Sheet, 55% Aluminum-Zinc Alloy-Coated by the Hot-Dip Process.
16. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
17. ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wires, Profiles, and Tubes.
18. ASTM C 208, Standard Specification for Cellulosic Fiber Insulating Board.
19. ASTM C 726, Standard Specification for Mineral Wool Roof Insulation Board.
20. ASTM C 920, Standard Specification for Elastomeric Joint Sealants.
21. ASTM C 1289, Standard Specification for Faced Rigid Cellular Polyisocyanurate Thermal Insulation Board.
22. ASTM C 1311, Standard Specification for Solvent Release Sealants.
23. ASTM C 1363, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
24. ASTM D 226/D 226M, Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
25. ASTM D 256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
26. ASTM D 1187/D 1187M, Standard Specification for Asphalt-Based Emulsions for Use as Protective Coatings for Metal.
27. ASTM D 2244, Standard Practice for Calculation of Color Tolerances and Color Differences from Instrumentally Measured Color Coordinates.
28. ASTM D 4214, Standard Test Methods for Evaluating the Degree of Chalking of Exterior Paint Films.
29. ASTM D 4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
30. ASTM D 4586/D 4586M, Standard Specification for Asphalt Roof Cement, Asbestos-Free.
31. ASTM D 4802, Standard Specification for Poly(Methyl Methacrylate) Acrylic Plastic Sheet.
32. ASTM F 2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners.

33. MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
34. MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
35. National Association of Architectural Metal Manufactures (NAAMM).
36. NFPA 204, Standard for Smoke and Heat Venting.
37. 29 CFR 1910.23, Ladders.
38. UL 972, Burglary-Resisting Glazing Material.

1.05 Delivery, Storage and Handling

A. Delivery:

1. Schedule delivery of materials at the job site at such time as required for proper coordination of work. Receive materials in the manufacturer’s unopened packages and bearing the manufacturer’s label.

B. Storage and Handling:

1. Store materials in a dry and well ventilated place, adequately protected from damage and exposure to the elements.

1.06 Coordination

A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.

B. Coordinate dimensions with rough-in information or shop drawings of equipment to be supported.

1.07 Warranty

A. Special Warranty on Painted Finishes:

1. The manufacturer's standard form in which the manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory applied finishes within specified warranty period.
   a. Fluoropolymer finish deterioration includes, but is not limited to, the following:
      1) Color fading more than 5 Hunter units when tested according to ASTM D 2244.
      2) Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
      3) Cracking, checking, peeling, or failure of paint to adhere to bare metal.
   b. Finish warranty period to be twenty (20) years from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. General Performance:

1. Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

2.02 Roof Curbs

A. Internally reinforced roof curb units capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on the Contract Drawings, bearing continuously on roof structure, and capable of meeting performance requirements; with welded or mechanically fastened and sealed corner joints, straight sides and integrally formed deck mounting flange at perimeter bottom.

B. Coordinate dimensions with roughing-in information on shop drawings of equipment to be supported.

C. Refer to the Contract Drawings for the supported load capacity.

D. Material:

1. Zinc coated (galvanized) steel sheet, 0.052 inch thick minimum.
   a. Finish:
      1) Two (2) coat fluoropolymer.
   b. Color:
      1) As selected by SEPTA from the manufacturer's full range.

E. Construction:

1. Curb profile to be the manufacturer's standard compatible with roofing system.
2. On ribbed or fluted metal roofs, form deck mounting flange at perimeter bottom to conform to roof profile.
3. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
4. Level top of curb with roof slope accommodated by use of leveler frame.
5. Where roof slope exceeds 1:48, fabricate curb with perimeter curb height tapered to accommodate roof slope so that top surface of perimeter curb is level. Equip unit with water diverter or cricket on side that obstructs water flow.
6. Factory insulated with 1 1/2 inch thick glass fiber board insulation.
7. Liner to be the same material as curb, of the manufacturer's standard thickness and finish.
8. Factory installed wood nailer continuous around curb perimeter.
9. Provide wind restraint straps, welded strap connectors and base flange attachment to roof structure at perimeter of curb, of size and spacing required to meet wind uplift requirements.
10. Where portion of roof curb is not covered by equipment, provide weather-tight platform cap formed from 3 inch thick plywood covered with metal sheet of same type, thickness and finish as required for curb.

11. Metal counterflashing to be the manufacturer's standard, removable, fabricated of same metal and finish as curb.
12. Provide security grille where indicated.
13. Provide damper tray or shelf with opening of size indicated.

2.03 Roof Hatches

A. Metal roof hatch units with lids and insulated single walled curbs, welded, or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing, and weathertight perimeter gasketing, straight sides, and integrally formed deck mounting flange at perimeter bottom.

B. Basis of Design:

1. Subject to compliance with the requirements. Provide Type E roof hatch manufactured by the Bilco Company.

C. Type and Size:

1. Single leaf lid, 36 inches by 36 inches.

D. Loads:

1. Minimum 40 lbf/sq. ft. external live load and 20 lbf/sq. ft. internal uplift load.

E. Construction:

1. Insulation:
   a. Polyisocyanurate board.
      1) R-Value:
         a) 12.0 according to ASTM C 1363.
2. Hatch Lid:
   a. Opaque, insulated, and double walled, with the manufacturer's standard metal liner of same material and finish as outer metal lid.
3. Curb Liner:
   a. The manufacturer's standard, of same material and finish as metal curb.
4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
5. Fabricate curbs to minimum height of 12 inches above roofing surface unless otherwise indicated.
6. Sloping Roofs:
   a. Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope, so that top surfaces of perimeter curb are level. Equip hatch with water diverter or cricket on side that obstructs water flow.

F. Hardware:

1. Spring operators, hold open arm, galvanized steel spring latch with turn handles, galvanized steel butt or pintle type hinge system, and padlock hasps inside and outside.

G. Safety Railing System:

1. The roof hatch manufacturer's standard system including rails, clamps, fasteners, safety barrier at railing opening, and accessories required for a complete installation; attached to roof hatch and meeting 29 CFR 1910.23 requirements and authorities having jurisdiction.
    a. Height:
        1) 42 inches above finished roof deck.
    b. Posts and Rails:
        1) Galvanized steel pipe, 1 1/4 inches in diameter.
    c. Flat Bar:
        1) Galvanized steel, 2 inches high by 3/8 inch thick.
    d. Maximum Opening Size:
        1) System constructed to prevent passage of a sphere 21 inches in diameter.
    e. Self-Latching Gate:
        1) Fabricated of same material and rail spacing as safety rail system. Provide the manufacturer's standard hinges and self-latching mechanism.
    f. Post and Rail Tops and Ends:
        1) Weather resistant, closed or plugged with prefabricated end fittings.
    g. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members
    h. Fabricate joints exposed to weather to be watertight.
    i. Fasteners:
        1) The manufacturer's standard finished to match railing system.
    j. Finish:
        1) The manufacturer's standard.
            b) Color:
                i. As selected by SEPTA from the manufacturer's full range.

H. Ladder Assist Post:

1. The roof hatch manufacturer's standard ladder device for attachment to roof access ladder.
    a. Operation:
        1) Post locks in place on full extension; release mechanism returns post to closed position.
    b. Height:
        1) 42 inches above finished roof deck.
    c. Material:
        1) Aluminum.
    d. Post:
        1) 1 5/8 inch diameter pipe.
    e. Finish:
        1) The manufacturer's standard baked enamel or powder coat.
            a) Color:
                i. As selected by SEPTA from the manufacturer's full range.

2.04 Equipment Supports

A. Internally reinforced perimeter or rail type metal equipment supports capable of supporting superimposed live and dead loads between structural supports, including equipment loads and other construction indicated on the Contract Drawings, spanning between structural supports; capable of meeting performance requirements; with welded corner joints and integrally formed structure-mounting flange at bottom.

B. Coordinate dimensions with roughing-in information or shop drawings of equipment to be supported.

C. Supported load capacity shall be coordinated with the requirements of Section 15700 and Section 16070.

D. Material:

1. Zinc coated (galvanized) steel sheet, 0.052 inch thick minimum.
    a. Finish to be two (2) coat fluoropolymer.
    b. Color as selected by SEPTA from the manufacturer's full range.

E. Construction:

1. Curb Profile:
    a. The manufacturer's standard compatible with roofing system.
2. Factory insulated with 1 1/2 inch thick glass fiber board insulation.
3. Liner:
    a. The same material as equipment support, of the manufacturer's standard thickness and finish.
4. Factory installed wood nailers continuous around support perimeter.
5. Provide wind restraint straps, welded strap connectors and base flange attachment to roof structure at perimeter of curb of size and spacing required to comply with wind uplift requirements.
6. Where portion of equipment support is not covered by equipment, provide weather tight platform cap formed from 3/4 inch thick plywood covered with metal sheet of same type, thickness, and finish as required for curb.
7. Metal Counterflashing:
    a. The manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
8. On ribbed or fluted metal roofs, form deck mounting flange at perimeter bottom to conform to roof profile.
9. Fabricate equipment supports to minimum height of 12 inches above roofing surface unless otherwise indicated.
10. Where slope or roof deck exceeds 1:48, fabricate curb with perimeter curb height that is tapered to accommodate roof slope, so that top surfaces of perimeter curb are level. Equip supports with water diverter or cricket on side that obstructs water flow.
11. Provide security grilles where indicated.

2.05 Pipe and Duct Supports

A. Fixed Height Cradle Type Pipe Supports:

1. Polycarbonate pipe stand accommodating up to 1 1/2 inch diameter pipe or conduit; with provision for pipe retainer and with the manufacturer's support pad or deck plate as recommended for penetration free installation over roof membrane type as required for quantity of pipe runs and sizes.

B. Fixed Height Roller Bearing Pipe Supports:

1. Polycarbonate pipe stand with stainless steel roller carrying assembly accommodating up to 7 inch diameter pipe or conduit; with provision for pipe retainer and with the manufacturer's support pad or deck plate as recommended for penetration free installation over roof membrane type as required for quantity of pipe runs and sizes.

C. Adjustable Height Roller Bearing Pipe Supports:

1. Polycarbonate pipe stand base, pipe support and roller housing, with stainless steel threaded rod designed for adjusting support height, accommodating up to 18 inch diameter pipe or conduit; with provision for pipe retainer and with the manufacturer's support pad or deck plate as recommended for penetration free installation over roof membrane type as required for quantity of pipe runs and sizes.

D. Adjustable Height Structure Mounted Pipe Supports:

1. Extruded aluminum tube, filled with urethane insulation; 2 inches in diameter; accommodating up to 7 inch diameter pipe or conduit, with provision for pipe retainer; with aluminum baseplate, EPDM base seal, the manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, stainless steel roller and retainer, and extruded aluminum carrier assemblies as required for quantity of pipe runs and sizes.

E. Curb Mounted Pipe Supports:

1. Galvanized steel support with welded or mechanically fastened and sealed corner joints, straight sides, and integrally formed deck mounting flange at perimeter bottom; with adjustable height roller bearing pipe support accommodating up to 20 inch diameter pipe or conduit and with provision for pipe retainer as required for quantity of pipe runs and sizes.

F. Duct Supports:

1. Extruded aluminum, urethane insulated supports, 2 inches in diameter; with the manufacturer's recommended hardware for mounting to structure or structural roof deck.
    a. Finish to be manufacturer's standard.

2.06 Pipe Portals

A. Curb Mounted Pipe Portal:

1. Insulated roof curb units with welded or mechanically fastened and sealed corner joints, straight sides and integrally formed deck mounting flange at perimeter bottom; with weather-tight curb cover with single or multiple collared openings and pressure

sealed conically shaped EPDM protective rubber caps sized for piping indicated, with stainless steel snaplock swivel clamps.

B. Flashing Pipe Portal:

1. Formed aluminum membrane mounting flashing flange and sleeve with collared opening and pressure sealed conically shaped EPDM protective rubber cap sized for piping indicated, with stainless steel snaplock swivel clamps.

2.07 Preformed Flashing Sleeves

A. Exhaust Vent Flashing:

1. Double walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches high, with removable metal hood and slotted metal collar.
   a. Metal:
      1) Aluminum sheet, 0.063 inch thick.
   b. Diameter:
      1) As indicated on the Contract Drawings.
   c. Finish:
      1) The manufacturer's standard.

B. Vent Stack Flashing:

1. Metal flashing sleeve, uninsulated, with integral deck flange.
   a. Metal:
      1) Aluminum sheet, 0.063 inch thick.
   b. Height:
      1) 7 inches.
   c. Diameter:
      1) As indicated on the Contract Drawings.
   d. Finish:
      1) The manufacturer's standard.

2.08 Metal Materials

A. Zinc coated (galvanized) steel sheet shall comply with ASTM A 653/A 653M, G90 coating designation and mill phosphatized for field painting where indicated.

1. Mill Phosphatized Finish:
   a. The manufacturer's standard for field painting.
2. Where field painting is indicated, apply pretreatment and white or light colored, factory applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
3. Pre-painted by the coil coating process shall comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to meet the coating and resin manufacturers' written instructions.
   a. Two (2) coat fluoropolymer finish shall comply with AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.

4. After cleaning and pretreating, apply the manufacturer's standard two (2) coat, baked-on powder coat finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
5. Pretreat with the manufacturer's standard white or light colored acrylic or polyester backer concealed finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

B. Aluminum zinc alloy coated steel sheet shall comply with ASTM A 792/A 792M, AZ50 coated.

1. Where field painting is indicated, apply pretreatment and white or light colored, factory applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
2. Pre-painted by the coil coating process shall comply with ASTM A 755/A 755M. Prepare, pretreat, and apply coating to exposed metal surfaces to meet the coating and resin manufacturers' written instructions.
    a. Two (2) coat fluoropolymer finish shall comply with AAMA 621. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
3. After cleaning and pretreating, apply the manufacturer's standard two (2) coat, baked-on baked enamel or powder coat finish consisting of prime coat and thermosetting topcoat to a minimum dry film thickness of 2 mils.
4. Pretreat with the manufacturer's standard white or light colored acrylic or polyester backer concealed finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

C. Aluminum sheet shall comply with ASTM B 209, the manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.

1. Mill finish as manufactured.
2. Where field painting is indicated, apply pretreatment and white or light colored, factory applied, baked-on epoxy primer coat, with a minimum dry film thickness of 0.2 mil.
3. Clear anodic finish shall comply with AAMA 611, or thicker.
4. Color anodic finish shall comply with AAMA 611, or thicker.
5. Prepare, pretreat, and apply exposed coil coated finish to exposed metal surfaces to meet the coating and resin manufacturers' written instructions.
    a. Two (2) coat fluoropolymer finish shall comply with AAMA 2605. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
6. Baked enamel or powder coat finish shall comply with AAMA 2603 except with a minimum dry film thickness of 1.5 mils. Comply with the coating manufacturer's written instructions for cleaning, conversion coating, and applying and baking finish.
7. Pretreat with the manufacturer's standard white or light colored acrylic or polyester backer concealed finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil.

D. Aluminum extrusions and tubes shall comply with ASTM B 221, the manufacturer's standard alloy and temper for type of use, finished to match assembly where used; otherwise mill finished.

E. Stainless steel sheet and shapes shall comply with ASTM A 240/A 240M or ASTM A 666, Type 304.

F. Steel shapes shall comply with ASTM A 36/A 36M, hot dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.

G. Steel tube shall comply with ASTM A 500/A 500M, round tube.

H. Galvanized steel tube shall comply with ASTM A 500/A 500M, round tube, hot dip galvanized according to ASTM A 123/A 123M.

I. Steel pipe shall comply with ASTM A 53/A 53M, galvanized.

2.09 Miscellaneous Materials

A. General:

1. Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by the manufacturer for a complete installation.

B. Acrylic glazing shall comply with ASTM D 4802, thermoformable, monolithic sheet, manufacturer's standard, Type UVA (formulated with UV absorber), Finish 1 (smooth or polished).

C. Polycarbonate Glazing:

1. Thermoformable, monolithic polycarbonate sheets manufactured by extrusion process, burglar resistance rated according to UL 972 with an average impact strength of 12 to 16 ft-lbf/in. of width when tested according to ASTM D 256, Method A (Izod).

D. Cellulosic fiber board insulation shall comply with ASTM C 208, Type II, Grade 1, thickness as indicated.

E. Glass fiber board insulation shall comply with ASTM C 726, nominal density of 3 lb/cu. ft., thermal resistivity of 4.3°F x h x sq. ft./Btu x in. at 75°F, thickness as indicated.

F. Polyisocyanurate board insulation shall comply with ASTM C 1289, thickness and thermal resistivity as indicated.

G. Wood Nailers:

1. Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1 1/2 inches thick.

H. Bituminous Coating:

1. Cold applied asphalt emulsion shall comply with ASTM D 1187/D 1187M.

I. Underlayment:

1. ASTM D 226/D 226M, Type II (No. 30), asphalt saturated organic felt, non-perforated.

2. 6 mil thick polyethylene sheet shall comply with ASTM D 4397.

3. Slip sheet building paper, 3 lb/100 sq. ft. minimum, rosin sized.

4. Self-Adhering High Temperature Sheet:

a. Minimum 30 to 40 mils thick, consisting of slip-resisting polyethylene film top surface laminated to layer of butyl or SBS modified asphalt adhesive, with release paper backing, cold applied. Provide primer when recommended by the underlayment manufacturer.

5. The roof accessory manufacturers recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide non-removable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:
   a. Fasteners for Zinc Coated or Aluminum Zinc Alloy Coated Steel:
      1) Series 300 stainless steel or hot dip zinc coated steel according to ASTM A 153/A 153M or ASTM F 2329.
   b. Fasteners for Aluminum Sheet:
      1) Aluminum or Series 300 stainless steel.
   c. Fasteners for Stainless Steel Sheet:
      1) Series 300 stainless steel.

J. Gaskets:

1. The manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.

K. Elastomeric sealant shall comply with ASTM C 920, elastomeric silicone polymer sealant as recommended by the roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.

L. Butyl sealant shall comply with ASTM C 1311, single component, solvent release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.

M. Asphalt roofing cement shall comply with ASTM D 4586/D 4586M, asbestos free, of consistency required for application.

2.10 General Finish Requirements

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Appearance of Finished Work:

1. Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas, and conditions, with the installer present, to verify actual locations, dimensions, and other conditions affecting performance of the work.

B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

C. Verify dimensions of roof openings for roof accessories.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Installation

A. General:

1. Install roof accessories according to the manufacturer's written instructions.
    a. Install roof accessories level; plumb; true to line and elevation; and without warping, jogs in alignment, buckling, or tool marks.
    b. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
    c. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
    d. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.

B. Metal Protection:

1. Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by the manufacturer.
    a. Coat concealed side of uncoated aluminum and stainless steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
    b. Underlayment:
        1) Where installing roof accessories directly on cementitious or wood substrates, install a course of underlayment and cover with the manufacturer's recommended slip sheet.
    c. Bed flanges in thick coat of asphalt roofing cement where required by the manufacturers of roof accessories for waterproof performance.

C. Roof Hatch Installation:

1. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
2. Attached safety railing system to roof hatch curb.
3. Attach ladder assist post according to the manufacturer’s written instructions.

D. Install each roof curb so top surface is level.

E. Install equipment supports so top surfaces are level with each other.

F. Heat and Smoke Vent Installation:

1. Install heat and smoke vent so top perimeter surfaces are level.
2. Install and test heat and smoke vents and their components for proper operation according to NFPA 204.

G. Verify that gravity ventilators operate properly and have unrestricted airflow. Clean, lubricate, and adjust operating mechanisms.

H. Pipe support installation shall comply with MSS SP-58 and MSS SP-89. Install supports and attachments as required to properly support piping. Arrange for grouping of parallel runs of horizontal piping and support together.

1. Pipes of Various Sizes:
    a. Space supports for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

I. Secure flashing sleeve to roof membrane according to the flashing sleeve manufacturer's written instructions; flash sleeve flange to surrounding roof membrane according to the roof membrane manufacturer's instructions.

J. Seal joints with elastomeric or butyl sealant as required by the roof accessory manufacturer.

3.03 Repair and Cleaning

A. Galvanized Surfaces:

1. Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780/A 780M.

B. Touch up factory primed surfaces with compatible primer ready for field painting according to Section 09910.

C. Clean exposed surfaces according to the manufacturer's written instructions.

D. Clean off excess sealants.

E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION

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SECTION 07841

PENETRATION FIRE STOPPING

PART 1 - GENERAL

1.01 Description

A. Requirements for an effective barrier against the spread of flame, smoke and gases and for maintaining the integrity of the rated fire stopping at slabs and fire rated wall penetrations.

1.02 Related Sections

A. Section 04200 – Unit Masonry

B. Section 07500 – Membrane Roofing

C. Section 07620 – Sheet Metal Flashing and Trim

D. Section 07842 – Joint Fire Stopping

E. Section 07900 – Joint Sealers

F. Section 08110 – Metal Doors and Frames

G. Section 10200 – Louvers and Vents

1.03 Submittals

A. Submit product data for each type of product.

B. Submit product schedule for each penetration fire stopping system. Include location, illustration of fire stopping system and design designation of qualified testing and inspecting agency.

1. Where Project conditions require modification to a qualified testing and inspecting agency's illustration for a particular penetration fire stopping system, submit illustration, with modifications marked, approved by the penetration fire stopping system manufacturer's fire protection engineer as an engineering judgment or equivalent fire resistance rated assembly. Obtain approval of authorities having jurisdiction prior to submittal.

C. Submit qualification data for installer.

D. Submit product test reports for each penetration fire stopping system. Tests shall be performed by a qualified testing agency.

E. Submit laboratory test reports for sealants, indicating compliance with the requirements for low-emitting materials.

F. Submit installer certificates indicating that penetration fire stopping systems have been installed in compliance with the requirements and the manufacturer's written instructions.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
3. ASTM E 2174, Standard Practice for On-Site Inspection of Installed Firestops.
4. International Building Code (IBC).
5. International Energy Conservation Code (IECC).
6. UL 1479, Standard for Fire Tests of Through-Penetration Firestops.
7. All other applicable local codes.

B. The installer shall be a firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," and been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

C. Obtain each type of joint sealant through one (1) source from a single manufacturer.

1.05 Delivery, Storage and Handling

A. Deliver materials in the manufacturers' original unopened containers, with brand names, date of manufacture, shelf life and material designation clearly marked thereon.

B. Carefully handle and store to prevent inclusion of foreign materials.

C. Do not subject to sustained temperatures exceeding 90°F or less than 40°F.

1.06 Coordination

A. Coordinate construction of openings and penetrating items to ensure that penetration fire stopping systems can be installed according to the specified fire stopping system design.

B. Coordinate sizing of sleeves, openings, core-drilled holes or cut openings to accommodate the penetration fire stopping systems.

1.07 Restrictions and Quality Control

A. Fire stopping shall be approved for use in the Commonwealth of Pennsylvania.

1.08 Project Conditions

A. Do not install penetration fire stopping system when ambient or substrate temperatures are outside limits permitted by the penetration fire stopping system manufacturer's written instructions or when substrates are wet because of rain, frost, condensation or other causes.

B. Install and cure penetration fire stopping materials per the manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Fire Test Response Characteristics:

1. Perform penetration fire stopping system tests by a qualified testing agency acceptable to authority having jurisdiction.

2. Test per testing standards referenced in Article 2.02 in this Section. Provide rated systems meeting the following requirements:

a. Penetration fire stopping systems shall bear classification marking of a qualified testing agency.

1) UL in its "Fire Resistance Directory."

2) Intertek Group in its "Directory of Listed Building Products."

b. FM Global in its "Building Materials Approval Guide."

B. Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking or fastener disengagement due to defective manufacture, fabrication, installation or other defects in construction.

C. Engage a Professional Engineer licensed in the Commonwealth of Pennsylvania to design roof curbs and equipment supports to meet the wind performance requirements, including comprehensive engineering analysis using performance requirements and design criteria indicated.

D. Wind restraint performance as indicated on the Contract Drawings.

2.02 Penetration Fire Stopping Systems

A. Penetration fire stopping systems that resist spread of fire, passage of smoke and other gases, and maintain original fire resistance rating of construction penetrated. Penetration fire stopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any. Provide penetration fire stopping system from one (1) of the following manufacturers:

1. Hilti Corporation.

2. Isolatek International.

3. Specified Technologies Inc.

4. 3M Company.

5. United States Gypsum Co.

6. Or Approved Equal.

B. Penetrations in fire resistance rated walls shall have ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg.

1. F-Rating shall not be less than the fire resistance rating of constructions penetrated.

C. Penetrations in horizontal assemblies shall have ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01 inch wg.

1. F-Rating shall have at least one (1) hour, but not less than the fire resistance rating of constructions penetrated.
2. T-Rating shall have at least one (1) hour, but not less than the fire resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
3. W-Rating shall have a penetration fire stopping systems showing no evidence of water leakage when tested according to UL 1479.

D. Penetrations in smoke barriers shall have ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30 inch wg.

1. L-Rating shall not exceed 5.0 cfm/sq. ft. of penetration opening at and no more than 50 cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.

E. Exposed penetration fire stopping systems shall have flame spread and smoke developed indexes of less than 25 and 450, respectively, per ASTM E 84.

1. Sealant shall have a VOC content of 250 g/L or less.

F. Provide components for each penetration fire stopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by the penetration fire stopping system manufacturer and approved by the qualified testing and inspecting agency for conditions indicated.

1. Permanent forming/damming/backing materials.
2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.03 Fill Materials

A. Cast-in-place firestop devices shall be factory assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one (1) end of the sleeve for fastening to concrete formwork, and a neoprene gasket.

B. Latex sealants shall be a single component latex formulations that do not re-emulsify after cure during exposure to moisture.

C. Firestop devices shall be factory assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.

D. Intumescent composite sheets shall be rigid panels consisting of aluminum foil faced intumescent elastomeric sheet bonded to galvanized steel sheet.

E. Intumescent putties shall be non-hardening, water resistant, intumescent putties containing no solvents or inorganic fibers.

F. Intumescent wrap strips shall be a single component intumescent elastomeric sheets with aluminum foil on one (1) side.

G. Mortars shall be prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a non-shrinking, homogeneous mortar.

H. Pillows/Bags shall be reusable heat expanding pillows/bags consisting of glass fiber cloth cases filled with a combination of mineral fiber, water insoluble expansion agents, and fire retardant additives. Where exposed, cover openings with steel reinforcing wire mesh to protect pillows/bags from being easily removed.

I. Silicone foams shall be multicomponent, silicone based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, non-shrinking foam.

J. Silicone sealants shall be a single component, silicone based, neutral curing elastomeric sealants.

2.04 Mixing

A. For those products requiring mixing before application, meeting the penetration fire stopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates and conditions, with installer present, for compliance with requirements for opening configurations, penetrating items, substrates and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation

A. Before installing penetration fire stopping systems, clean out openings immediately to meet the manufacturer's written instructions and with the following requirements:

1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration fire stopping materials.

2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration fire stopping materials. Remove loose particles remaining from cleaning operation.

3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by the manufacturer using the manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 Installation

A. Install penetration fire stopping systems to meet the manufacturer's written installation instructions and published drawings for products and applications.

B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.

1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of fire stopping.

C. Install fill materials by proven techniques to produce the following results:

1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire resistance ratings.

2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.

3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 Identification

A. Permanently label walls containing penetration fire stopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375 inch strokes.

1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.

B. Identify each penetration fire stopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration fire stopping system edge so labels are visible to anyone seeking to remove penetrating items or fire stopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Penetration Fire Stopping - Do Not Disturb. Notify Building Management of Any Damage."

2. Contractor's name, address and phone number.

3. Designation of applicable testing and inspecting agency.

4. Date of installation.

5. Manufacturer's name.

6. Installer's name.

3.05 Field Quality Control

A. SEPTA will engage a qualified testing agency to perform tests and inspections according to ASTM E 2174.

B. Where deficiencies are found or penetration fire stopping system is damaged or removed because of testing, repair or replace penetration fire stopping system to meet the requirements.

C. Proceed with enclosing penetration fire stopping systems with other construction only after inspection reports are issued and installations meet the requirements.

3.06 Cleaning and Protection

A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by the penetration fire stopping system manufacturer and that do not damage materials in which openings occur.

B. Provide final protection and maintain conditions during and after installation that ensure that penetration fire stopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration fire stopping material and install new materials to produce systems meeting the specified requirements.

END OF SECTION

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SECTION 07842

JOINT FIRE STOPPING

PART 1 - GENERAL

1.01 Description

A. Section Includes:

1. Joints in or between fire resistance rated constructions.

1.02 Related Sections

A. Section 04200 – Unit Masonry

B. Section 07500 – Membrane Roofing

C. Section 07620 – Sheet Metal Flashing and Trim

D. Section 07841 – Penetration Fire Stopping

E. Section 07900 – Joint Sealers

F. Section 08110 – Metal Doors and Frames

G. Section 10200 – Louvers and Vents

1.03 Submittals

A. Submit product data for each type of product.

B. Submit product schedule for each joint fire stopping system. Include location, illustration of fire stopping system and design designation of qualified testing agency.

1. Where Project conditions require modification to a qualified testing agency's illustration for a particular joint fire stopping system condition, submit illustration, with modifications marked, approved by the joint fire stopping system manufacturer's fire protection engineer licensed in the Commonwealth of Pennsylvania as an engineering judgment or equivalent fire resistance rated assembly.

C. Submit qualification data for installer.

D. Submit product test reports for each joint fire stopping system. Tests shall be performed by a qualified testing agency.

E. Submit laboratory test reports for sealants, indicating compliance with the requirements for low-emitting materials.

F. Submit installer certificates indicating that joint fire stopping systems have been installed in compliance with the requirements and the manufacturer's written instructions.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.

2. ASTM E 1966, Standard Test Method for Fire-Resistive Joint Systems.
3. ASTM E 2393, Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers.
4. International Building Code (IBC).
5. International Energy Conservation Code (IECC).
6. UL 2079, Standard for Fire Resistance of Building Joint Systems.
7. All other applicable local codes.

B. The installer shall be a firm that has been approved by FM Global according to FM Global 4991, "Approval of Firestop Contractors," and been evaluated by UL and found to comply with its "Qualified Firestop Contractor Program Requirements."

C. Obtain each type of joint sealant through one (1) source from a single manufacturer.

1.05 Delivery, Storage and Handling

A. Deliver materials in the manufacturers' original unopened containers, with brand names, date of manufacture, shelf life and material designation clearly marked thereon.

B. Carefully handle and store to prevent inclusion of foreign materials.

C. Do not subject to sustained temperatures exceeding 90°F or less than 40°F.

1.06 Coordination

A. Coordinate construction of joints to ensure that joint fire stopping systems can be installed according to specified fire stopping system design.

B. Coordinate sizing of joints to accommodate joint fire stopping systems.

1.07 Restrictions and Quality Control

A. Fire stopping shall be approved for use in the Commonwealth of Pennsylvania.

1.08 Project Conditions

A. Do not install joint fire stopping systems when ambient or substrate temperatures are outside limits permitted by the joint fire stopping system manufacturer's written instructions or when substrates are wet due to rain, frost, condensation or other causes.

B. Install and cure joint fire stopping systems per the manufacturer's written instructions using natural means of ventilation or, where this is inadequate, forced-air circulation.

PART 2 - PRODUCTS

2.01 Performance Requirements

A. Fire Test Response Characteristics:

1. Perform joint fire stopping system tests by a qualified testing agency acceptable to authority having jurisdiction.

2. Test per testing standards referenced in Article 2.02 in this Section. Provide rated systems meeting the following requirements:
   a. Joint fire stopping systems shall bear classification marking of a qualified testing agency.
      1) UL in its "Fire Resistance Directory."
      2) Intertek Group in its "Directory of Listed Building Products."
   b. Joint fire stopping systems shall be recognized in FM Global's "Building Materials Approval Guide."

2.02 Joint Fire Stopping Systems

A. Joint fire stopping systems that resist spread of fire, passage of smoke and other gases, and maintain original fire resistance rating of assemblies in or between which joint fire stopping systems are installed. Joint fire stopping systems shall accommodate building movements without impairing their ability to resist the passage of fire and hot gases. Provide joint fire stopping system from one (1) of the following manufacturers:
   1. Hilti Corporation.
   2. Isolatek International.
   3. Specified Technologies Inc.
   4. 3M Company.
   5. Or Approved Equal

B. Provide joint fire stopping systems for joints in or between fire resistance rated construction with ratings determined per ASTM E 1966 or UL 2079.
   1. Fire resistance rating shall be equal to or exceeding the fire resistance rating of the wall, floor, or roof in or between which it is installed.

C. Exposed joint fire stopping systems flame spread and smoke developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
   1. Sealant shall have a VOC content of 250 g/L or less.

D. Provide components of fire resistive joint systems, including primers and forming materials, that are needed to install elastomeric fill materials and to maintain ratings required. Use only components specified by the joint fire stopping system manufacturer and approved by the qualified testing agency for conditions indicated.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates and conditions, with installer present, for compliance with requirements for joint configurations, substrates and other conditions affecting performance of the Work.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation

A. Before installing fire resistive joint systems, clean joints immediately to meet the fire resistive joint system manufacturer's written instructions and the following requirements:

1. Remove from surfaces of joint substrates foreign materials that could interfere with adhesion of elastomeric fill materials or compromise fire resistive rating.
2. Clean joint substrates to produce clean, sound surfaces capable of developing optimum bond with elastomeric fill materials. Remove loose particles remaining from cleaning operation.
3. Remove laitance and form-release agents from concrete.

B. Prime substrates where recommended in writing by the joint fire stopping system manufacturer using the manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.03 Installation

A. Install fire resistive joint systems to meet the manufacturer's written installation instructions and published drawings for products and applications indicated.

B. Install forming materials and other accessories of types required to support elastomeric fill materials during their application and in position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.

1. After installing elastomeric fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of fire resistive joint system.

C. Install elastomeric fill materials for fire resistive joint systems by proven techniques to produce the following results:

1. Elastomeric fill voids and cavities formed by joints and forming materials as required to achieve fire resistance ratings indicated.
2. Apply elastomeric fill materials so they contact and adhere to substrates formed by joints.
3. For elastomeric fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.04 Identification

A. Identify joint fire stopping systems with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of joint edge so labels are visible to anyone seeking to remove joint fire stopping system. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:

1. The words "Warning - Joint Fire Stopping - Do Not Disturb. Notify Building Management of Any Damage."
2. Contractor's name, address and phone number.
3. Designation of applicable testing agency.
4. Date of installation.
5. Manufacturer's name.

6. Installer's name.

3.05 Field Quality Control

A. SEPTA will engage a qualified testing agency to perform tests and inspections according to ASTM E 2393.

B. Where deficiencies are found or joint fire stopping systems are damaged or removed due to testing, repair or replace joint fire stopping systems so they meet the requirements.

C. Proceed with enclosing joint fire stopping systems with other construction only after inspection reports are issued and installations meet the requirements.

3.06 Cleaning and Protection

A. Clean off excess elastomeric fill materials adjacent to joints as the Work progresses by methods and with cleaning materials that are approved in writing by the joint fire stopping system manufacturer and that do not damage materials in which joints occur.

B. Provide final protection and maintain conditions during and after installation that ensure joint fire stopping systems are without damage or deterioration at time of Substantial Completion. If damage or deterioration occurs despite such protection, cut out and remove damaged or deteriorated fire resistive joint systems immediately and install new materials to produce fire resistive joint systems meeting the specified requirements.

END OF SECTION

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SECTION 07900

JOINT SEALERS

PART 1 - GENERAL

1.01 Description

A. Section covers all sealant and caulking materials and their application, wherever required for complete installation of building materials or systems.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 04200 – Unit Masonry

C. Section 05120 – Structural Steel

D. Section 07620 – Sheet Metal Flashing and Trim

E. Section 07841 – Penetration Fire Stopping

F. Section 07842 – Joint Fire Stopping

1.03 Submittals

A. Submit in accordance with Section 01300.

B. Submit manufacturer's installation instructions for each product used.

C. Submit samples for initial selection of the manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

D. Submit samples for verification of each kind and color of joint sealant required, provide samples with joint sealants in 1/2 inch wide joints formed between two (2) 6 inch long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.

E. Submit joint sealant schedule to include the following information:

1. Joint sealant application, joint location and designation.
2. Joint sealant manufacturer and product name.
3. Joint sealant formulation.
4. Joint sealant color.

F. Submit the manufacturer's literature and data:

1. Caulking compound.
2. Primers.
3. Sealing compound, each type, including compatibility when different sealants are in contact with each other.
4. The manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

1.04 Quality Assurance

A. The installer is to be qualified in installing joint sealants similar in material, design, and extent to those indicated for this Contract and whose work has resulted in joint sealant installations with a record of successful in service performance.

B. Obtain each type of joint sealant through one (1) source from a single manufacturer.

C. Obtain test results from a qualified testing agency based on testing current sealant formulations within a twelve (12) month period.

1. An independent testing agency qualified according to ASTM C 1021.
2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion in peel and indentation hardness.
4. Test other joint sealants for compliance with requirements indicated by referencing standard specifications and test methods.

D. Before installing elastomeric sealants, field test their adhesion to joint substrates in accordance with the sealant manufacturer's recommendations:

1. Locate test joints where indicated or, if not indicated, as directed by the Contractor.
2. Conduct field tests for each application indicated below:
   a. Each type of elastomeric sealant and joint substrate indicated.
   b. Each type of non-elastomeric sealant and joint substrate indicated.
3. Notify SEPTA seven (7) days in advance of dates and times when test joints will be erected.
4. Arrange for tests to take place with the joint sealant manufacturer's technical representative present.

E. Project Conditions:

1. Do not proceed with installation of joint sealants under the following conditions:
   a. When ambient and substrate temperature conditions are outside limits permitted by the joint sealant manufacturer or are below 40°F.
   b. When joint substrates are wet.
2. Do not proceed with installation of joint sealants where joint widths are less than those allowed by the joint sealant manufacturer for applications indicated.
3. Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

F. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM C 509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
2. ASTM C 612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

3. ASTM C 717, Standard Terminology of Building Seals and Sealants.
4. ASTM C 834, Standard Specification for Latex Sealants.
5. ASTM C 919, Standard Practice for Use of Sealants in Acoustical Applications.
6. ASTM C 920, Standard Specification for Elastomeric Joint Sealants.
7. ASTM C 1021, Standard Practice for Laboratories Engaged in Testing of Building Sealants.
8. ASTM C 1193, Standard Guide for Use of Joint Sealants.
9. ASTM C 1330, Standard Specification for Cylindrical Sealant Backing for Use with Cold Liquid-Applied Sealants.
10. ASTM D 1056, Standard Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
11. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
12. SWRI, The Professionals' Guide.

1.05 Delivery, Handling and Storage

A. Deliver materials in the manufacturers' original unopened containers, with brand names, date of manufacture, shelf life and material designation clearly marked thereon.

B. Carefully handle and store to prevent inclusion of foreign materials.

C. Do not subject to sustained temperatures exceeding 90°F or less than 40°F.

1.06 Field Conditions

A. Do not proceed with installation of joint sealants under the following conditions:

1. When ambient and substrate temperature conditions are outside limits permitted by the joint sealant manufacturer or are below 40°F.
2. When joint substrates are wet.
3. Where joint widths are less than those allowed by the joint sealant manufacturer for applications indicated.
4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

1.07 Warranty

A. Warranties specified in this Article shall not deprive SEPTA of other rights that SEPTA may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties under requirements of the Contract Documents.

B. Written installer's warranty, signed by the installer agreeing to repair or replace elastomeric joint sealants that do not meet the performance and other requirements specified in this Section within specified warranty period.

1. Warranty period to be two (2) years from date of final acceptance.

C. Written standard manufacturer's warranty, signed by the elastomeric sealant manufacturer agreeing to furnish elastomeric joint sealants to repair or replace those that do not meet the performance and other requirements specified in this Section within specified warranty period.

1. Warranty period to be twenty (20) years from date of final acceptance.

D. Warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:

1. Movement of the structure resulting in stresses on the sealant exceeding the sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.

2. Disintegration of joint substrates from natural causes exceeding design specifications.

3. Mechanical damage caused by individuals, tools or other outside agents.

4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

PART 2 - PRODUCTS

2.01 General

A. Provide only products which are recommended and approved by their manufacturer for the specific use to which they are put and which meet all requirements of the Contract Documents.

1. For each generic product, use only materials from one (1) manufacturer.

2. Provide only materials, which are compatible with each other and with joint substrates.

3. Colors of exposed sealers to match color of adjoining materials; to be approved by SEPTA.

2.02 Sealants

A. S-1:

1. ASTM C 920, polyurethane or polysulfide.

2. Type M.

3. Class 25.

4. Grade NS.

5. Shore A hardness of 20-40.

B. S-2:

1. ASTM C 920, polyurethane or polysulfide.

2. Type M.

3. Class 25.

4. Grade P.

5. Shore A hardness of 25-40.

C. S-3:

1. ASTM C 920, polyurethane or polysulfide.
2. Type S.
3. Class 25, joint movement range of plus or minus 50 percent.
4. Grade NS.
5. Shore A hardness of 15-25.
6. Minimum elongation of 700 percent.

D. S-4:

1. ASTM C 920 polyurethane or polysulfide.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-40.

E. S-5:

1. ASTM C 920, polyurethane or polysulfide.
2. Type S.
3. Class 25.
4. Grade P.
5. Shore hardness of 15-45.

F. S-6:

1. ASTM C 920, silicone, neutral cure.
2. Type S.
3. Class to have joint movement range of plus 100 percent to minus 50 percent.
4. Grade NS.
5. Shore A hardness of 15-20.
6. Minimum elongation of 1200 percent.

G. S-7:

1. ASTM C 920, silicone, neutral cure.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-30.

6. Structural glazing application.

H. S-8:

1. ASTM C 920, silicone, acetoxy cure.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-30.
6. Structural glazing application.

I. S-9:

1. ASTM C 920 silicone.
2. Type S.
3. Class 25.
4. Grade NS.
5. Shore A hardness of 25-30.
6. Non-yellowing, mildew resistant.

J. S-10:

1. ASTM C 920, coal tar extended fuel resistance polyurethane.
2. Type M/S.
3. Class 25.
4. Grade P/NS.
5. Shore A hardness of 15-20.

K. S-11:

1. ASTM C 920 polyurethane.
2. Type M/S.
3. Class 25.
4. Grade P/NS.
5. Shore A hardness of 35 to 50.

L. S-12:

1. ASTM C 920, polyurethane.
2. Type M/S.
3. Class 25 to have joint movement range of plus or minus 50 percent.
4. Grade P/NS.
5. Shore A hardness of 25 to 50.

M. S-13:

1. Pourable Penetration Sealant, 1-Part, non-shrink.
2. ASTM C 920, polyether sealant.
3. Type S.
4. Class 25.
5. Grade NS.

2.03 Caulking Compound

A. C-1:

1. ASTM C 834, acrylic latex.

B. C-2:

1. One (1) component acoustical caulking, non-drying, non-hardening, synthetic rubber.

2.04 Joint Sealant Backing

A. Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by the sealant manufacturer based on field experience and laboratory testing.

B. Backup rod sealant backings to meet ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:

1. Type C to be closed cell material with a surface skin.
2. Elastomeric tubing sealant backings to be neoprene, butyl, EPDM or silicone tubing to meet ASTM D 1056, nonabsorbent to water and gas, and capable of remaining resilient at temperatures down to minus 26°F. Provide products with low compression set and of size and shape to provide a secondary seal, to control sealant depth and otherwise contribute to optimum sealant performance.

C. Bond breaker tape to be polyethylene tape or other plastic tape recommended by the sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.05 Filler

A. Mineral fiber board to meet ASTM C 612, Class 1.

B. Thickness same as joint width.

C. Depth to fill void completely behind back-up rod.

2.06 Primer

A. As recommended by the manufacturer of caulking or sealant material.

B. Stain free type.

2.07 Cleaners Non-Porous Surfaces

A. Chemical cleaners acceptable to the manufacturer of sealants and sealant backing material free of oily residues and other substances capable of staining or harming joint substrates and adjacent non-porous surfaces and formulated to promote adhesion of sealant and substrates.

PART 3 - EXECUTION

3.01 Inspection

A. Inspect substrate surface for bond breaker contamination and unsound materials at adherent faces of sealant.

B. Coordinate for repair and resolution of unsound substrate materials.

C. Inspect for uniform joint widths and that dimensions are within tolerance established by the sealant manufacturer.

3.02 Preparations

A. Prepare joints in accordance with the manufacturer's instructions and SWRI.

B. Clean surfaces of joint to receive caulking or sealants leaving joint dry to the touch, free from frost, moisture, grease, oil, wax, lacquer paint, or other foreign matter that would tend to destroy or impair adhesion.

1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt and frost. Clean porous joint substrate surfaces by brushing, grinding, mechanical abrading or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining after cleaning operations above by vacuuming or blowing out joints with oil free compressed air. Porous joint substrates include the following:
    a. Concrete.
    b. Masonry.
    c. Unglazed surfaces of ceramic tile.
2. Remove laitance and form release agents from concrete.
3. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates or leave residues capable of interfering with adhesion of joint sealants.
    a. Metal.
    b. Glass.
    c. Porcelain enamel.
    d. Glazed surfaces of ceramic tile.

C. Do not cut or damage joint edges.

D. Apply masking tape to face of surfaces adjacent to joints before applying primers, caulking

or sealing compounds.

1. Do not leave gaps between ends of sealant backings.
2. Do not stretch, twist, puncture or tear sealant backings.
3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.

E. Apply primer to sides of joints wherever required by the compound manufacturer's printed instructions.

1. Apply primer prior to installation of back-up rod or bond breaker tape.
2. Use brush or other approved means that will reach all parts of joints.

F. Take all necessary steps to prevent three (3) sided adhesion of sealants.

3.03 Backing Installation

A. Install back-up material to form joints enclosed on three (3) sides as required for specified depth of sealant.

B. Where deep joints occur, install filler to fill space behind the back-up rod and position the rod at proper depth.

C. Cut fillers installed by others to proper depth for installation of back-up rod and sealants.

D. Install back-up rod, without puncturing the material, to a uniform depth, within plus or minus 1/8 inch for sealant depths specified.

E. Where space for back-up rod does not exist, install bond breaker tape strip at bottom (or back) of joint so sealant bonds only to two (2) opposing surfaces.

F. Take all necessary steps to prevent three (3) sided adhesion of sealants.

3.04 Sealant Depths and Geometry

A. At widths up to 1/4 inch, sealant depth equal to width.

B. At widths over 1/4 inch, sealant depth 1/2 of width up to 1/2 inch maximum depth at center of joint with sealant thickness at center of joint approximately 1/2 of depth at adhesion surface.

3.05 Installation

A. General:

1. Apply sealants and caulking only when ambient temperature is between 40°F and 100°F.
2. Do not use polysulfide base sealants where sealant may be exposed to fumes from bituminous materials or where water vapor in continuous contact with cementitious materials may be present.
3. Do not use sealant type listed by the manufacturer as not suitable for use in locations specified.
4. Apply caulking and sealing compound in accordance with the manufacturer's printed instructions.

5. Avoid dropping or smearing compound on adjacent surfaces.
6. Fill joints solidly with compound and finish compound smooth.
7. Tool joints to concave surface unless shown or specified otherwise.
8. Finish paving or floor joints flush unless joint is otherwise detailed.
9. Apply compounds with nozzle size to fit joint width.
10. Test sealants for compatibility with each other and substrate. Use only compatible sealant.

B. For application of sealants, follow requirements of ASTM C 1193 unless specified otherwise.

3.06 Field Quality Control

A. Field test joint sealant adhesion to joint substrates as recommended by the sealant manufacturer:

1. Test completed elastomeric sealant joints as follows:
   a. Perform ten (10) tests for first 1000 feet of joint length for each type of elastomeric sealant and joint substrate.
   b. Perform one (1) test for each 1000 feet of joint length thereafter or one (1) test per each floor per elevation.

B. Inspect joints for complete fill, for absence of voids and for joint configuration meeting the specified requirements. Record results in a field adhesion test log.

C. Inspect tested joints and report on the following:

1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate.
2. Compare these results to determine if adhesion passes the sealant manufacturer's field adhesion hand pull test criteria.
3. Whether sealants filled joint cavities and are free from voids.
4. Whether sealant dimensions and configurations meet the specified requirements.

D. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration and sealant dimensions.

E. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.

F. Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or meet the other requirements. Retest failed applications until test results prove sealants meet the indicated requirements.

3.07 Cleaning

A. Scrape off fresh compound accidentally smeared on adjoining surface immediately and rub clean with a solvent as recommended by the caulking or sealant manufacturer.

B. After filling and finishing joints, remove masking tape.

C. Leave adjacent surfaces in a clean and unstained condition.

3.08 Locations

A. Exterior Building Joints, Horizontal and Vertical:

1. Metal to metal to be Type S-1, S-2.
2. Metal to masonry or stone to be Type S-1.
3. Masonry to masonry or stone to be Type S-1.
4. Stone to stone to be Type S-1.
5. Cast stone to cast stone to be Type S-1.
6. Threshold setting bed to be Type S-1, S-3, S-4.
7. Masonry expansion and control joints to be Type S-6.
8. Wood to masonry to be Type S-1.

B. Metal Reglets and Flashings:

1. Flashings to wall to be Type S-6.
2. Metal to metal to be Type S-6.

C. Sanitary Joints:

1. Walls to plumbing fixtures to be Type S-9.
2. Pipe penetrations to be Type S-9.

D. Horizontal Traffic Joints:

1. Concrete paving, unit pavers to be Type S-11 or S-12.

E. High Temperature Joints over 400°F:

1. Exhaust pipes, flues, breech stacks to be Type S-7 or S-8.

F. Interior Caulking:

1. Typical narrow joint 1/4 inch or less at walls and adjacent components to be Type C-1, C-2.
2. Perimeter of doors, windows, access panels which adjoin concrete or masonry surfaces to be Type C-1, C-2.
3. Joints at masonry walls and columns, piers, concrete walls or exterior walls to be Type C-1, C-2.
4. Exposed isolation joints at top of full height walls to be Type C-1, C-2.

END OF SECTION

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SECTION 08110

METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 Description

A. Section includes hollow metal work doors and frames and removable transoms.

1.02 Related Sections

A. Section 07841 – Penetration Fire Stopping

B. Section 07842 – Joint Fire Stopping

C. Section 08710 – Door Hardware

D. Section 09910 – Paints and Coatings

1.03 Submittals

A. Submit product data for each type of product.

1. Include construction details, material descriptions, core descriptions, fire resistance ratings, temperature rise ratings and finishes.

B. Submit shop drawings including the following:

1. Elevations of each door type.
2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
4. Locations of reinforcement and preparations for hardware.
5. Details of each different wall opening condition.
6. Details of anchorages, joints, field splices and connections.
7. Details of accessories.
8. Details of moldings, removable stops and glazing.
9. Details of conduit and preparations for power, signal and control systems.

C. Submit samples for initial selection for units with factory applied color finishes.

D. Submit samples for verification:

1. For each type of exposed finish required, prepared on samples of not less than 3 by 5 inches.

E. Submit a schedule of hollow metal work prepared by or under the supervision of the supplier, using same reference numbers for details and openings as those on the Contract Drawings. Coordinate with final Door Hardware Schedule.

F. Submit product test reports for each type of hollow metal door and frame assembly. Tests performed by a qualified testing agency.

G. Submit oversize construction certification for assemblies required to be fire rated and exceeding limitations of labeled assemblies.

H. Submit qualification data for the installer, the manufacturer and the acoustical testing agency.

I. Submit field quality control reports.

J. Submit sample warranty for the manufacturer's special warranties.

1.04 Quality Assurance

A. Applicable standards are specifications and standards of ANSI/SDI A250.8 (SDI 100).

B. Wind load performance requirements to meet the wind load requirements of Uniform Building Code. Deflection shall not exceed 1/175 of span.

C. An entity that employs installers and supervisors who are trained and approved by the manufacturer.

D. Obtain hollow metal work from single source from single manufacturer.

E. Verify actual dimensions of openings by field measurements before fabrication.

F. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI/SDI 111, Recommended Details for Standard Steel Doors, Frames, Accessories and Related Components.
2. ANSI/SDI A250.4, Test Procedure and Acceptance Criteria for Physical Endurance for Steel Doors, Frame and Frame Anchors.
3. ANSI/SDI A250.6, Recommended Practice for Hardware Reinforcing and Standard Steel Doors and Frames.
4. ANSI/SDI A250.8, Specifications for Standard Steel Doors and Frames.
5. ANSI/SDI A250.10, Test Procedure and Acceptance Criteria for Prime Painted Steel Surfaces for Steel Doors and Frames.
6. ANSI/SDI A250.11, Recommended Erection Instructions for Steel Frames.
7. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
8. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
9. ASTM A 879/A 879M, Standard Specification for Steel Sheet, Zinc Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
10. ASTM A 1008/A 1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.

11. ASTM A 1011/A 1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
12. ASTM C 143/C 143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
13. ASTM C 476, Standard Specification for Grout for Masonry.
14. ASTM C 665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.
15. ASTM C 1363, Standard Test Method for Thermal Performance of Building Materials and Envelope Assemblies by Means of a Hot Box Apparatus.
16. ASTM E 136, Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C.
17. BHMA A156.115, Hardware Preparation in Steel Doors and Steel Frames.
18. NAAMM-HMMA 803, Door Components.
19. NAAMM-HMMA 840, Guide Specification for Installation and Storage of Hollow Metal Doors and Frames.
20. NFPA 80, Standard for Fire Doors and Other Opening Protectives.
21. NFPA 105, Standard for Smoke Door Assemblies and Other Opening Protectives.
22. NFPA 252, Fire Tests for Door Assemblies.
23. UL 10C, Positive Pressure Fire Tests of Door Assemblies.
24. UL 1784, Air Leakage Tests for Door Assemblies.

1.05 Delivery, Storage and Handling

A. Deliver hollow metal work palletized, packaged or crated to provide protection during transit and Project site storage. Do not use non-vented plastic.

1. Provide additional protection to prevent damage to factory finished units.

B. Deliver welded frames with two (2) removable spreader bars across bottom of frames, tack welded to jambs and mullions.

C. Store hollow metal work vertically under cover at Project site with head up. Place on minimum 4 inch high wood blocking. Provide minimum 1/4 inch space between each stacked door to permit air circulation.

1.06 Definitions

A. Minimum thickness of base metal without coatings according to NAAMM-HMMA 803 or SDI A250.8.

1.07 Coordination

A. Coordinate anchorage installation for hollow metal frames. Furnish setting drawings, templates and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts and items with integral anchors. Deliver such items to Project site in time for installation.

1.08 Project Conditions

A. Verify actual dimensions of openings by field measurements before fabrication.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Manufacturers:

1. Steelcraft.
2. Cornell Ironworks.
3. Curries.
4. Ceco.
5. Or Approved Equal.

B. Obtain hollow-metal work from single source from single manufacturer.

2.02 Regulatory Requirement

A. Fire rated assemblies to meet NFPA 80 and listed and labeled by a qualified testing agency acceptable to authorities having jurisdiction for fire protection ratings and temperature rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.

1. Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.

2.03 Interior Doors and Frames

A. Construct interior doors and frames to meet the standards indicated for materials, fabrication, hardware locations, hardware reinforcement, tolerances, clearances and as specified.

B. Heavy duty doors to meet SDI A250.8, Level 2.

1. Physical performance to meet Level B according to SDI A250.4, 18 gauge.
2. Doors:
    a. Type as indicated in the Door and Frame Schedule.
    b. Thickness to be 1 3/4 inches.
    c. Face to be uncoated cold rolled steel sheet, minimum thickness of 0.042 inch.
    d. Edge construction to be model 2, Seamless.
    e. Core:
        1) Kraft paper honeycomb.
        2) Mineral board, vertical steel stiffener (for fire rated doors).
3. Exposed finish to be factory primed. Refer to Section 09910 for finish system requirements.

2.04 Extra Heavy Duty Frames

A. Frames:

1. Materials to be uncoated steel sheet, minimum thickness of 0.053 inch, 16 gauge.
2. Construction to be full profile welded.
3. To meet SDI A250.8, Level 3.

B. Exposed finish to be factory primed. Refer to Section 09910 for finish system requirements.

2.05 Exterior Doors and Frames

A. Extra heavy duty doors to meet SDI A250.8, Level 3.

1. Physical performance to meet Level A according to SDI A250.4, 16 gauge.
2. Doors:
   a. Type as indicated in the Door and Frame Schedule.
   b. Thickness to be 1 3/4 inches.
   c. Face to be metallic coated steel sheet, minimum thickness of 0.053 inch, with minimum A40 (ZF120) coating.
   d. Edge construction to be Model 2, seamless.
   e. Core to be mineral board, vertical steel stiffener.
      1) Provide doors fabricated with thermal resistance value (R-value) of not less than 2.1°F x h x sq. ft. /Btu when tested according to ASTM C 1363.
3. Exposed finish to be factory primed. Refer to Section 09910 for finish system requirements.

B. Maximum duty frames to meet SDI A250.8, Level 4.

1. Frames:
   a. Materials to be metallic coated steel sheet, minimum thickness of 0.067 inch, with minimum A40 coating, 14 gauge.
   b. Transom frames to be fabricated from same thickness material as adjacent door frame.
   c. Construction to be full profile welded.
2. Exposed finish to be factory primed. Refer to Section 09910 for finish system requirements.

2.06 Frame Anchors

A. Jamb Anchors:

1. Masonry type to be adjustable strap and stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
2. Stud wall type to be designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
3. Compression type for drywall slip-on frames to be adjustable compression anchors.

4. Post-installed expansion type for in-place concrete or masonry to be a minimum of 3/8 inch diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.

B. Floor anchors to be formed from same material as frames, minimum thickness of 0.042 inch, and as follows:

1. Monolithic concrete slabs to be clip type anchors, with two (2) holes to receive fasteners.

2. Separate topping concrete slabs to be adjustable type anchors with extension clips, allowing not less than 2 inch height adjustment. Terminate bottom of frames at finish floor surface.

2.07 Materials

A. Cold rolled steel sheet to meet ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.

B. Hot rolled steel sheet to meet ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting or surface defects; pickled and oiled.

C. Metallic coated steel sheet to meet ASTM A 653/A 653M, Commercial Steel (CS), Type B.

D. Frame anchors to meet ASTM A 879/A 879M, Commercial Steel (CS), 04Z coating designation; mill phosphatized.

1. For anchors built into exterior walls, steel sheet to meet ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot dip galvanized according to ASTM A 153/A 153M, Class B.

E. Inserts, bolts and fasteners to be hot dip galvanized according to ASTM A 153/A 153M.

F. Power actuated fasteners in concrete to be a fastener system of type suitable for application indicated, fabricated from corrosion resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.

G. Grout to meet ASTM C 476, except with a maximum slump of 4 inches as measured according to ASTM C 143/C 143M.

H. Mineral fiber insulation to meet ASTM C 665, Type I (blankets without membrane facing); consisting of fibers manufactured from slag or rock wool; with maximum flame spread and smoke developed indexes of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics.

I. Bituminous coating to be cold applied asphalt mastic, compounded for 15 mil dry film thickness per coat. Provide inert type noncorrosive compound free of asbestos fibers, sulfur components and other deleterious impurities.

2.08 Fabrication

A. Fabricate hollow metal work to be rigid and free of defects, warp or buckle. Accurately form metal to required sizes and profiles, with minimum radius for metal thickness. Where practical, fit and assemble units in the manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.

B. Hollow Metal Doors:

1. Steel stiffened door cores to be a minimum thickness 0.026 inch, steel vertical stiffeners of same material as face sheets extending full door height, with vertical webs spaced not more than 6 inches apart. Spot weld to face sheets no more than 5 inches on center. Fill spaces between stiffeners with glass or mineral fiber insulation.
2. Provide fire door cores as required to provide fire protection and temperature rise ratings indicated.
3. Vertical edges for single acting doors to have bevel edges 1/8 inch in 2 inches.
4. Close top edges of doors with flush closures of same material as face sheets.
5. Close bottom edges of doors where required for attachment of weather stripping with end closures or channels of same material as face sheets.
6. Provide weep-hole openings in bottoms of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.

C. Where hollow metal frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.

1. Provide transom bar frames as closed tubular members with no visible face seams or joints, fabricated from same material as door frame. Fasten members at crossings and to jambs by butt welding.
2. Provide countersunk, flat or oval head exposed screws and bolts for exposed fasteners unless otherwise indicated.
3. Weld guards to frame at back of hardware mortises in frames to be grouted.
4. Weld floor anchors to bottoms of jambs with at least four (4) spot welds per anchor; however, for slip-on drywall frames, provide anchor clips or countersunk holes at bottoms of jambs.
5. Provide number and spacing of jamb anchors as follows:
    a. Locate masonry type anchors not more than 16 inches from top and bottom of frame. Space anchors not more than 32 inches on center, to match coursing, and as follows:
        1) Two (2) anchors per jamb up to 60 inches high.
        2) Three (3) anchors per jamb from 60 to 90 inches high.
        3) Four (4) anchors per jamb from 90 to 120 inches high.
        4) Four (4) anchors per jamb plus one (1) additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
    b. Locate stud wall type anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches on center and as follows:
        1) Three (3) anchors per jamb up to 60 inches high.
        2) Four (4) anchors per jamb from 60 to 90 inches high.
        3) Five (5) anchors per jamb from 90 to 96 inches high.
        4) Five (5) anchors per jamb plus one (1) additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
    c. Not less than two (2) compression type anchors in each frame.

d. Locate post-installed expansion type anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches on center

6. Two (2) anchors per head for frames more than 42 inches wide and mounted in metal stud partitions.

7. Except on weather stripped frames, drill stops to receive door silencers as follows. Keep holes clear during construction.
   a. For single door frames, drill stop in strike jamb to receive three (3) door silencers.
   b. For double door frames, drill stop in head jamb to receive two (2) door silencers.

8. Terminate stops 6 inches above finish floor with a 45 degree angle cut and close open end of stop with steel sheet closure. Cover opening in extension of frame with welded-steel filler plate, with welds ground smooth and flush with frame.

D. Fabricate concealed stiffeners and edge channels from either cold or hot rolled steel sheet.

E. Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling and tapping according to SDI A250.6, the Door Hardware Schedule and templates.

1. Reinforce doors and frames to receive non-templated, mortised and surface mounted door hardware.

2. Meet the applicable requirements in SDI A250.6 and BHMA A156.115 for preparation of hollow metal work for hardware.

F. Provide stops and moldings around glazed lites and louvers where indicated. Form corners of stops and moldings with mitered hairline joints.

1. Provide fixed and removable stops and moldings welded on secure side of hollow metal work for single transom panels.

2. Provide fixed and removable stops and moldings so that each glazed lite is capable of being removed independently.

3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.

4. Provide loose stops and moldings on inside of hollow metal work.

5. Coordinate rabbet width between fixed and removable stops with glazing and installation types indicated.

2.09 Steel Finishes

A. Clean, pretreat and apply the manufacturer's standard primer.

1. The manufacturer's standard, fast-curing, lead and chromate free primer that meets SDI A250.10; recommended by the primer manufacturer for substrate; compatible with substrate and field applied coatings despite prolonged exposure.

2. Refer to Section 09910 for color and gloss.

2.10 Accessories

A. Provide louvers for interior doors, where indicated, that meet SDI 111, with blades or baffles formed of 0.020 inch thick, cold rolled steel sheet set into 0.032 inch thick steel frame.

1. Stationary sight-proof louvers constructed with inverted-V or inverted-Y blades.

B. Mullions and transom bars to join to adjacent members by welding or rigid mechanical anchors.

C. Grout guards to be formed from same material as frames, not less than 0.016 inch thick.

PART 3 - EXECUTION

3.01 Examination

A. Examine substrates, areas and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the work.

B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.

C. Prepare written report, endorsed by the installer, listing conditions detrimental to performance of the work.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Preparation

A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling and dressing, as required to make repaired area smooth, flush and invisible on exposed faces.

B. Drill and tap doors and frames to receive non-templated, mortised and surface mounted door hardware.

3.03 Installation

A. Install hollow metal work plumb, rigid, properly aligned and securely fastened in place. Meet the Contract Drawing requirements and the manufacturer's written instructions.

B. Install hollow metal frames for doors, transoms, sidelites, borrowed lites, and other openings of size and profile indicated. Meet SDI A250.11 or NAAMM-HMMA 840 as required by standards specified.

1. Set frames accurately in position; plumbed, aligned and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
    a. At fire rated openings, install frames according to NFPA 80.
    b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress and make splice smooth, flush and invisible on exposed faces.
    c. Install frames with removable stops located on secure side of opening.

d. Install door silencers in frames before grouting.

e. Remove temporary braces necessary for installation only after frames have been properly set and secured.

f. Check plumb, square and twist of frames as walls are constructed. Shim as necessary to meet installation tolerances.

g. Field apply bituminous coating to backs of frames that will be filled with grout containing anti-freezing agents.

2. Provide floor anchors for each jamb and mullion that extends to floor and secure with post-installed expansion anchors.

   a. Floor anchors may be set with power actuated fasteners instead of post-installed expansion anchors if so indicated and approved on shop drawings.

3. Solidly pack mineral fiber insulation inside frames for metal stud partitions.

4. Coordinate installation of frames to allow for solidly filling space between frames and masonry with grout.

5. Solidly fill space between frames and concrete with mineral-fiber insulation.

6. Secure frames in place with post-installed expansion anchors. Countersink anchors, and fill and make smooth, flush and invisible on exposed faces.

7. Secure slip-on drywall frames in place according to the manufacturer's written instructions.

8. Adjust hollow metal door frames for squareness, alignment, twist and plumb to the following tolerances:

   a. Squareness to be plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.

   b. Alignment to be plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.

   c. Twist to be plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines and perpendicular to plane of wall.

   d. Plumbness to be plus or minus 1/16 inch, measured at jambs at floor.

C. Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.

1. Non Fire Rated Steel Doors:

   a. Provide 1/8 inch plus or minus 1/32 inch between door and frame jambs and head.

   b. Provide 1/8 inch to 1/4 inch plus or minus 1/32 inch between edges of pairs of doors.

   c. Provide 5/8 inch plus or minus 1/32 inch at bottom of door.

   d. Provide 1/16 inch to 1/8 inch plus or minus 1/32 inch between door face and stop.

2. Install fire rated doors with clearances according to NFPA 80.

3. Install smoke control doors and gaskets according to NFPA 105.

3.04 Adjusting and Cleaning

A. Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed or otherwise unacceptable.

B. Remove grout and other bonding material from hollow metal work immediately after installation.

C. Immediately after erection, sand smooth rusted or damaged areas of prime coat and apply touchup of compatible air drying, rust inhibitive primer for prime coat touchup.

D. Clean abraded areas and repair with galvanizing repair paint according to the manufacturer's written instructions for metallic coated surface touchup.

E. Clean abraded areas and repair with same material used for factory finish according to the manufacturer's written instructions for factory finish touchup.

F. Cleaning and touchup painting of abraded areas of paint are specified in painting Sections.

END OF SECTION

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SECTION 08331

OVERHEAD COILING DOORS

PART 1 - GENERAL

1.01 Description

A. This Section includes electric motor operated overhead coiling doors:

1. Insulated service doors.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

B. Section 01700 - Contract Closeout

C. Section 05500 - Metal Fabrications

D. Section 08710 - Door Hardware

E. Division 16 Sections for electrical service and connections for powered operators and accessories.

1.03 Submittals

A. Submit product data for each type and size of overhead coiling door and accessory. Include the following:

1. Summary of forces and loads on walls and jambs.

B. Submit shop drawings for special components and installations not dimensioned or detailed in manufacturer's product data.

C. Submit samples for initial selection from manufacturer's color charts showing full range of colors available for units with factory applied finishes.

D. Submit qualification data for the installer.

1.04 Quality Assurance

A. Manufacturer's authorized representative who is trained and approved for both installation and maintenance of units required for the Contract.

B. Obtain overhead coiling doors through one (1) source from a single manufacturer.

C. Obtain operators and controls from the overhead coiling door manufacturer.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.

2. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

3. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Allot-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
5. ASTM E 1886, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
6. ASTM E 1996, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
7. National Association of Architectural Metal Manufacturers (NAAMM).
8. NEMA ICS 1, Industrial Control and Systems - General Requirements.
9. NEMA ICS 2, Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600 Volts.
10. NEMA ICS 6, Enclosures.
11. NEMA MG 1, Motors and Generators.
12. NFPA 70, National Electrical Code (NEC).

1.05 Definitions

A. Operation cycle is one (1) cycle of a door is complete when it is moved from the closed position to the fully open position and returned to the closed position.

1.06 Performance Requirements

A. Provide overhead coiling doors capable of withstanding the effects of gravity loads and the following loads and stresses without evidencing permanent deformation of door components:
   1. Wind load to be uniform pressure (velocity pressure) of 20 lbf/sq. ft., acting inward and outward.
   2. Impact test for flying debris to meet ASTM E 1996, tested according to ASTM E 1886.
      a. Level of protection to be enhanced protection.
      b. Wind zone 1 to be 110 mph, pressure test to 1/2 and 1 1/2 x design pressure (positive and negative).

B. Provide overhead coiling door components and operators capable of operating for not less than ten thousand (10,000) cycles and for ten (10) cycles per day.
   1. Include tamperproof cycle counter.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Cookson Company.
2. Cornell Iron Works Inc.
3. Overhead Door Corp.
4. Or Approved Equal.

2.02 Door Curtain Materials and Construction

A. Fabricate overhead coiling door curtain of interlocking slats, designed to withstand wind loading indicated, in a continuous length for width of door without splices. Unless otherwise indicated, provide slats of thickness and mechanical properties recommended by the door manufacturer for performance, size and type of door indicated, and as follows:

1. Steel door curtain slats to be zinc coated (galvanized), cold rolled structural steel (SS) sheet; meeting ASTM A 653/A 653M, G90 (Z275) coating designation.
   a. Minimum base metal (uncoated) thickness to be 0.0209 inch.
   b. Flat profile slats.
2. Fill slat with the manufacturer's standard rigid cellular polystyrene or polyurethane foam type thermal insulation meeting the maximum flame spread and smoke developed indexes of 75 and 450, respectively, according to ASTM E 84. Enclose insulation completely within metal slat faces.
3. Inside curtain slat face to match material of outside metal curtain slat.

B. End-locks and wind-locks for service doors to be malleable iron casings galvanized after fabrication, secured to curtain slats with galvanized rivets or high strength nylon. Provide locks on not less than alternate curtain slats for curtain alignment and resistance against lateral movement.

C. Bottom bar for service doors consisting of two (2) angles, each not less than 1 1/2 by 1 1/2 by 1/8 inch thick; galvanized, stainless steel or aluminum extrusions to suit type of curtain slats.

D. Fabricate curtain jamb guides of steel angles or channels and angles, with sufficient depth and strength to retain curtain, to allow curtain to operate smoothly and to withstand loading. Build up units with not less than 3/16 inch thick galvanized steel sections meeting ASTM A 36/A 36M and ASTM A 123/A 123M. Slot bolt holes for guide adjustment. Provide removable stops on guides to prevent over-travel of curtain and a continuous bar for holding wind-locks.

2.03 Hoods and Accessories

A. Form hood to act as weather seal and entirely enclose coiled curtain and operating mechanism at opening head. Contour to fit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface mounted

hoods and provide fascia for any portion of between jamb mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sagging.

1. Fabricate hoods for steel doors of minimum 0.028 inch thick, hot dip galvanized steel sheet with G90 zinc coating.
2. Shape to be square.

B. Provide replaceable, adjustable, continuous, compressible weather stripping gaskets fitted to bottom and top of exterior doors, unless otherwise indicated. At door head, use 1/8 inch thick, replaceable, continuous sheet secured to inside of hood.

1. Provide motor operated doors with combination bottom weather seal and sensor edge.
2. In addition, provide replaceable, adjustable, continuous, flexible, 1/8 inch thick seals of flexible vinyl, rubber or neoprene at door jambs for a weather tight installation.

C. For push up operated or emergency operated doors, provide galvanized steel lifting handles on each side of door.

1. Provide pull down straps or pole hooks for doors more than 84 inches high.

D. If door unit is power operated, provide safety interlock switch to disengage power supply when door is locked.

2.04 Counterbalancing Mechanism

A. Counterbalance doors by means of adjustable tension, steel helical torsion spring mounted around a steel shaft and contained in a spring barrel connected to door curtain with barrel rings. Use grease sealed bearings or self-lubricating graphite bearings for rotating members.

B. Fabricate counterbalance spring barrel of hot formed, structural quality, welded or seamless carbon steel pipe, of sufficient diameter and wall thickness to support rolled-up curtain without distortion of slats and to limit barrel deflection to not more than 0.03 inches/foot of span under full load.

C. Provide spring balance of one (1) or more oil tempered, heat treated steel helical torsion springs. Size springs to counterbalance weight of curtain, with uniform adjustment accessible from outside barrel. Provide cast steel barrel plugs to secure ends of springs to barrel and shaft.

D. Fabricate torsion rod for counterbalance shaft of cold-rolled steel, sized to hold fixed spring ends and carry torsional load.

E. Provide mounting brackets of the manufacturer's standard design, either cast iron or cold rolled steel plate.

2.05 Electric Door Operators

A. Provide electric door operator assembly of size and capacity recommended and provided by the door manufacturer for door and operation cycle requirements specified, with electric motor and factory prewired motor controls, starter, gear reduction unit, solenoid operated brake, clutch, remote control stations, control devices, integral gearing for locking door and accessories required for proper operation.

B. Meet the requirements of the NEC.

C. Provide hand operated disconnect or mechanism for automatically engaging chain and sprocket operator and releasing brake for emergency manual operation while disconnecting motor without affecting timing of limit switch. Mount disconnect and operator so they are accessible from floor level. Include interlock device to automatically prevent motor from operating when emergency operator is engaged.

D. Design operator so motor may be removed without disturbing limit switch adjustment and without affecting emergency auxiliary operator.

E. Provide control equipment meeting NEMA ICS 1, NEMA ICS 2, and NEMA ICS 6, with NEC Class 2 control circuit, maximum 24 V, AC or DC.

F. Provide wall, hood, or bracket mounted, jackshaft type door operator unit consisting of electric motor, enclosed gear head reduction drive, and chain and sprocket secondary drive.

G. Provide high starting torque, reversible, continuous duty, Class A insulated, electric motors meeting NEMA MG 1; with overload protection; sized to start, accelerate, and operate door in either direction from any position, at not less than 2/3 FPS and not more than 1 FPS, without exceeding nameplate ratings or service factor.

1. Type to be polyphase, medium induction type.
2. Service factor to be according to NEMA MG 1, unless otherwise indicated.
3. Coordinate wiring requirements and electrical characteristics of motors with building electrical system.
4. Provide totally enclosed, non-ventilated or fan cooled motor, fitted with plugged drain, and controller with NEMA ICS 6, Type 4 enclosure where indicated.

H. Provide momentary contact, three (3) button control station with push button controls labeled "Open," "Close," and "Stop."

1. Provide interior units, full guarded, surface mounted, heavy duty type, with general purpose NEMA ICS 6, Type 1 enclosure.
2. Provide exterior units, full guarded, standard duty, surface mounted, weatherproof type, NEMA ICS 6, Type 4 enclosure, key operated.

I. Provide each motorized door with indicated external automatic obstruction device safety sensor capable of protecting full width of door opening. Activation of sensor immediately stops and reverses downward door travel.

1. Photoelectric sensor to be the manufacturer's standard system designed to detect an obstruction in door opening without contact between door and obstruction.
    a. Self-monitoring type to be designed to interface with door operator control circuit to detect damage to or disconnection of sensing device. When self-monitoring feature is activated, door closes only with sustained pressure on close button.

J. Provide adjustable limit switches, interlocked with motor controls and set to automatically stop door at fully opened and fully closed positions.

K. Provide radio control system consisting of the following:

1. Three (3) channel universal coaxial receiver to open, close and stop door, one (1) per operator.

2. Multifunction remote control.
3. Remote antenna mounting kit.

2.06 Finishes

A. Meet NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Variations in appearance of abutting or adjacent pieces are acceptable if they are within one half of the range of approved samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved samples and are assembled or installed to minimize contrast.

2.07 Steel and Galvanized Steel Finishes

A. Baked finish to be the manufacturer's standard baked finish consisting of primer and topcoat according to the coating manufacturer's written instructions for cleaning, pretreatment, application, thermosetting and minimum dry film thickness.

1. Color and gloss as selected by SEPTA from the manufacturer's full range.

PART 3 - EXECUTION

3.01 Installation

A. Install coiling doors and operating equipment complete with necessary hardware, jamb and head molding strips, anchors, inserts, hangers and equipment supports.

3.02 Adjusting

A. Lubricate bearings and sliding parts; adjust doors to operate easily, free of warp, twist, or distortion and with weather tight fit around entire perimeter.

3.03 Startup Services

A. Engage a factory authorized service representative to perform startup service.

1. Complete installation and startup checks according to the manufacturer's written instructions.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.04 Demonstration

A. Engage a factory authorized service representative to train SEPTA's maintenance personnel to adjust, operate and maintain overhead coiling doors. Refer to Section 01700.

END OF SECTION

SECTION 08710

DOOR HARDWARE

PART 1 - GENERAL

1.01 Description

A. Work of this Section includes all labor, materials, equipment and services necessary to furnish all the hardware as shown on the Contract Drawings and specified herein.

1.02 Related Sections

A. Section 08110 – Metal Doors and Frames

1.03 Submittals

A. Submit product data for each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles and finishes.

B. Submit shop drawings for electrified door hardware.

1. Include diagrams for power, signal and control wiring.
2. Include details of interface of electrified door hardware and building safety and security systems.

C. Submit samples for each exposed product in each finish specified, in the manufacturer's standard size.

1. Tag samples with full product description to coordinate samples with Door Hardware Schedule.

D. Submit samples for initial selection of each type of exposed finish.

E. Submit samples for verification of each type of exposed product, in each finish specified.

1. Sample size to be full size units or minimum 2 inch by 4 inch samples for sheet and 4 inch long samples for other products.
    a. Full size samples will be returned to the Contractor. Units that are acceptable and remain undamaged through submittal, review and field comparison process may, after final check of operation, be incorporated into the work, within limitations of keying requirements.
2. Tag samples with full product description to coordinate samples with Door Hardware Schedule.

F. Submit Door Hardware Schedule prepared by or under the supervision of the installer's Architectural Hardware Consultant. Coordinate Door Hardware Schedule with doors, frames and related work to ensure proper size, thickness, hand, function and finish of door hardware.

1. Submit Door Hardware Schedule concurrent with submissions of product data, samples and shop drawings. Coordinate submission of Door Hardware Schedule with the

scheduling requirements of other work to facilitate the fabrication of other work that is critical in Contract construction schedule.

2. Use same scheduling sequence, format and use same door numbers as in Door Hardware Schedule in the Contract Documents.

3. Include the following information:

a. Identification number, location, hand, fire rating, size, and material of each door and frame.

b. Locations of each door hardware set, cross referenced to the Contract Drawings on floor plans and to Door and Frame Schedule.

c. Complete designations, including name and manufacturer, type, style, function, size, quantity, function and finish of each door hardware product.

d. Description of electrified door hardware sequences of operation and interfaces with other building control systems.

e. Fastenings and other installation information.

f. Explanation of abbreviations, symbols and designations contained in Door Hardware Schedule.

g. Mounting locations for door hardware.

1) List of related door devices specified in other Sections for each door and frame.

G. Submit keying schedule prepared by or under the supervision of the installer's Architectural Hardware Consultant, detailing SEPTA's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations that are coordinated with the Contract Documents.

1.04 Quality Assurance

A. Hardware shall be suitable and adapted for its required use and shall fit its designated location. Should any hardware as shown, specified or required fail to meet the intended requirements or require modification to suit or fit the designated location, determine the correction or modification necessary and notify SEPTA in ample time to avoid delay in the manufacture and delivery of hardware.

B. Provide fire rated opening hardware to meet NFPA 80 requirements of authorities having jurisdiction.

C. The hardware supplier shall have been regularly engaged in the sale and distribution of hardware for Projects of comparable scope and size. The hardware supplier shall have an Architectural Hardware Consultant of the Door and Hardware Institute on staff who will be responsible for overseeing the scheduling, detailing, ordering, and coordinating of hardware, and shall be available for consultation with SEPTA, at no additional cost to SEPTA, during progress of construction. The hardware supplier shall be a direct factory authorized distributor for all finish hardware items being furnished in accordance with this Specification.

D. Meet the applicable provisions of the most recent issues of the following references:

1. Americans with Disabilities Act (ADA).

2. ANSI/SDI A250.8, Specifications for Standard Steel Doors and Frames.

3. ASTM F 476, Standard Test Methods for Security of Swinging Door Assemblies.

4. AWL, Architectural Woodwork Institute.
5. BHMA A156.4, Door Controls - Closers.
6. BHMA A156.13, Mortise Locks & Latches, Series 1000.
7. BHMA A156.18, Continuous Hinges.
8. DHI, Door and Hardware Institute.
9. ICC A117.1, Standard for Accessible and Usable Buildings and Facilities.
10. NAAMM, National Association of Architectural Metal Manufacturers.
11. NFPA 80, Standard for Fire Doors and Other Opening Protectives.
12. NFPA 105, Standard for Smoke Door Assemblies and Other Opening Protectives.
13. NFPA 252, Fire Tests of Door Assemblies.
14. Pennsylvania Uniform Construction Code (PA-UCC).
15. UL 10C, Positive Pressure Fire Tests for Door Assemblies.
16. WDI, Wood Door Institute.

1.05 Delivery, Storage and Handling

A. Inventory door hardware on receipt and provide secure lock up for door hardware delivered to Project site.

B. Tag each item or package separately with identification coordinated with the final Door Hardware Schedule, and include installation instructions, templates and necessary fasteners with each item or package.

C. Pack finish hardware in the manufacturer's containers, complete with trimmings, bolts, screws, washers, etc., as required for application. Each container shall bear a suitable label which shall state the quantity and kind of contents of said container, as well as identifying marks relating to the approved hardware schedule and its location in the Project.

1. Knobs, handles, pulls and other items of finish hardware with easily damaged finishes shall be individually wrapped before placing in containers and with sufficient sheet cloth or cotton backed paper which shall be adequately secured all as necessary to protect the finishes.

2. Finish hardware shall be delivered, as directed, to the building site or the factories of the various fabricators of metal or wood work to which such hardware is to be applied. Deliver hardware in the order required and in ample time to permit application at the building, or fabricators' shops, within the time required for the completion of the building.

1.06 Job Conditions

A. The hardware supplier shall assign a competent representative, acceptable to SEPTA, to be at the job site each time a major shipment of finish hardware is received. Such representative shall assist in "checking in" these shipments and shall secure a receipt covering the contents of each shipment. In addition, such representative shall be available for immediate call to the job site when, in the opinion of SEPTA, his presence is necessary.

B. Promptly following approval of the Door Hardware Schedule by SEPTA, furnish and deliver template information, to the fabricators, of items to which finish hardware is to be applied.

1. Such deliveries shall be made in ample time to avoid delays in such work of said fabricators. Provide drawings, schedules and detailed information to other trades as necessary for them to accommodate and prepare their work to receive the finish hardware.

C. Prior to the installation of any finish hardware, all parties and trades having responsibility to any or all of the openings for the job, shall meet in a pre-construction meeting, for instruction on the proper installation of finish hardware with the manufacturers' representative.

1. Cooperate and coordinate work with that of other trades supplying materials or performing work in contact with, connecting to, underlying or overlaying the work of this Section.

2. Provide complete data of requirements for work of this Section to those other trades whose work is affected by or dependent upon the work of this Section.

3. Furnish all items to be built into other work in ample time to avoid delaying the progress of such work.

4. Examine all drawings covering the work of this Section and refer to all other drawings, including the Contract Drawings, which may affect the work of this Section or require coordination by this trade.

D. Verify all existing conditions in the field to ensure compatibility with hardware specified in the hardware sets herein. Any discrepancies between the existing field conditions and hardware specified shall be brought to the attention of SEPTA immediately. The hardware supplier shall not order any hardware until all discrepancies are rectified and SEPTA grants written approval.

PART 2 - PRODUCTS

2.01 General

A. Requirements for design, grade, function, finish, size and other distinctive qualities of each type of finish hardware are indicated herein. Products are identified by using appropriate hardware designation numbers.

2.02 Manufacturers

A. Provide hardware as indicated in hardware sets. Products other than those listed in the sets may be considered, provided that they are proven to be of equal quality and have equal performance to those products specified. See product description for each type of product for details on performance and quality requirements. SEPTA reserves the right to review and approve all proposed equivalents.

B. Provide additional hardware items required to complete the work in accordance with these Specifications and manufacturers' instructions, including items inadvertently omitted from this Section. Note these items in the submittal for review.

2.03 Hanging Means

A. Stainless steel.

B. Manufacturers:

1. Scheduled Manufacturer:
    a. Ives.
2. Acceptable Manufacturers:
    a. Markar.
    b. Stanley.
    c. Or Approved Equal.

C. Requirements:

1. Provide pin and barrel continuous hinges to meet BHMA A156.26, Grade 2.
2. Provide pin and barrel continuous hinges fabricated from 14 gauge, type 304 stainless steel.
3. Provide twin self-lubricated nylon bearings at each hinge knuckle, with 0.25 inch diameter stainless steel pin.
4. Provide hinges capable of supporting door weights up to 600 pounds, and successfully tested for one million five hundred thousand (1,500,000) cycles.
5. On fire rated doors, provide pin and barrel continuous hinges that are classified for use on rated doors by testing agency acceptable to authority having jurisdiction.
    a. Provide pin and barrel continuous hinges with electrified options as scheduled in the hardware sets. Provide with sufficient number and wire gauge to accommodate electric function of specified hardware.
    b. Install hinges with fasteners supplied by the manufacturer.
    c. Provide hinges with symmetrical hole pattern.

2.04 Locksets and Latchsets

A. Locksets:

1. All door hardware must be compatible with SEPTA's existing lock system and SEPTA's existing core key (BEST lock system).
2. Lock cases to be constructed with a protected leading edge and screw configuration that limits access to operating parts.
3. Lock cases are to be multi-functional that transform into different functions without opening the lock case.
4. Lock components to be manufactured of zinc dichromate plated steel. Manufacturers utilizing plastic parts, spacers and/or bushings are not acceptable.
5. Lock components to incorporate a spring loaded fusible link for Fire/Life Safety. Manufacturers utilizing gravity, fusible link are acceptable.
6. Latch bolts to have a standard 2 3/4 inch backset with a full 3/4 inch throw.
7. Latch bolts to be non-handed, field reversible without opening the lock case.

8. Latch bolts to be two (2) piece anti-friction, manufactured from stainless steel. Solid latch bolts and/or plastic anti-friction devices are not acceptable.
9. Cylinders to be secured by a cast stainless steel, dual retainer. Manufacturers utilizing screws and/or stamped retainers are not acceptable.
10. Manufacturers utilizing an exposed toggle on edge of door as “locked indicator” are not acceptable.

B. Lever Trim:

1. Lever assembly (external) to be one (1) piece design attached by threaded bushing. Lever assembly (internal) shall be attached by screwless shank. Lever attachment by common tools (allen nuts and/or set screws) are not acceptable.
2. Thru-bolt lever assemblies through the door for positive interlock. Manufacturers utilizing a through the door spindle for attachment are not acceptable.
3. Levers to have independent rotation in both directions.
4. Spring cages are to be incorporated into the lever assemblies.
5. Hub blocking plate to be solid, cast stainless steel. Manufacturers utilizing open hub designs are not acceptable.
6. Spindles to be independent, designed to “break-away” at a maximum of 75 psi torque.

C. Deadbolts:

1. Deadbolts to be 1 3/4 inch total length; have standard 1 inch throw with a minimum 3/4 inch internal engagement when fully extended.
2. Deadbolts to be constructed of stainless steel, incorporating a security roller pin with a minimum RC60 rating for surface hardness.

D. Strikes:

1. Strikes to be non-handed and bridged to ensure dead latching. Manufactures utilizing fillers of any kind for dead-latch engagement are not acceptable.
2. Mounting tabs are to be automatic self-adjusting, vertically and horizontally for door bevel and strike alignment.

E. Lock series and design manufacturers, lever trim as specified in hardware sets.

1. Schlage L Series Heavy Duty Mortise Locks.
2. Falcon M Series.
3. Sargent 8200 Series.
4. Or Approved Equal.

F. Certifications:

1. Provide locksets to meet BHMA A156.13, Series 1000, Operational Grade 1 and Security Grade 1 with all standard trims.
2. Provide locksets to meet UL 10C and NFPA 252 positive pressure requirements.

3. Provide locksets to meet ASTM F 476 Grade 40, UL Listed for locksets utilizing concealed cylinders.

2.05 Exit Devices

A. Exit devices shall be touch bar type, as specified in hardware sets.

1. Furnish stainless steel touch bars on all exit devices.
2. Touch bar and touch bar end caps shall overlap the mechanism case.
3. Touch bar sub assembly shall be minimum 0.160 inch thick, with minimum 0.060 inch supports.
4. Touch bar surface shall be minimum 2 1/4 inches high by 18 inches long for 36 inch doors, and minimum 2 1/4 inches high by 24 inches long for doors wider than 36 inches.
5. Exit device touch bars shall be equipped with a fluid sound dampening feature.

B. Furnish exit devices, less bottom rod, on all cross corridor pairs of doors, where doors are for compartmentalization only.

C. Rim and mortise type devices shall have 3/4 inch throw latch bolt. Surface and concealed vertical rod devices shall have 5/8 inch throw latch bolts.

1. Latch bolt security deadlocking shall be standard.

D. All fire doors shall receive devices UL listed fire exit hardware.

E. Furnish roller strikes, which interlock the door to the frame (499F) for all rim devices and surface vertical rod devices.

F. All internal springs shall be compression type.

G. Where lever trim is specified, levers shall match the balance of the Contract.

1. Escutcheons of all lever trim shall be forged brass or bronze, with four (4) thru-bolts anchoring trim assembly to exit device chassis.
2. Levers shall be solid forged brass or bronze.
3. Lever return springs shall be compression type.
4. Cylinders shall be recessed from face of escutcheon.

H. Lever trim shall be breakaway type. When rotational force of 35 ft.lbs. is applied, lever trim appears to break. Lever trim can be reset to normal function, without disassembly.

1. Lever shall be protected by a shear pin, which will withstand a rotational force of 55 ft.lbs. before shearing, to prevent further damage to lever. Lever shall not separate from the escutcheon.

I. Furnish all necessary glass bead kits where exit device may interfere with raised glass beads on doors.

J. Certifications:

1. Devices shall be Underwriters Laboratories™ listed for Panic Hardware (FVSR) SA163.
2. Fire Devices shall be Underwriters Laboratories™ listed Fire Exit Hardware (GXHX) R4501, A Label.

3. Exit devices shall be certified by an independent testing lab for one million (1,000,000) cycles.

K. Exit device series and design manufacturers, exit devices with outside trim as specified in hardware sets.

1. Von Duprin 98/99 Series.
2. Falcon Series 25 Series.
3. Sargent 80 Series.
4. Or Approved Equal.

2.06 Closers

A. All surface closers shall exceed BHMA A156.4 Grade 1 requirements in all aspects as called for below. All closers shall have certification by an independent testing laboratory of ten million (10,000,000) cycles without failure.

B. Closer cylinders shall be cast iron. Closer pinions shall be dual heat treated. Pinion and piston shall be steel alloy. Piston diameter shall be minimum 1 1/2 inches.

C. Closers shall be barrier free with spring tension adjustable from size 1 to size 5.

D. Closers shall maintain control of the door in all conditions. Closers shall have three (3) non critical adjusting valves; latch, main and backcheck. Backcheck shall take affect at 45 (AVB) degrees of opening for parallel arm closers and 70 degrees for regular arm closers. Closers with pressure relief valves are not acceptable.

E. All closers shall have forged main arms. Forearms of parallel arm closers shall be forged. Parallel arm brackets shall be forged. All parallel arm joints shall have bronze bushings with minimum 5/8 inch diameter pins. Cylinders, arms, brackets and mounting plates shall be powder coated.

F. Provide all plates, brackets and special templates when needed for interface with particular header, door and wall conditions and neighboring hardware. Consult factory for special template (“ST” suffix to closer number) pricing.

G. All closers shall be installed so that closer bodies are positioned on room side of doors to and from corridors. Out swing doors shall have an Extra Heavy Duty Parallel Arm (EDA). Parallel arm shall be used on connecting doors between rooms.

H. All exterior closers shall have all weather fluid that does not require seasonal adjustment to control speed of door, and shall exhibit the same viscosity from minus 30°F to plus 120°F.

I. All closers shall have a powder coated aluminum finish on cylinder, arm and accessories. There shall be a full metal, powder coated cover.

J. Furnish all brackets, drop plates and any other necessary hardware required to insure proper installation.

K. All closers shall meet UL 10C requirements for positive pressure testing.

L. All closers shall be of one (1) manufacturer’s products. All closers shall be inspected after installation by a factory representative to insure proper adjustment and operation.

M. Closer Manufacturers:

1. LCN 4011/4111 series.
2. Falcon SC70 Series.
3. Sargent 281 Series.
4. Or Approved Equal.

2.07 Door Stops

A. Unless otherwise noted, all door stops shall be wall mounted with concealed fasteners Ives WS407CCV/CVX series; Or Approved Equal. Where wall stops will not function for the application, furnish floor mounted stops Ives FS436/438 series; Or Approved Equal.

2.08 Overhead Stops

A. Stainless steel, non-plastic mechanisms and finished metal end caps. Provide field changeable hold open, friction and stop only functions. Coordinate templates for door and wall conditions and neighboring hardware. Furnish drop plates at locations where regular arm closer are used in conjunction with overhead stops. See hardware sets for specific model numbers.

2.09 Protection Plates

A. All kick plates and mop plates unless otherwise noted shall be 8 inches high by 2 inches Less Door Width (LDW), beveled three (3) sides by 0.050 inches thick.

2.10 Flush Bolts and Coordinators

A. Manual flush bolts to be Ives FB458/FB358 series; Or Approved Equal; furnished with DP2 dustproof strikes for all bottom bolts. Top bolts shall be furnished with proper extensions to allow for easy operation.

B. Self-latching flush bolts to be Ives FB51P/FB61P series; Or Approved Equal; furnished with DP2 dustproof strikes for all bottom bolts. Furnish wear plates as required.

C. Automatic flush bolts to be Ives FB31P/FB41P series; Or Approved Equal; furnished with DP2 dustproof strikes for all bottom bolts. Furnish wear plates as required.

D. Coordinators to be Ives COR series; Or Approved Equal. Furnish all fillers, mounting brackets, carry bars and special cut outs for use with exit devices, as required. Finish shall be black.

2.11 Key Requirements

A. Final keying requirements to be determined by SEPTA. A meeting must take place between SEPTA, the end user, SEPTA's representative, and the hardware distributor prior to cylinders being ordered, to establish the keying requirements and required keyway.

B. Key system to tie into the existing interchangeable core key system. Coordinate with SEPTA Locksmith.

C. Provide Concealed Key Control (CKC) keyset symbol stamping on the side of each master keyed core. Provide visual key control for all operating and master keys.

D. Provide brass keyed alike temporary cores for construction keying plus ten (10) operating keys for all cylinders, interior and exterior.

E. Provide three (3) change keys for each differently keyed lock. Provide three (3) control keys for construction cores and three (3) control keys for permanent cores. Provide ten (10) copies of each level master key, grand master key, and/or great grand master key. Permanent keys and cores to be a secured shipment direct from point of origination to SEPTA. Provide bitting list, ship direct from point of origin to SEPTA upon Contract completion.

F. Provide a key control system including envelopes. Labels, tags with self-locking key clips, receipt forms, three (3) way visible card index, temporary markers, permanent markers, and standard metal cabinet, all as recommended by the system manufacturer, with capacity for 150 percent of the number of locks required for the Contract.

1. Provide four (4) hinged panel type cabinet for wall mounting.

G. All door hardware must be compatible with SEPTA's existing lock system and SEPTA's existing core key (BEST lock system).

2.12 Weather Seals and Thresholds

A. Zero (0) as scheduled.

B. Perimeter seals shall be of compressible black neoprene material. Housing shall be solid aluminum stock. Furnish seals on three (3) sides of the opening. Coordinate the amount of material required in each specified opening.

C. Seals shall be mechanically fastened to door frame.

D. Door sweeps shall be extruded aluminum and black neoprene sweep.

1. Fasten door sweeps with wood screws for wood doors and sheet metal screws for hollow metal and fiberglass reinforced doors.

2. Door sweep shall be 1 1/4 inches in overall height with a 1/2 inch high neoprene sweep.

3. Mount door sweep on the exterior side of the door, with the neoprene engaged with the threshold or finish floor.

E. Thresholds shall be extruded aluminum meeting ADA requirements. They shall not exceed 1/4 inch in height with a wall thickness of 0.125 inches unless specified otherwise. Coordinate templates for any and all hardware, which may require cutouts or slots within the threshold for the proper installation of that hardware.

1. Furnish threshold with non-slip epoxy abrasive bonded within the grooves of the threshold.

2. Thresholds shall extend a minimum of 1 inch past the exterior face of the door and have returned closed ends.

3. Set all thresholds in grout and seal with silicone caulk.

4. Fasten thresholds with expansion shield mounting at masonry substrate locations and wood screws at wood substrate locations.

PART 3 - EXECUTION

3.01 Acceptable Installers

A. Factory trained and certified, and carries a factory issued card certifying that person is a "Certified Installer".

3.02 Preparation

A. Ensure that walls and frames are square and plumb before hardware installation.

B. The installer shall notify SEPTA, in writing, of all unacceptable conditions that could affect the proper operation of the finish hardware.

C. Locate hardware per ANSI/SDI A250.8 (SDI 100) and applicable building, fire, life safety, accessibility and security codes.

D. Where new hardware is to be installed near existing doors/hardware scheduled to remain, match locations of existing hardware.

E. Existing frames and doors scheduled to receive new hardware; carefully remove existing hardware and turn over to SEPTA. Patch and fill wood frames and doors with solid wood stock or dowel material before cutting for new hardware. Do not reuse existing screw holes; fill and re-pilot.

3.03 Installation

A. Install hardware per the manufacturer's instructions and recommendations. Do not install surface mounted items until finishes have been completed on substrate. Set units level, plumb and true to line and location. Adjust and reinforce attachment substrate for proper installation and operation.

1. Unless otherwise specified, locate all hardware in accordance with the recommended locations for builder's hardware for standard doors and frames as published by the Door and Hardware Institute.
2. Install jamb applied gaskets before closers, overhead stops, rim strikes, etc. Install sweeps across bottoms of doors before astragals, cope sweeps around bottom pivots, trim astragals to tops of sweeps.
3. Unless otherwise specified or detailed, install thresholds with the bevel in vertical alignment with the outside door face. Notch and closely fit thresholds to frame profile. Set thresholds in full bed of sealant.
4. When hardware is to be attached to existing metal surface and insufficient reinforcement exists, use RivNuts, NutSerts or similar anchoring device for screws.
5. Locate floor stops not more than 4 inches from the wall.
6. Drill pilot holes for fasteners in wood doors and/or frames.
7. Shim doors as required to maintain proper operating clearance between door and frame.
8. Use only fasteners supplied by or approved by the manufacturer for each respective item of hardware.

9. Lubricate and adjust existing hardware scheduled to remain. Carefully remove and give to SEPTA items not scheduled for reuse.
10. Where necessary, adjust doors and hardware as required to eliminate binding between strike and latchbolt. Doors should not rattle.
11. Install door closers on corridor side of lobby doors, room side of corridor doors and stair side of stairways.
12. Adjust spring power of door closers to insure exterior and fire rated doors will consistently close and latch doors under existing conditions. Adjust all other door closers to insure opening force does not to exceed 5 pounds.
13. Adjust "sweep", "latch", and "back check" valves on all door closers to properly control door throughout the opening and closing cycle. Adjust total closing speed as required to meet all applicable state and local building codes.
14. Deliver to SEPTA one (1) complete set of installation and adjustment instructions, and tools as furnished with the hardware.

3.04 Quality Assurance

A. After installation has been completed, the hardware supplier and the manufacturers' representative for locksets, door closers, exit devices and overhead stops shall check the Project and verify compliance with installation instructions, adjustment of all hardware items and proper application according to the approved hardware schedule. The hardware supplier shall submit a list of all hardware that has not been installed correctly.

B. After installation has been completed, the hardware supplier and the manufacturers' representative shall meet with SEPTA to explain the functions, uses, adjustment and maintenance of each item of hardware.

3.05 Adjusting and Cleaning

A. Adjust and check for proper operation and function. Replace units which cannot be adjusted to operate freely and smoothly.

B. At final completion, and when HVAC equipment is in operation, the installer shall make final adjustments to and verify proper operation of all door closers and other items of hardware. Lubricate moving parts with lubrication type recommended by the manufacturer.

C. All hardware shall be left clean and in good operation. Hardware found to be disfigured, defective or inoperative shall be repaired or replaced.

D. Wherever hardware installation is made more than one (1) month prior to acceptance or occupancy of space or area, return to work during week prior to acceptance or occupancy, and make final check and adjustment of hardware items in such space or area. Clean operating items as necessary to restore proper function and finish of hardware and doors.

3.06 Extra Stock

A. See hardware sets for additional hardware. Additional hardware is to be delivered directly to SEPTA for maintenance purposes.

B. Extra screws shall be furnished to the Contractor for installation purposes. See hardware sets for a detailed listing of extra screws.

C. All extra hardware items, fasteners and special installation tools are to be turned over to SEPTA at completion of the Contract.

3.07 Demonstration

A. Demonstrate electrical, electronic and pneumatic hardware systems, including adjustment and maintenance procedures.

3.08 Protection

A. Cover installed hardware, protect from paint, cleaning agents, weathering, carts/barrows, etc. Remove covering materials and clean hardware just prior to Substantial Completion.

B. Clean adjacent wall, frame and door surfaces soiled from installation/reinstallation process.

3.09 Schedule of Finish Hardware

A. See Door Hardware Schedule on the Contract Drawings for hardware set assignments.

B. Hardware groups to be determined.

END OF SECTION

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SECTION 08800

GLAZING

PART 1 - GENERAL

1.01 Description

A. Section includes glazing for the products and applications shown in the Contract Drawings including those specified in other Sections where glazing requirements are specified by reference to this Section, including:

1. Insulated glazing units with clear safety glass.
2. Laminated tempered interior glass, clear or spandrel.
3. Sacrificial window film.
4. UV protection window film.
5. Accessories.

1.02 Related Sections

A. Section 05120 – Structural Steel

B. Section 07620 – Sheet Metal Flashing and Trim

C. Section 07900 – Joint Sealers

1.03 Submittals

A. Submit product data for each glass product and glazing material indicated.

1. For glazing sealants used inside of the weatherproofing system, including printed statement of VOC content.

B. Submit four (4) glazing samples of each type specified.

C. Submit four (4) 6 inch by 6 inch glazing accessory samples of each accessory specified.

D. List glass types and thicknesses for each size opening and location on the glazing schedule. Use same designations indicated on the Contract Drawings.

E. Submit delegated design submittal for glass indicated to meet the performance requirements and design criteria, including analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

F. Submit qualification data for manufacturers of insulating glass units with sputter coated, low-e coatings and sealant testing agency.

G. Submit product certificates for glass and glazing products, from manufacturer.

H. Submit product test reports based on evaluation of comprehensive tests performed by a qualified testing agency.

1. For glazing sealants, provide test reports based on testing current sealant formulations within previous thirty-six (36) month period.

I. Submit preconstruction adhesion and compatibility test report.

J. Submit warranties as specified in this Section.

1.04 Quality Assurance

A. A qualified insulating glass manufacturer who is approved and certified by the coated glass manufacturer for insulating glass units with sputter coated, low-e coatings.

B. Installer of glazing is a certified installer with a documented history installing the manufacturer's products according to the manufacturer's specifications.

C. A qualified installer who employs glass installers for this Contract who are certified under the National Glass Association's Certified Glass Installer Program.

D. Preconstruction Testing:

1. Test each glazing material type, tape sealant, gasket, glazing accessory, and glass framing member for adhesion to and compatibility with elastomeric glazing sealants.

2. Testing will not be required if data is submitted based on previous testing of current sealant products and glazing materials matching those submitted.

3. Use ASTM C 1087 to determine whether priming and other specific joint preparation techniques are required to obtain rapid, optimum adhesion of glazing sealants to glass, tape sealants, gaskets and glazing channel substrates.

4. Test no fewer than eight (8) samples of each type of material, including joint substrates, shims, sealant backings, secondary seals and miscellaneous materials.

5. Schedule sufficient time for testing and analyzing results to prevent delaying the work.

6. For materials failing tests, submit the sealant manufacturer's written instructions for corrective measures including the use of specially formulated primers.

E. A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program for glassing testing.

F. An independent testing agency qualified according to ASTM C 1021 to conduct the sealant testing indicated.

G. Obtain all glass from single source from single manufacturer for each glass type.

H. Obtain from single source from single manufacturer for each glazing product and installation method.

I. Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC or the manufacturer. Label shall indicate the manufacturer's name, type of glass, thickness and safety glazing standard with which glass meets. Tempered safety glazing shall be provided at all locations required by code and all locations indicated within the Contract Drawings.

J. Permanently mark fire protection rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate the manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose stream test, whether or not glazing has a temperature rise rating of 450°F and the fire resistance rating in minutes.

K. Permanently marked either on spacers or on at least one (1) component lite of units with appropriate certification label of IGCC.

L. Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

M. Conduct a pre-installation conference at the Project site.

1. Review and finalize construction schedule and verify availability of materials, the installer's personnel, equipment, and facilities needed to make progress and avoid delays.

2. Review temporary protection requirements for glazing during and after installation.

N. Project Conditions:

1. Environmental Limitations:

a. Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by the glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation or other causes.

b. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by the sealant manufacturer or below 40°F.

2. Verify actual measurements for openings by field measurements before fabrication. Show recorded measurements on shop drawings. Coordinate field measurements and fabrication schedule with construction progress to avoid construction delays.

O. Definitions:

1. Glass Manufacturers are firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

2. Glass Thicknesses is indicated by thickness designations in millimeters according to ASTM C 1036.

3. Interspace is the space between lites of an insulating glass unit.

P. Meet the applicable provisions of the most recent issues of the following references:

1. AAMA 804.3, Back Bedding Mastic Glazing Tape for use in less severe back bedding and drop-in glazing applications.

2. AAMA 806.3, Back Bedding Mastic Glazing Tape in which the tape is subjected to continuous pressure exerted from gaskets or pressure generating stop designs.

3. AAMA 807.3, Back Bedding Mastic Glazing Tape for commercial fenestration products in which the tape is not subjected to continuous pressure from gaskets or pressure generating stop designs.

4. AAMA 810.1, Type 1, Expanded Cellular Glazing Tapes intended as primary seals where tape is used by itself to prevent air and water leakage or in a system when the tape acts as the primary sealant.

5. AAMA 810.1, Type 2, Expanded Cellular Glazing Tape intended as secondary seals where the tape is used in combination with a full bead of wet sealant to prevent air and water leakage.

6. AAMA GDSG-1, Glass Design for Sloped Glazing.

7. AAMA TIR-A7, Sloped Glazing Guidelines.
8. ASTM C 509, Standard Specification for Elastomeric Cellular Preformed Gasket and Sealing Material.
9. ASTM C 542, Standard Specification for Lock-Strip Gaskets.
10. ASTM C 716, Standard Specification for Installing Lock-Strip Gaskets and Infill Glazing Materials.
11. ASTM C 864, Standard Specification for Dense Elastomeric Compression Seal Gaskets, Setting Blocks, and Spacers.
12. ASTM C 920, Standard Specification for Elastomeric Joint Sealants.
13. ASTM C 1021, Standard Practice for Laboratories Engaged in Testing of Building Sealants.
14. ASTM C 1036, Standard Specification for Flat Glass.
15. ASTM C 1048, Standard Specification for Heat-Strengthened and Fully Tempered Flat Glass.
16. ASTM C 1087, Standard Test Method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
17. ASTM C 1115, Standard Specification for Dense Elastomeric Silicone Rubber Gaskets and Accessories.
18. ASTM C 1172, Standard Specification for Laminated Architectural Flat Glass.
19. ASTM C 1281, Standard Specification for Preformed Tape Sealants for Glazing Applications.
20. ASTM E 1886, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
21. ASTM E 1996, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris in Hurricanes.
22. GANA's Glazing Manual.
23. Insulating Glass Certification Council (IGCC).
24. IGMA TB-3001, Guidelines for Sloped Glazing.
25. NFRC 100, Determining Fenestration Product U-Factors.
26. NFRC 200, Determining Fenestration Product Solar Heat Gain Coefficient and Visible Transmittance at Normal Incidence.
27. NFRC 300, Determining the Solar Optical Properties of Glazing Materials and Systems.
28. 16 CFR 1201, Safety Standard for Architectural Glazing Materials.
29. 40 CFR 59, Subpart D, National Volatile Organic Compound Emission Standards for Architectural Coatings.

30. Safety Glazing Certification Council (SGCC).

1.05 Delivery, Storage and Handling

A. Protect glazing materials according to the manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun or other causes.

B. Meet the glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.06 Warranty

A. Manufacturer's standard form in which the insulating glass manufacturer agrees to replace insulating glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to the manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture or film on interior surfaces of glass.

B. Warranty period to be five (5) years from date of final acceptance.

PART 2 - PRODUCTS

2.01 Materials

A. Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. AFG Industries Inc.
2. PPG Industries.
3. Libbey-Owens-Ford Co.
4. Or Approved Equal.

B. Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to meet the requirements indicated.

1. Minimum glass thickness for exterior lites to be as indicated on the Contract Drawings.

C. Where float glass is indicated, provide annealed float glass, Kind HS heat treated float glass, or Kind FT heat treated float glass as needed to meet Article 2.01/E in this Section. Where heat strengthened glass is indicated, provide Kind HS heat treated float glass or Kind FT heat treated float glass as needed to meet Article 2.01/E in this Section. Where fully tempered glass is indicated, provide Kind FT heat treated float glass.

D. Provide exterior glazing that passes basic windborne debris impact resistance protection testing requirements in ASTM E 1996 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than glazing indicated for use on the Contract and shall be installed in same manner as glazing indicated for use on the Contract.

E. Provide glass with thermal and optical performance properties specified, as indicated in the manufacturer's published test data, based on procedures indicated below:

1. For laminated glass lites, properties are based on products of construction indicated.
2. U factors to be center of glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x °F.
3. Solar heat gain coefficient and visible transmittance to be center of glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
4. Visible reflectance to be center of glazing values, according to NFRC 300.

F. Float glass to meet the requirements of ASTM C 1036.

G. Uncoated, heat treated fully tempered glass to meet the requirements of ASTM C 1048.

H. Coated, heat treated, fully tempered glass to meet the requirements of ASTM C 1048.

I. Heat treated spandrel glass to meet the requirements of ASTM C 1048, Condition B, with ceramic coating applied to the second surface.

J. Sealed insulating glass units shall be the manufacturer’s standard preassembled dual seal insulating glass units and custom radiused glass consisting of organically sealed panes of 1 1/4 inch thick clear tempered glass and 1 1/4 inch thick clear laminated glass enclosing a hermetically sealed dehydrated 1/2 inch air space. Provide units with a silicone secondary seal with an IGCC certified CBA level compatible with structural silicone sealant.

2.02 Laminated Glass

A. Laminated glass to meet ASTM C 1172, and meet the testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Laminate glass with polyvinyl butyral interlayer to meet the interlayer manufacturer's written recommendations.
2. Provide thickness not less than that indicated and as needed to meet the requirements.
3. Interlayer color to be clear unless otherwise indicated.

B. Windborne debris impact resistant laminated glass to meet ASTM C 1172, and meet the testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

1. Laminate glass with one (1) of the following to meet the interlayer manufacturer's written recommendations:
   a. Polyvinyl butyral interlayer.
   b. Polyvinyl butyral interlayers reinforced with polyethylene terephthalate film.
   c. Ionoplast interlayer.
   d. Cast-in-place and cured transparent resin interlayer.
   e. Cast-in-place and cured transparent resin interlayer reinforced with polyethylene terephthalate film.
2. Provide thickness not less than that indicated and as needed to meet the requirements.
3. Interlayer color to be clear unless otherwise indicated.

2.03 Glazing Gaskets

A. Dense compression gaskets to be molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one (1) of the following:

1. Neoprene meeting ASTM C 864.
2. Ethylene Propylene Diene Monomer (EPDM) meeting ASTM C 864.
3. Silicone meeting ASTM C 1115.
4. Thermoplastic polyolefin rubber meeting ASTM C 1115.

B. Soft compression gaskets to be extruded or molded, closed cell, integral skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets meeting ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.

1. Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure glazing stops on opposite side of glazing.

C. Lock strip gaskets to be neoprene extrusions in size and shape indicated, fabricated into frames with molded corner units and zipper lock strips, meeting ASTM C 542, black.

2.04 Glazing Sealants

A. General:

1. Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by the sealant manufacturer based on testing and field experience.
2. Meet the sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
3. VOC content for sealants used inside of the weatherproofing system, not more than 250 g/L when calculated according to 40 CFR 59, Subpart D.
4. Colors of exposed glazing sealants as selected by SEPTA from the manufacturer's full range.

B. Glazing sealant to be neutral curing silicone glazing sealant meeting ASTM C 920, Type S, Grade NS, Class 100/50, use NT.

1. Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    a. Dow Corning Corporation; 790.
    b. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
    c. May National Associates, Inc.; Bondaflex Sil 290.
    d. Pecora Corporation; 890.
    e. Sika Corporation, Construction Products Division; SikaSil-C990.
    f. Tremco Incorporated; Spectrem 1.
    g. Or Approved Equal.

2.05 Glazing Tapes

A. Back bedding mastic glazing tapes to be preformed, butyl based, 100 percent solids elastomeric tape; non-staining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by the tape and glass manufacturers for application indicated; and meeting ASTM C 1281 and AAMA 800 series for products indicated below:

1. AAMA 804.3 tape, where indicated.
2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.

B. Expanded cellular glazing tapes to be closed cell, PVC foam tapes; factory coated with adhesive on both surfaces; and meeting AAMA 800 series for the following types:

1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.06 Miscellaneous Glazing Materials

A. Provide products of material, size, and shape meeting the referenced glazing standard, requirements of the manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.

B. Cleaners, primers and sealers to be types recommended by the sealant or gasket manufacturer.

C. Setting blocks to be elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

D. Spacers to be elastomeric blocks or continuous extrusions of hardness required by the glass manufacturer to maintain glass lites in place for installation indicated.

E. Edge blocks to be elastomeric material of hardness needed to limit glass lateral movement (side walking).

F. Perimeter insulation for fire resistive glazing to be a product that is approved by the testing agency that listed and labeled fire resistant glazing product with which it is used for application and fire protection rating indicated.

2.07 Fabrication of Glazing Units

A. Fabricate glazing units in sizes required to fit openings indicated for the Contract, with edge and face clearances, edge and surface conditions, and bite meeting the written instructions of the product manufacturer and referenced glazing publications, to meet the system performance requirements.

2.08 Sacrificial Window Film "Vandal Shield"

A. Manufacturers:

1. GPFilms Inc., 575 Maryville Centre Drive, St Louis, MO 63141; 800-851-7781; www.llumar.com
2. Graffiti removal Inc., Po Box 2991, La Habra, CA 90632; 909-464-2700; www.vandalshield.com
3. Madico, Inc, 65 Industrial Pky, Woburn, MA 01801; 800-225-1926; www.madico.com
4. Or Approved Equal.

B. Multi-layered product, 4 mils thick, applied to interior glass surfaces, from outboard surface to inboard surface.

1. Removable release liner.
2. Pressure sensitive adhesive.
3. Clear, dyed or metalized layers of polyester film.
4. Scratch resistant coating.

C. Color to be clear.

D. Glazing film accessories:

1. Provide products meeting the requirements of the glazing film manufacturer for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
2. Adhesive to be pressure sensitive acrylic adhesive system.
3. Cleaners, primers and sealers to be types recommended by the glazing film manufacturer.

E. Window film is required to be installed at all locations accessible to the public throughout the area of work.

2.09 UV Protection Window Film

A. Manufacturers:

1. Llumar.
2. 3M.
3. Vista Window Film.
4. Or Approved Equal.

B. Product requirements (basis of design AIR-80BL SR HPR as manufactured by Llumar; Or Approved Equal.)

1. Total solar transmittance to be 48 percent.
2. Total solar reflectance to be 7 percent.
3. Total solar absorption to be 45 percent.

4. Visible light transmittance to be 79 percent.
5. Visible reflectance (exterior) to be 9 percent.
6. Visible reflectance (interior) to be 9 percent.
7. Winter U-value to be 0.99.
8. Shading coefficient to be 0.71.
9. Ultraviolet ray protection (wavelengths 280-380 nm) to be 99.
10. Emissivity to be 0.75.
11. Solar heat gain coefficient to be 0.61.
12. Total solar energy rejected to be 39.
13. Light to Solar Heat Gain Ratio (LSG) to be 1.30.
14. Summer solar heat gain reduction to be 29 percent.
15. Winter heat loss reduction to be 4 percent.
16. Glare reduction to be 12 percent.
17. Color to be clear.

PART 3 - EXECUTION

3.01 Examination

A. Examine framing, glazing channels, and stops, with the installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass framing members.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Window film:

1. Examine glass and surrounding adjacent surfaces for conditions affecting installation.
   a. Report conditions that may adversely affect installation. In report, include description of any glass that is broken, chipped, cracked, abraded or damaged in any way.
2. Proceed with installation only after unsatisfactory conditions have been corrected.
3. Beginning of installation means acceptance of conditions.

3.02 Preparation

A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.

B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that will leave visible marks in the completed work.

3.03 Glazing

A. Meet the combined written instructions of the manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.

B. Adjust glazing channel dimensions as required by Contract conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.

D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.

E. Install setting blocks in sill rabbets, sized and located to meet the referenced glazing publications, unless otherwise required by the glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.

F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.

G. Provide spacers for glass lites where length plus width is larger than 50 inches.

1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to meet the system performance requirements.

2. Provide 1/8 inch minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by the glass manufacturer and according to requirements in the referenced glazing publications.

I. Set glass lites in each series with uniform pattern, draw, bow and similar characteristics.

J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

K. Where wedge shaped gaskets are driven into one (1) side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.

L. Square cut wedge shaped gaskets at corners and install gaskets in a manner recommended by the gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by the gasket manufacturer.

M. Window film:

1. Meet the manufacturer's written instructions for surface preparation.
2. Immediately before beginning installation of films, clean glass surfaces of substances that could impair glazing film's bond, including mold, mildew, oil, grease, dirt and other foreign materials.
3. Protect window frames and surrounding conditions from damage during installation.
4. Protect installed products until completion of Contract.
5. Touch-up, repair or replace damaged products before Substantial Completion.

3.04 Tape Glazing

A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.

B. Install tapes continuously, but not necessarily in one (1) continuous length. Do not stretch tapes to make them fit opening.

C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.

D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by the tape manufacturer.

E. Do not remove release paper from tape until right before each glazing unit is installed.

F. Apply heel bead of elastomeric sealant.

G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.

H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.05 Gasket Glazing (Dry)

A. Cut compression gaskets to lengths recommended by the gasket manufacturer to fit openings exactly, with allowance for stretch during installation.

B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.

C. Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by the gasket manufacturer.

D. Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by the gasket manufacturer.

E. Install gaskets so they protrude past face of glazing stops.

3.06 Sealant Glazing (Wet)

A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.

B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.

C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.07 Lock Strip Gasket Glazing

A. MEET ASTM C 716 and the gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

3.08 Cleaning and Protection

A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by the glass manufacturer.

C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by the glass manufacturer.

D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

E. Wash glass on both exposed surfaces in each area of Project not more than four (4) days before date scheduled for inspections that establish date of final acceptance. Wash glass as recommended in writing by the glass manufacturer.

F. Provide and install sacrificial window film at all locations accessible to the public throughout the area of work.

1. Remove excess mounting solution at finished seams, perimeter edges and adjacent surfaces.
2. Use cleaning methods recommended by the glazing film manufacturer.
3. Replace films that cannot be cleaned.

END OF SECTION

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SECTION 09662

ELECTRICALLY INSULATED FLOOR COVERING

PART 1 - GENERAL

1.01 Description

A. This Section specifies requirements for electrically insulated floor covering.

B. The electrically insulated floor covering shall be poured into place to separate and insulate all the traction power equipment, Supervisor Control and Data Acquisition (SCADA) and battery equipment from the Traction Power Substation (TPSS), control room and battery room floors and from earth ground.

C. The Contractor shall develop a design drawing showing location and limits where the insulated flooring material shall be installed to coincide with final equipment placement for SEPTA's approval.

D. Each section shall be one (1) continuous pour with no joints or cracks. Joints or cracks in the finished covering shall require removal and reinstallation.

1.02 Submittals

A. Submit the following in accordance with Division 1.

B. Submit shop drawings:

1. The manufacturer's standard catalog cuts, material safety sheets, maintenance instructions, descriptive literature and diagrams, in 8 1/2 inch by 11 inch format, and in sufficient detail so as to clearly indicate compliance with all specified requirements and standards.

C. Submit certification:

1. The manufacturer's certification signed by the manufacturer certifying that the company meets the required qualifications. Upon request submit evidence of company's experience.

2. Product certification signed by the manufacturer certifying that the product meets the Specification.

D. Submit five (5) certified copies of field tests, prior to shipment of products.

1.03 Quality Assurance

A. The completed installation shall meet the Contract Documents. The work shall also meet applicable provisions of IEEE C2 and the NEC.

B. Electrically insulated floor covering shall be manufactured and tested under control of Quality Assurance system that meets the requirements of ISO 9000.

C. The floor covering installation shall be in accordance with the manufacturer's recommendations.

D. Each bidder for this Contract shall be pre-qualified and approved in writing by the material manufacturer.

E. Each bidder must have documented experience in the application of the type of system specified. The Contractor shall submit a list of Projects of similar size, scope and complexity.

F. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM C 413, Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, and Monolithic Surfacing and Polymer Concretes.
2. ASTM C 579, Standard Test Method for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacing and Polymer Concretes.
3. ASTM D 149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
4. ASTM D 522/D 522M, Standard Test Methods for Mandrel Bend Test of Attached Organic Coatings.
5. ASTM D 570, Standard Test Method for Water Absorption of Plastics.
6. ASTM D 695, Standard Test Method for Compressive Properties of Rigid Plastics.
7. ASTM D 2240, Standard Test Method for Rubber Property - Durometer Hardness.
8. ASTM D 2369, Standard Test Method for Volatile Content of Coatings.
9. ASTM D 2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
10. ASTM D 4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
11. ASTM D 4541, Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers.
12. ASTM E 96/ E96M, Standard Test Methods for Water Vapor Transmission of Materials.
13. IEEE C2, National Electric Safety Code (NESC).
14. ISO 9000, Quality Management Systems - Fundamentals and Vocabulary.
15. ISO 9001, Quality Management Systems - Requirements.
16. NFPA 70, National Electrical Code (NEC).

1.04 Delivery, Storage and Handling

A. Deliver materials to site in the manufacturer's original, unopened containers and packaging, with labels clearly identifying product name, manufacturer, batch or lot number and date of manufacture.

B. Material should be delivered to job site and checked for completeness and shipping damage prior to job start.

C. Storage:

1. Store materials in accordance with the manufacturer's written instructions.

2. Keep containers sealed until ready for use. Material should be stored in a dry, enclosed, protected area from the elements.
3. Do not subject material to excessive heat or freezing.
4. Shelf life to be established based on the manufacturer's written recommendation for each material being used.

D. Protect materials during handling and application to prevent damage or contamination.

E. Condition materials for use according to the manufacturer's written instructions prior to application.

F. Record material lot number and quantity delivered to jobsite/storage.

1.05 Site Conditions

A. Do not install the work of this Section outside of the following environmental ranges with the manufacturer's written acceptance.

1. Precondition material for at least twenty-four (24) hours between 65°F to 75°F.
2. Ambient temperature minimum/maximum to be 50°F/85°F.
3. Substrate temperature minimum/maximum to be 50°F/85°F. Substrate temperature must be at least 5°F above measured dew point.
4. Mixing and application attempted at material, ambient and/or substrate temperature conditions less than 65°F will result in a decrease in product workability and slower cure rates.
5. The minimum relative ambient humidity to be 30 percent and the maximum relative ambient humidity to be 75 percent (during application and curing).
6. Measure and confirm substrate moisture content, ambient relative humidity, ambient and surface temperature and dew point.

B. Maintain constant ambient room temperature of plus or minus 15°F with a minimum temperature of 50°F and maximum temperature of 85°F. Maintain constant ambient room temperature for forty-eight (48) hours before, during and after installation or until cured. Do not apply while ambient temperatures are rising.

C. Erect suitable barriers and post legible signs at points of entry to prevent traffic and trades from entering the work area during application and cure period of the floor.

D. Protection of finished floor from damage by subsequent trades shall be the responsibility of the Contractor.

E. Insure adequate ventilation and air flow.

1.06 Warranty

A. The manufacturer's warranty covering the resinous flooring against defects in materials for one (1) year from date of installation.

PART 2 - PRODUCTS

2.01 Manufacturers

A. The manufacturer shall be certified under ISO 9001. All liquid materials, including primers, resins, curing agents, finish coats, and sealants are manufactured and tested under ISO 9001 registered quality system.

B. The manufacturer shall be regularly engaged in production with documented experience in the actual production of the specified products.

C. Manufacturers:

1. ESD Epoxy Electrostatic Control System.
2. Sherwin Williams.
3. PPG.
4. Or Approved Equal.

D. Primer to be Sikafloor 161 applied between 8 -10 mils.

E. Top coat to be Sikafloor 200 ESD applied at 16 mils.

2.02 General Requirements

A. Furnish only materials that are new and of specified quality. Where Underwriters' Laboratories, Inc. have established standards for such materials furnish only materials bearing the UL label.

B. Electrically insulated floor covering shall be an epoxy material, consisting of two (2) semi-fluid components and shall contain no Portland cement.

C. The epoxy flooring shall be dense, resist thermal expansion and contraction, shall have a high electrical insulation resistance, and be dustless and skid proof.

D. The epoxy material shall adhere to clean dry concrete or metal surface and shall be suitable for application to a thickness of 1/4 inch or greater. The thickness of the epoxy floor material for this Contract shall be 1/2 inch.

E. The insulated floor covering shall be resistant to fire and acids, resist abrasion and impact and be suitable for industrial trucking. The floor covering shall not be affected by high or low ambient temperature after cure.

F. The epoxy coating shall meet the following:

1. Primer:
   a. Pull-off strength to meet ASTM D 4541 and be > 400psi (2.7MPa) with 100 percent concrete failure.
   b. Shore D hardness to meet ASTM D 2240 and be 76 at seven (7) days.
   c. Solid content to be ~ 100 percent (by volume) / ~ 100 percent (by weight).
   d. VOC content to meet ASTM D 2369 and be ≤ 50 g/L.
   e. Permeability to meet ASTM E 96/E 96M and be 9.0 g/m^2 (twenty-four (24) hours / plus 75°F).
   f. Water absorption to meet ASTM D 570 and be 0.14 g/h - m2.
   g. Viscosity (approximately) of components A + B to be 775 (SP2/100).

h. Color to be gray as approved by SEPTA.

2. Top Coat:
   a. Pull-off strength to meet ASTM D 4541 and be > 350 psi (2.4MPa) with 100 percent concrete failure.
   b. VOC content to meet ASTM D 2369 and be ≤ 50 g/L.
   c. Abrasion resistance to meet ASTM D 4060 and be 160 - 180 mgs (CS-17 Wheel, 1000 gm load, one thousand (1000) cycles).
   d. Gloss (60°) to be 80 - 90.
   e. Viscosity to be 300 - 650 cps. at 73°F.
   f. Flexibility to meet ASTM D 522/D 522M and be 1/4 inch passes test.

PART 3 - EXECUTION

3.01 Examination

A. Examine surfaces to receive flooring system. Notify the Contractor, SEPTA and SEPTA's representative if surfaces are not acceptable. Do not begin surface preparation or application until unacceptable conditions have been corrected. Do not apply to substrate treatments for moisture, repair or leveling not of the same manufacturer.

B. Surface must be clean, sound and dry. Remove dust, laitance, grease, curing compounds bond inhibiting impregnations, waxes and any other contaminants. All projections, rough spots, etc. should be dressed off to achieve a level surface prior to the application.

C. Concrete substrate to have a minimum compressive strength of 3,500 psi at twenty-eight (28) days and a minimum of 215 psi in tension at time of application.

D. Substrate moisture:
   1. Measure and confirm substrate moisture content, ambient relative humidity, ambient and surface temperature and dew point.
   2. Confirm and record above values at least one every three (3) hours during installation or more frequently whenever conditions change (e.g. ambient temperature rise/fall, relative humidity increase/decrease, etc.).

E. Ensure the concrete substrate meets the minimum requirements of the flooring manufacturer.

F. Flooring system shall not be applied to sand cement setting beds. Sand cement beds shall be removed to structural concrete substrate and re-leveled/sloped as necessary to achieve grade and/or adequate drainage.

G. Flooring system shall not be applied to asphaltic or bitumen membranes, soft wood, aluminum, copper or fiberglass reinforced polyester/vinyl ester composites.

H. Application to glazed or vitrified brick and tile, structural wood, steel shall only be permitted with the manufacturer's written recommendations.

3.02 Surface Preparation

A. Prepare the surface to receive flooring systems in accordance with the manufacturer's written instructions.

B. Remove dirt, oil, grease, wax, laitance, curing compounds, water soluble concrete hardeners and other surface contaminants. Remove sealers, finishes and paint. Remove unsound concrete by appropriate mechanical means.

C. Concrete shall be cleaned and prepared to achieve laitance free and contaminant free, open textured surface by shot blasting or equivalent mechanical means (CSP level as per ICRI guidelines and the manufacturer's written recommendation).

D. Chemical surface preparation (acid etching) is unacceptable and will void the manufacturer's warranty.

E. Provide repair and treatment of control joints and surface cracks utilizing the manufacturer's standard materials and installation details.

3.03 Application

A. Mix and apply material with strict adherence to the manufacturer's written installation procedures and coverage rates.

B. Follow the manufacturer's written recommendations on terminations and connections to walls, drains, doorways, columns and floor to floor transitions.

C. Do not apply while ambient and substrate temperatures are rising.

D. Apply resinous flooring with care to ensure that no laps, voids, or other marks or irregularities are visible, and with an appearance of uniform color, sheen and texture, all within limitations of materials and areas concerned.

E. Match colors and textures of approved samples.

F. Install cove base in accordance with the manufacturer's written instructions.

3.04 Cleanup

A. Disposal of this product, solution and any by-products should at all times meet the requirements of environmental protection and waste disposal legislation and any regional local authority requirements.

B. Empty containers should be taken to an approved waste handling site for recycling or disposal.

3.05 Protection

A. Freshly applied material should be protected from dampness, condensation and water for at least seventy-two (72) hours.

B. Beware of air flows and changes in air flow. Introduction of dust, debris, and particles, etc. may result in surface imperfections and other defects.

C. Follow the manufacturer's written recommendation with respect to cure, wait time and return to service.

3.06 Installation by Contractor

A. Installation shall be accomplished by the Contractor's workmen with established skill in this type of work and shall conform to the Contract Documents.

B. The epoxy floor covering shall be applied to a minimum thickness of 3/8 inches as one (1) piece level surface, free from cracks and joints.

C. Before installation, properly seal conduits to prevent the entrance of epoxy material into conduits. Apply masking to prevent the encapsulation of grounding conductors.

D. Where edge of the insulated floor meets the bare metal/concrete floor, epoxy material shall be tapered from full thickness to the level of the metal/concrete floor over a length of 6 inches. Where the epoxy floor covering meets wall insulating panel, the floor covering shall completely fill any gap to a minimum thickness of 1/4 inch.

3.07 Field Testing

A. Field test epoxy floor covering to verify insulation from ground per the most applicable code or standard.

END OF SECTION

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SECTION 09705

EPOXY RESIN FLOORING

PART 1 - GENERAL

1.01 Description

A. Furnish all labor, materials, tools and equipment required to perform the work of this Section as shown on the Contract Drawings and as specified herein.

1. Application method is by metal, power or hand, troweled.

1.02 Related Sections

A. Section 03300 – Cast-In-Place Concrete

B. Section 03930 – Concrete Repair

1.03 Submittals

A. Submit product data for each type of product indicated. Include manufacturer's technical data, application instructions and recommendations for each resinous flooring component required.

B. Submit shop drawings for floor design and integral cove base, based on verified field conditions.

C. Submit samples for verification.

1. For each resinous flooring system required, minimum 6 inches square, applied to a rigid backing by the installer for this Contract.

2. Samples of transitions for each system, color, and type, minimum 6 inches long, applied to a rigid backing by the installer for this Contract.

D. Submit product schedule using resinous flooring designations indicated in Part 2 in this Section and room designations indicated on the Contract Drawings in the product schedule. Schedule to be coordinated with Project specific staging and approved by the SEPTA Project Manager.

E. Submit installer certificates signed by manufacturer certifying that the installers meet the specified requirements.

F. Submit material certificates for each resinous flooring component, from manufacturer.

G. Submit material test reports for each resinous flooring system, by a qualified testing agency.

H. Submit maintenance data for resinous flooring to include in maintenance manuals.

1.04 Quality Assurance

A. Engage an experienced installer (applicator) who is experienced in applying resinous flooring systems similar in material, design, and extent to those indicated for this Contract, whose work has resulted in applications with a record of successful in-service performance, and who is acceptable to resinous flooring manufacturer.

1. Engage an installer who is certified in writing by resinous flooring manufacturer as qualified to apply resinous flooring systems indicated.
2. The Contractor shall have completed Projects of similar size and complexity.

B. Obtain primary resinous flooring materials, including primers, resins, hardening agents, grouting coats, and topcoats, through one (1) source from a single manufacturer. Provide secondary materials, including patching and fill material, joint sealant, and repair materials, of type and from source recommended by manufacturer of primary materials.

C. Apply mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Apply full thickness mockups on 48 inch square floor area selected by the SEPTA Project Manager.
2. Include 48 inch length of integral cove base and the typical transition detail for flooring colors.
3. Approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.
4. Sign off from the SEPTA Project Manager on texture for slip resistance must be complete before installation of flooring system.

D. Pre-Installation Conference:

1. The Contractor shall arrange a meeting not less than fifteen (15) days prior to starting work.
2. Coordinate attendees with the SEPTA Project Manager.

E. Meet the applicable provisions of the most recent issues of the following references:

1. ICC A117.1, Standard for Accessible and Usable Building and Facilities.
2. ASTM C 307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
3. ASTM C 413, Standard Test Method for Absorption of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
4. ASTM C 579, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
5. ASTM C 580, Standard Test Method for Flexural Strength and Modulus of Elasticity of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
6. ASTM D 2240, Standard Test Method for Rubber Property-Durometer Hardness.
7. ASTM D 2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
8. ASTM E 648, Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source.
9. ASTM F 1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.

10. ASTM F 2170, Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes.

1.05 Delivery, Storage and Handling

A. Deliver materials in original packages and containers, with seals unbroken, bearing the manufacturer's label indicating brand name and directions for storage and mixing with other components.

B. Store materials to prevent deterioration from moisture, heat, cold, direct sunlight or other detrimental effects.

C. All materials used shall be factory pre-weighed and pre-packaged in single, easy to manage batches to eliminate on site mixing errors. No on site weighing or volumetric measurements allowed.

1.06 Project Conditions

A. Meet the resinous flooring manufacturer's written instructions for substrate temperature, ambient temperature, moisture, ventilation and other conditions affecting resinous flooring application.

B. Provide permanent lighting or, if permanent lighting is not in place, simulate permanent lighting conditions during resinous flooring application.

C. Close spaces to traffic during resinous flooring application and for not less than twenty-four (24) hours after application, unless the manufacturer recommends a longer period.

D. Concrete substrate shall be properly cured for a minimum of thirty (30) days. Refer to Part 3 in this Section for moisture test requirements of concrete substrate.

1.07 Warranty

A. Manufacturer shall furnish a single, written warranty covering both material and workmanship for a period of five (5) full years from date of installation, or provide a joint and several warranty signed on a single document by the material manufacturer and applicator jointly and severally warranting the materials and workmanship for a period of five (5) full years from date of installation. A sample warranty letter must be included with bid package or bid may be disqualified.

PART 2 - PRODUCTS

2.01 Resinous Flooring

A. Subject to compliance with requirements, product that may be incorporated into the work include:

1. Meet with the troweled mortar base with broadcast topping. Liquid rich, slurry type systems will not be accepted, and will result in a disqualification from bid.

B. Manufactures:

1. Stonhard, Inc.; Stonshield HRI.

2. Dur-A-Flex.

3. Sherwin Williams.
4. Or Approved Equal.

C. System Characteristics:

1. Color and pattern to be custom, as selected by SEPTA.
2. Wearing surface to be standard or medium texture. Texture must be in compliance with requirements noted within Article 2.01/E in this Section and approved by the SEPTA Project Manager.
3. Integral cove base to be as shown on the Contract Drawings.
4. Overall system thickness to be nominal 1/4 inch.

D. System components to be the manufacturer's components that are compatible with each other and as follows:

1. Sealant for Metal and Expansion Joints:
   a. Material basis to be Stonhard Stonflex MP7; Or Approved Equal.
   b. Formulation description to be (2) two component polyurethane.
   c. Method to be saw cut resinous system and fill void with MP7 product.
   d. Number of coats to be (1) one.
2. Positive Side Vapor Barrier:
   a. Refer to Article 3.01 in this Section for use requirements of this product.
      1) Basis of design to be Stonhard Stonfill OP2; Or Approved Equal.
3. Primer:
   a. Material basis to be Stonhard Standard Primer; Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (2) two component, 100 percent solids.
   d. Application method to be squeegee and roller.
   e. Number of coats to be (1) one.
4. Mortar Base:
   a. Material design basis to be Stonclad GS; Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (3) three component, 100 percent solids.
   d. Application method to be metal trowel.
      1) Thickness of coats to be nominal 3/16 inch.
      2) Number of coats to be (1) one.
   e. Aggregates to be pigmented blended aggregate.
5. Undercoat:
   a. Material basis to be Stonshield undercoat; Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (2) two component, 100 percent solids, UV Stable.
   d. Type to be clear.
   e. Finish to be gloss.

f. Number of coats to be (1) one.

6. Broadcast Media:
   a. Material basis to be Stonshield quartz aggregate; Or Approved Equal.
   b. Type to be pigmented.
   c. Finish to be standard.
   d. Number of coats to be (1) one.
   e. Pattern to be tweed.
7. Sealer:
   a. Material basis to be Stonshield Sealer; Or Approved Equal.
   b. Resin to be epoxy.
   c. Formulation description to be (2) two component, 100 percent solids, UV Stable.
   d. Type to be clear.
   e. Finish to be gloss.
   f. Number of coats to be (1) one.
   g. Texture level to be standard or medium.
   h. Prep for seal coat to be light sanding and vacuum as required by the manufacturer.
8. Seal coat:
   a. Material basis to be Stonseal CF7 clear flat; Or Approved Equal.
   b. Resin to be aliphatic polyurethane.
   c. Formulation description to be (2) two component, waterborne, flat, aliphatic polyurethane that is chemical resistant and UV stable.
   d. Type to be clear.
   e. Finish to be gloss.
   f. Number of coats to be (1) one.

E. Slip Coefficient:
   1. Slip coefficient of friction shall be in compliance with ICC A117.1 requirements.
   2. Provide minimum wet static coefficient of friction of 0.8 for sloped surfaces and 0.6 flat surfaces.
   3. Final wearing surface to be approved by the SEPTA Project Manager.

F. Provide resinous flooring system with the following minimum physical property requirements when tested according to test methods indicated:
   1. Compressive strength to be 10,000 psi after seven (7) days per ASTM C 579.
   2. Tensile strength to be 2,000 psi per ASTM C 307.
   3. Flexural strength to be 4,300 psi per ASTM C 580.
   4. Water absorption to be < 1 percent per ASTM C 413.
   5. Impact resistance to be > 160 in. lbs. per ASTM D 2794.
   6. Flammability to be Class 1 per ASTM E 648.
   7. Hardness to be 85 to 90, Shore D per ASTM D 2240.

2.02 Accessory Materials

A. Patching and fill material to be a resinous product of or approved by the resinous flooring manufacturer and recommended by the manufacturer for application indicated.

B. Joint sealant to be the type recommended or produced by the resinous flooring manufacturer for type of service and joint condition indicated. Allowances should be included for Stonflex MP7 joint fill material (Or Approved Equal) and CT5 concrete crack treatment (Or Approved Equal).

PART 3 - EXECUTION

3.01 Preparation

A. Prepare and clean substrates according to the resinous flooring manufacturer's written instructions for substrate indicated. Provide clean, dry and neutral Ph substrate for resinous flooring application.

B. Prepare metal substrates according to the resinous flooring manufacturer’s written instructions for substrate indicated.

C. Provide sound concrete surfaces free of laitance, glaze, efflorescence, curing compounds, form release agents, dust, dirt, grease, oil and other contaminants incompatible with resinous flooring.

1. Mechanically prepare substrates as follows:
    a. Shot blast surfaces with an apparatus that abrades the concrete surface, contains the dispensed shot within the apparatus and recirculates the shot by vacuum pickup.
    b. Meet the manufacturer's written instructions if they are more stringent.
2. Repair damaged and deteriorated concrete according to the resinous flooring manufacturer's written recommendations.
3. Verify that concrete substrates are dry and moisture vapor emissions are within acceptable levels according to the manufacturer’s written instructions.
    a. Perform in situ probe test, ASTM F 2170. Proceed with application only after substrates do not exceed a maximum potential equilibrium relative humidity of 85 percent.
    b. Perform anhydrous calcium chloride test, ASTM F 1869. Proceed with application only after substrates have maximum moisture vapor emission rate of 7 pounds of water/1000 sq. ft. of slab in twenty-four (24) hours.
    c. Perform additional moisture tests recommended by the manufacturer. Proceed with application only after substrates pass testing.
    d. If tests result in high moisture content then a positive side vapor barrier shall be installed as required by the manufacturer.
4. Verify that concrete substrates have neutral Ph and that resinous flooring will adhere to them. Perform tests recommended by the manufacturer. Proceed with application only after substrates pass testing.
5. SEPTA to verify concrete substrate prior to application of resinous material.

D. Mix components and prepare materials according to the resinous flooring manufacturer's written instructions.

E. Use patching and fill material to fill holes and depressions in substrates according to the manufacturer's written instructions.

F. Treat control joints and other nonmoving substrate cracks to prevent cracks from reflecting through resinous flooring according to the manufacturer's written recommendations. Allowances should be included for Stonflex MP7 joint fill material (Or Approved Equal) and CT5 concrete crack treatment (Or Approved Equal).

3.02 Application

A. Apply components of resinous flooring system according to the manufacturer's written instructions to produce a uniform, monolithic wearing surface of thickness indicated.

1. Coordinate application of components to provide optimum adhesion of resinous flooring system to substrate and optimum intercoat adhesion.

2. Cure resinous flooring components according to the manufacturer's written instructions. Prevent contamination during application and curing processes.

3. At substrate expansion and isolation joints, provide joint in resinous flooring to meet the resinous flooring manufacturer's written recommendations.

a. Apply joint sealant to meet the manufacturer's written recommendations.

B. Apply primer where required by resinous system, over prepared substrate at the manufacturer's recommended spreading rate.

C. Stonshield cove mortar (Or Approved Equal), apply cove base mix to wall surfaces before applying flooring. Apply according to the manufacturer's written instructions and details including those for taping, mixing, priming, troweling and sanding of cove base. Round internal and external corners.

D. Refer to the Contract Documents for integral cover base.

E. Apply metal trowel single mortar coat in thickness indicated for flooring system. Hand or power trowel and grout to fill voids. When cured, sand to remove trowel marks and roughness.

F. Remove any surface irregularities by lightly abrading and vacuuming the floor surface. Mix and apply undercoat with strict adherence to the manufacturer's installation procedures and coverage rates.

G. Immediately broadcast quartz silica aggregate into the undercoat using the manufacturer's specially designed spray caster. Strict adherence to the manufacturer's installation procedures and coverage rates is imperative.

H. Apply topcoat in number of coats indicated for flooring system and at spreading rates recommended in writing by the manufacturer.

3.03 Terminations

A. Chase edges to “lock” the flooring system into the concrete substrate along lines of termination.

B. Lap and seal the flooring system onto the perimeter of the penetrating item by bridging over compatible elastomer at the interface to compensate for possible movement.

C. Continue flooring system into trenches to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

D. Treat floor drains by chasing the flooring system to lock in place at point of termination.

E. Continue flooring system over curbs to maintain monolithic protection. Treat cold joints to assure bridging of potential cracks.

3.04 Joints and Cracks

A. Treat control joints to bridge potential cracks and to maintain monolithic protection.

B. Treat cold joints and construction joints to bridge potential cracks and to maintain monolithic protection on horizontal and vertical surfaces as well as horizontal and vertical interfaces.

C. Discontinue floor coating system at vertical and horizontal contraction and expansion joints by installing backer rod and compatible sealant after coating installation is completed. Provide sealant type recommended by the manufacturer for traffic conditions and chemical exposures to be encountered.

3.05 Field Quality Control

A. SEPTA Project Manager may at any time and any numbers of times during resinous flooring application require material samples for testing for compliance with requirements.

1. If test results show applied materials do not meet the specified requirements, the Contractor will pay for testing, remove noncomplying materials, prepare surfaces coated with unacceptable materials, and reapply flooring materials to meet the requirements.

3.06 Cleaning, Protecting and Curing

A. Cure resinous flooring materials in compliance with the manufacturer's directions, taking care to prevent contamination during stages of application and prior to completion of curing process. Close area of application for a minimum of eighteen (18) hours.

B. Protect resinous flooring materials from damage and wear during construction operation. Where temporary covering is required for this purpose, meet the manufacturer's recommendations for protective materials and method of application at no cost to SEPTA. The Contractor is responsible for protection and cleaning of surfaces after final coats.

C. Remove temporary covering and clean resinous flooring just prior to final inspection. Use cleaning materials and procedures recommended by the resinous flooring manufacturer.

END OF SECTION

SECTION 09910

PAINTS AND COATINGS

PART 1 - GENERAL

1.01 Description

A. Provide painting, as shown and scheduled per the Contract Drawings; including, but not limited to:

1. Painting and surface preparation for interior and exterior finished surfaces.
2. Priming of substrates.
3. All work is to be performed with the assumption that all painted surfaces are lead containing/contaminated. The Contractor is responsible for following all required OSHA 1926.62 Lead in Construction standards when disturbing or impacting these painted surfaces during the course of the renovation including but not limited to activities such as, cutting and patching, core drilling, penetration, anchoring, fastening, etc. The areas shall be visually clean upon completion of any of these activities.
4. Refer to Section 09662 for electrically insulated concrete/metal floor coating of the Traction Power Substations (TPSSs).
5. Refer to Section 09705 for epoxy concrete/metal floor coating of the TPSSs.
6. Refer to Section 09960 for sealing/painting steel members.
7. Refer to Section 09965 for graffiti resistant top coat to paint systems. Refer to the Contract Drawings for extent of application of graffiti resistant coating.

1.02 Related Sections

A. Section 01400 – Quality Requirements

B. Section 08110 – Metal Doors and Frames

C. Section 09662 – Electrically Insulated Floor Covering

D. Section 09705 – Epoxy Resin Flooring

E. Section 09960 – Painting of Steel

F. Section 09965 – Graffiti Resistant Coatings

G. Section 10200 – Louvers and Vents

H. Document #3001 “MANAGEMENT OF LEAD PAINT ON SEPTA CONSTRUCTION PROJECTS” included in the Reference Documents.

1.03 Submittals

A. Submit the manufacturer's specifications, data and installation instructions for review.

B. Submit product list to cross reference coating system and locations of application areas. Use same designations indicated on the Contract Drawings and in schedules. Include color designations.

C. Submit samples:

1. Submit specified colors for each surface finishing product.
2. Field samples:
   a. In place, on material scheduled to be finished, illustrating coating color, texture and finish. Locate where directed; accepted sample may remain as part of the work.
   b. One (1) entire unit as scheduled to be finished.

D. Submit statement of VOC compliance with local regulations.

1.04 Quality Assurance

A. Refer to Section 01400.

B. Qualifications:

1. Applicator to be specializing in performing the work of this Section with documented experience.
2. Use only products in compliance with VOC content limits required by state and local regulations.

C. Preparation and cleaning procedures shall be in accordance with Steel Structures Painting Council (SSPC) and Document #3001 “MANAGEMENT OF LEAD PAINT ON SEPTA CONSTRUCTION PROJECTS”. Cleaned surfaces shall be inspected by SEPTA prior to the application of any paint. Mixing and application of coating shall be in strict accordance with the manufacturer’s recommendations. Sandblasting is not permitted as a means to clean the surfaces(s).

D. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications.
2. National Paint and Coatings Association (NPCA), Guide to U.S. Government Paint Specifications.
3. OSHA 1926.62, Lead in Construction.
4. Painting and Decorating Contractors of America (PDCA), Painting Architectural Specifications Manual.
5. SEPTA System Safety Document #3001, Management of Lead Paint on SEPTA Property.
6. SSPC-SP 1, Solvent Cleaning.
7. SSPC-SP 2, Hand Tool Cleaning.
8. SSPC-SP 3, Power Tool Cleaning.
9. SSPC-SP 11, Power Tool Cleaning to Bare Metal.

1.05 Delivery, Storage and Handling

A. Delivery:

1. Schedule delivery of materials at the site at such time as required for proper coordination of the work. Receive materials in the manufacturer's unopened packages and bearing the manufacturer's label.

B. Storage:

1. Store materials in a dry and properly ventilated separate structure not less than 50 feet from any other structure on the site. Adequately protect from damage and exposure to the elements.
2. Maintain a minimum temperature of 45°F and a maximum temperature of 90°F.
3. Take necessary precautions to prevent fire; remove paint soiled rags and waste from building each day or store in metal containers with covers in the paint storage structure.

C. Provide label on each container with the following information:

1. Name or title of material.
2. Manufacturers stock number.
3. Manufacturers name.
4. Contents by volume for major pigment.
5. Thinning instructions.
6. Application instructions.

1.06 Warranty

A. Manufacturer's Standard Warranty:

1. Provide, in required form, for a period of five (5) years from date of final acceptance.
2. Color and finish appearance shall remain unchanged throughout entire guarantee period.

1.07 Extra Material

A. Deliver 1 percent or a minimum of two (2) gallons of each color, type and surface texture of paint installed. Label each container with color, type, texture and room locations.

PART 2 - PRODUCTS

2.01 Materials

A. Manufacturer:

1. Basis of Design is Sherwin Williams.
2. Carboline Co.
3. Benjamin Moore.
4. Or Approved Equal.

B. Container label to identify with the manufacturer's name, and include description of type of paint, brand name, lot number, and brand code and color designation.

C. Provide ready mixed products, except field catalyzed coatings. Provide accessory materials such as linseed oil, shellac, thinners, cleaners and other materials not specifically indicated but required to achieve finishes specified.

1. Use only one (1) lot of paint for any individual element to be painted. Do not mix lots of paint.

D. Exterior:

1. Composite Trim:
   a. One (1) coat Pro Industrial Pro-Cryl Universal Gray Primer B66-310.
   b. Two (2) coats Pro Industrial HP Acrylic, Semi-Gloss B66-650.
2. Miscellaneous Metal Trim:
   a. One (1) coat Macropoxy 646-100 Fast Cure Epoxy, B58-620.
   b. Two (2) coats High Solids 100 Polyurethane B65-600.
3. Various Slightly Rusted Substrates – Interior or Exterior:
   a. One (1) coat Kem Bond HS Universal Metal Primer B50AZ8.
   b. Two (2) coats Industrial Enamel High Solids Gloss B54 series.

   or

   c. One (1) coat Macropoxy 646-100, Fast Cure Epoxy B58-620.
   d. Two (2) coats High Solids Polyurethane 100 B65-600.

E. Interior:

1. Ceiling or Curbs:
   a. Concrete:
      1) One (1) coat Loxon Concrete & Masonry Primer, A24.
      2) Two (2) coats ProMar 200 Zero VOC Latex Semi-Gloss B31W200.

F. Miscellaneous Cleaning and Refinishing Materials:

1. Fine grade Scotch-Brite pads (white and/or green type,) manufactured by 3M Co, St Paul MN; Or Approved Equal.
2. Very fine steel wool, clean and free of contaminants and corrosion.
3. Clean, soft, lint-less, cotton rags.
4. Cotton pads and swabs.

G. Solvent Cleaners and Thinners:

1. Xylene to be commercial manufacture.
2. White spirit to be commercial manufacture.
3. Odorless lacquer thinner to be commercial manufacture.
4. Denatured alcohol to be commercial manufacture.
5. Or Approved Equal.

2.02 Mixing

A. Mix paints at the factory; do not alter or reduce materials except as directed by the manufacturer.

B. See finish schedule on the Contract Drawings for colors.

C. Add fungicidal agent to paint per the manufacturer's recommendations. Add agent at the factory; clearly indicate on label that paint is mildew resistant.

PART 3 - EXECUTION

3.01 Preparation

A. Environmental Requirements:

1. Do not apply exterior coatings during rain or snow, or when relative humidity is outside the humidity ranges required by the manufacturer.
2. Temperature:
   a. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the manufacturer.
   b. Exterior paints to be applied at 40°F minimum during and for forty-eight (48) hours after application; do not apply when temperature is over 90°F, except in protected or shaded areas.
   c. Interior paints to be applied at 50°F for minimum of forty-eight (48) hours before, during and for forty-eight (48) hours after application.
3. Provide adequate ventilation of all interior spaces during application and curing of all painting products.
4. Provide minimum 80 foot candles measured at mid height of room. At exterior, provide minimum of 80 foot candles measured at mid height of element to be painted.

B. Examination:

1. Examine conditions of surfaces in place before beginning work; report defects.
2. Test shop applied primer for compatibility with subsequent cover materials.
3. Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the following maximums:
   a. Concrete - 12 percent.
   b. Fiber cement boards - 12 percent.
   c. Masonry (clay and CMUs) - 12 percent.
   d. Wood - 15 percent.
   e. Portland cement plaster - 12 percent.
   f. Gypsum board - 12 percent.
4. Application of first coat of painting process constitutes acceptance of surface.

C. Protect adjacent surfaces not scheduled for paint finish from damage resulting from painting operations.

D. Painting of Interior Walls and Ceiling:

1. All existing TPSS, control and battery room interior walls and ceilings shall be stripped of their existing coating/paint, cleaned and painted.
2. Remove rust, loose mille scale and all other contaminants. Clean using methods recommended in writing by the paint manufacturer. Sandblasting will not be permitted as a means to clean the surface.
3. All surfaces to receive paint and protective coatings shall be cleaned as specified herein prior to application of coating materials. The Contractor shall examine all surfaces to be coated, and shall correct all surface defects before application of any coating material. Beginning the Work of this Section without reporting unsuitable conditions to SEPTA constitutes acceptance of conditions by the Contractor. Any required removal, repair, or replacement of the Work caused by unsuitable conditions shall be done at no additional cost to SEPTA. All marred or abraded spots on shop-primed and factory-finished surfaces shall receive touch-up restoration prior to any other coating application.

E. Steel/Metals Surface Preparation:

1. Oil, grease, salts or other surface contaminations must first be removed by the methods outlined in SSPC-SP 1.
2. Remove rust, loose mill scale, and shop primer, if any, on steel substrates. Clean using methods recommended in writing by the paint manufacturer, but not less than the following:
   a. SSPC-SP 2.
   b. SSPC-SP 3.
   c. SSPC-SP 11.
3. Dust conditions at the site shall be anticipated and such dust as may collect shall be removed before touch-up paint is applied.
4. All flux, spatter, slag or laminations from welding or other sharp projections shall be ground smooth prior to cleaning.
5. All areas cleaned on any day shall be coated on the same day. Any such areas not coated that are exposed overnight shall be lightly cleaned to remove any visible or invisible rust that may have formed.
6. Remove or mask electrical plates, hardware, light fixture trim, escutcheons and fittings prior to preparing surfaces or finishing. Correct defects and clean surfaces that affect work of this Section. Remove existing coatings that exhibit loose surface conditions. Use shellac to seal marks, which may bleed through surface finishes.
7. Remove mildew by scrubbing with solution of trisodium phosphate and bleach on impervious surfaces. Rinse with clean water and allow surface to dry.
8. Sand and scrape shop primed steel surfaces to remove loose primer and rust. Feather edges to make touch up patches inconspicuous. Clean surfaces with solvent to remove all oil, grease and other foreign matter. Provide prime coat on bare steel surfaces.

3.02 Application

A. Install in conformance with referenced standards, the manufacturer's written directions, as shown, and as specified.

1. Application preferred to be by brushes or rollers.

2. Spray painting is **not** an acceptable method of application.

B. Performance:

1. Apply each coat to uniform finish, slightly darker than preceding coat unless otherwise approved. Sand surfaces lightly between coats to achieve required finish. Vacuum clean surfaces free of loose particles; use tack cloth just prior to applying next coat. Allow applied coat to dry before next coat is applied.

3.03 Inspection and Correction of Defects

A. The SEPTA Project Manager and the Engineer shall approve all surface preparation prior to the application of new coating.

B. Each coat will be examined prior to the application of the next coat. Areas that show overspray, roughness or other signs of improper application shall be repaired or re-coated in accordance with the manufacturer’s recommendations.

C. The completed system shall produce a dry film thickness recommended by the manufacturer, and determine by the Mictotest thickness gauge or comparable instrument available to the SEPTA Project Manager’s request for testing. All structures painted will be tested for dry film thickness. Tests are to be performed by the Contractor at its sole expense, in the presence of the SEPTA Project Manager. Written results of said test shall be submitted to SEPTA.

3.04 Cleaning

A. Upon completion, remove masking materials, reinstall electrical cover plates, hardware, light fixture trim, escutcheons, and fittings removed prior to finishing, and thoroughly clean all exposed surfaces per the manufacturer's instructions. Keep premises free from accumulation of waste and rubbish. At the completion of work remove surplus materials, rubbish and debris.

B. After detailed inspection of paint work, touch up or refinish abraded, stained, or otherwise disfigured work, as required by SEPTA.

C. Remove containers, rags and debris from the site; observe special care in control or disposal of flammable materials.

END OF SECTION

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SECTION 09960

PAINTING OF STEEL

PART 1 - GENERAL

1.01 Description

A. This Section specifies the painting and finishing of steel surfaces of Traction Power Substation (TPSS) structures, exterior steel structures and repaired concrete foundations.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 02085 - Lead Paint Abatement

1.03 Submittals

A. Submit product data for each type of product indicated. Include preparation requirements and application instructions.

B. Submit samples for verification for each type of painting system and in each color and gloss of topcoat indicated.

1. Submit samples on hardboard backing with texture to simulate actual condition, 12 inches square.
2. Step coats on samples to show each coat required for system.
3. Label each coat of each sample.
4. Label each sample for location and application area.

C. Submit product list for each product indicated, include the following:

1. Cross-reference to paint system and locations of application areas. Use same designations indicated on the Contract Drawings and in schedules.
2. Printout of current "MPI Approved Products List" for each product category specified in Part 2 in this Section, with the proposed product highlighted.
3. VOC content.

D. Submit Lead Paint Work Plan:

1. Comply with the requirements of Section 02085.
2. Prior to commencing work on a potentially lead contaminated area, the Contractor shall submit a pollution control plan for review and written approval. A Lead Health and Safety Plan (LHASP) and a compliance plan will be required. Coordinate with final paint finishes and concrete coatings to determine if full removal or encapsulation of existing lead paint is required and provide a specific process for each site condition.

E. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Coatings to be 2 percent, but not less than one (1) gallon of each material and color applied.

1.04 Quality Assurance

A. General:

1. Cleaning of existing surfaces, painting operations and materials shall meet Occupational Safety and Health Administration (OSHA) and Environmental Protection Administration (EPA).

2. Preparation and cleaning procedures shall be in accordance with Steel Structures Painting Council (SSPC) and Document #3001 “MANAGEMENT OF LEAD PAINT ON SEPTA CONSTRUCTION PROJECTS”. Cleaned surfaces shall be inspected by SEPTA prior to the application of any paint. Mixing and application of coating shall be in strict accordance with the manufacturer’s recommendations.

3. Materials not displaying the manufacturer’s identifications as a standard best grade product will not be approved.

4. Materials shall be by one (1) manufacturer and where the manufacturer does not make a part of the coating system, the Contractor may substitute another manufacturer of the part or finish coat subject to SEPTA’s approval.

5. Compatibility of the total coating system for the various substrates shall be ensured by providing barrier coats over incompatible primers or removal and re-priming as required.

6. Use of proprietary names to designate colors or material is not intended to imply that products of the designated manufacturers exclude products by other manufacturers.

B. Apply mockups of each coating system indicated to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. The SEPTA Project Manager will select one (1) surface to represent surfaces and conditions for application of each coating system specified in Part 3 in this Section.
   a. The SEPTA Project Manager will designate other items or areas as required.

2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless the SEPTA Project Manager specifically approves such deviations in writing.

3. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM D 523, Standard Test Method for Specular Gloss.

2. ASTM E 1795, Standard Specification for Non-Reinforced Liquid Coating Encapsulation Products for Leaded Paint in Buildings.

3. OSHA 1910.134, Respiratory Protection Standard.

4. OSHA 1926.62, Lead in Construction.
5. OSHA 1926.103, Respiratory Protection.
6. SSPC-SP 1, Solvent Cleaning.
7. Document #3001 “MANAGEMENT OF LEAD PAINT ON SEPTA CONSTRUCTION PROJECTS”.

1.05 Delivery, Storage and Handling

A. Delivery:

1. Schedule delivery of materials at the site at such time as required for proper coordination of the work. Receive materials in the manufacturer’s unopened packages and bearing the manufacturer’s label.

B. Storage:

1. Store materials in a dry and properly ventilated separate structure not less than 50 feet from any other structure on the site. Adequately protect from damage and exposure to the elements.
2. Maintain a minimum temperature of 45°F and a maximum temperature of 90°F.
3. Take necessary precautions to prevent fire; remove paint soiled rags and waste from building each day or store in metal containers with covers in the paint storage structure.

C. Provide label on each container with the following information:

1. Name or title of material.
2. Manufacturers stock number.
3. Manufacturers name.
4. Contents by volume for major pigment.
5. Thinning instructions.
6. Application instructions.

1.06 Definitions

A. Gloss Level 6 to be 70 to 85 units at 60°F, according to ASTM D 523.

B. Gloss Level 7 to be more than 85 units at 60°F, according to ASTM D 523.

1.07 Lead Based Paint

A. The Contractor is to assume all surfaces are contaminated. The Contractor shall work with the SEPTA Safety Department to establish acceptable management of lead paint. Refer to the Reference Documents for document #3001 “MANAGEMENT OF LEAD PAINT ON SEPTA CONSTRUCTION PROJECTS”.

1. All work is to be performed with the assumption that all painted surfaces are lead containing. The Contractor is responsible for following all required OSHA 1926.62 standards when disturbing or impacting these painted surfaces during the course of the renovation including but not limited to activities such as; cutting and patching, core

drilling, penetration, anchoring, fastening, etc. The area(s) shall be visually clean upon completion of any of these activities.

2. The Contractor shall submit an action plan to SEPTA for approval at the initial job conference which specifically outlines details of means and methods to be used for each dust generating activity involving lead painted surfaces, erection of critical barriers and plastic sheeting for dust control, subsequent exposure assessment, personal protective equipment, hygiene and clean-up.
3. The Contractor shall utilize means and methods that preclude uncontained dust generation to complete work that disturbs/impacts lead containing paint (i.e., paint stripper, HEPA assisted drills, etc.).
4. The Contractor shall ensure areas beyond work area are not contaminated and shall immediately stop work and erect plastic sheeting to prevent the spread of dust anytime means and methods inadvertently create dust.
5. The Contractor is solely responsible for the health and safety of its workers during execution of this Contract. Work shall be conducted under the assumption that all existing surface coatings contain lead, and in accordance with applicable local, state and federal regulations, including but not limited to, OSHA 1926.62, 1926.103 and 1910.134, and U.S. EPA and PA DEP regulations as applicable. These regulations and their successors are binding upon the Contractor and are considered part of the Contract.
    a. The Contractor shall determine methods used to handle materials and precautions taken, and retains responsibility for use of those methods. The methods used by the Contractor shall be generally accepted and considered the optimum methods available for the treatment and handling necessary for the Contract.
6. Disposal of lead-containing surface coating debris:
    a. Remove lead-containing surface coating debris from Project site and legally dispose of it.
    b. Obtain a certificate of disposal from the disposal facility for each manifested hazardous waste shipment.
7. Other possible removal methods are as follows:
    a. Peel away strippers.
    b. Solvent-based chemical strippers.
    c. Needle guns with shroud attached to a HEPA vacuum.

1.08 Field Conditions

A. Apply coatings only when temperature of surfaces to be coated and surrounding air temperatures are between 40°F and 95°F.

B. Additives to allow for cold-weather application (below 40°F) shall be submitted to SEPTA for approval prior to the commencement of work.

C. Do not apply coatings when relative humidity exceeds 85 percent; at temperatures less than 5°F above the dew point; or to damp or wet surfaces.

D. Do not apply exterior coatings in snow, rain, fog or mist.

PART 2 - PRODUCTS

2.01 Source Quality Control

A. SEPTA reserves the right to invoke the following coating testing procedure:

1. SEPTA will engage the services of a qualified testing agency to sample coating materials. The Contractor will be notified in advance and may be present when samples are taken. If coating materials have already been delivered to Project site, samples may be taken at Project site. Samples will be identified, sealed and certified by testing agency.
2. Testing agency will perform tests for compliance with product requirements.
3. SEPTA may direct the Contractor to stop applying paints if test results show materials being used do not comply with product requirements. The Contractor shall remove noncomplying coating materials from Project site, pay for testing and recoat surfaces coated with rejected materials. The Contractor will be required to remove rejected materials from previously coated surfaces if, on recoating with complying materials, the two (2) coatings are incompatible.

2.02 Materials

A. Steel All Exposed Rusted Beams:

1. Primer shall be a rust converter-encapsulated; primer color shall not be too closely matched to the intermediate or top coat color. The SEPTA Project Manager to review and approve prior to application.
2. Intermediate coat shall be Sherwin-Williams B58W00401 –Macropoxy HS High Solids Epoxy White/Tint Base Part A White/Tint Base Part A; Or Approved Equal. Intermediate coat color shall not be too closely color matched to the intermediate or top coat color. The SEPTA Project Manager to review and approve prior to application. Color to be determined by the SEPTA Project Manager.
3. Top coat shall be Sherwin-Williams B65W00611 –Acrolon 218 HS Plyurethane –Gloss (Part A) Extra White; Or Approved Equal. Color to be determined by the SEPTA Project Manager.

B. All Exposed Concrete Foundations at Steel Structure:

1. Intermediate coat shall be Sherwin-Williams B58W00401 –Macropoxy HS High Solids Epoxy White/Tint Base Part A White/Tint Base Part A; Or Approved Equal. Color to be determined by the SEPTA Project Manager.
2. Top coat shall be Sherwin-Williams B65W00611 –Acrolon 218 HS Polyurethane –Gloss (Part A) Extra White; Or Approved Equal. Color to be determined by the SEPTA Project Manager.

2.03 Rust Converter Products

A. Prior to encapsulation provide rust converter from the following manufacturers:

1. SEI Chemical CPT-298 Rust Converter Primer.
2. Corroseal Rust Converting Primer (CS100).
3. Or Approved Equal.

2.04 Encapsulation Products

A. The preferred method for addressing lead based paints will be encapsulation for all exterior conditions when determined by the SEPTA project manager that encapsulation of lead based paints in exterior locations is warranted.

1. LBC Lead Barrier Compound (5800 Antique Linen) and Lead Shield –Post Removal Lockdown (5475). www.fiberlock.com
2. LEAD Stop –Lead Encapsulating Compound by Dumond. www.dumondchemicals.com
3. Or Approved Equal with a twenty (20) year manufacturer warranty and meets or surpasses the ASTM E 1795 and all HUD and EPA requirements which define encapsulation as a permanent abatement method.

2.05 Cold Weather Products

A. The Contractor shall be permitted to submit cold weather painting product additives and/or painting systems that will match the basis of design painting systems but permit painting in colder weather.

2.06 Paint Drying Accelerators

A. The Contractor shall be permitted to submit paint additives that will speed up the drying of any of the coats of paint so long as the additives will not degrade the performance and/or appearance of the basis of design painting products.

PART 3 - EXECUTION

3.01 Examination

A. Work shall include the painting and finishing of all repaired surfaces of overhead steel structures. Replacement steel pieces to also be finished.

B. Surfaces shall be painted unless otherwise specifically indicated or herein specified to remain unfinished.

C. Do not paint operating parts of equipment and labels, unless otherwise indicated by the SEPTA Project Manager.

D. Verify suitability of substrates, including surface conditions and compatibility with existing finishes and primers.

E. Proceed with coating application only after unsatisfactory conditions have been corrected.

1. Beginning coating application constitutes the Contractor's acceptance of substrates and conditions.

3.02 Surface Preparation

A. General:

1. The Contractor shall examine all surfaces and parts of the structure to which top coatings are to be applied and shall not proceed with the work until unsatisfactory conditions have been corrected.

2. Do not paint over oil, dust, dirt, loose rust, grease, moisture, scuffed surfaces or conditions otherwise detrimental to the formation of a durable paint finish film.
3. Surface must be clean, dry and in sound condition. The Contractor shall remove all oil, dust, grease, dirt, loose rust and other foreign material to ensure adequate adhesion.
4. Surfaces shall be cleaned to SSPC Specifications. Prepare painted surfaces in strict accordance with the paint manufacturer's instructions as required to form a durable paint finish film. Where required, the Contractor shall remove existing coatings and/or provide barrier coatings.
5. Preparation and cleaning procedures shall be performed in strict accordance with the paint manufacturer's instructions and as herein specified, for each particular substrate condition.
6. Surface-applied protection shall be provided prior to surface preparation and painting operations, for all items not to be finished painted. Remove items if necessary for the completion of painting of items and adjacent surfaces.
7. Following completion of painting each space or area, the Contractor shall reinstall the removed items by workmen skilled in the trades involved.

B. Remove all grease, oil or other petroleum products from the surface with clean rags soaked in Mobil 7-T-12 or Xylol; Or Approved Equal; in accordance with SSPC-SP 1. Chemical contamination must be neutralized and/or flushed away.

C. Comply with the manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual" applicable to substrates indicated.

D. Remove hardware, covers, plates, and similar items already in place that are removable and are not to be painted. If removal is impractical or impossible because of size or weight of item, provide surface-applied protection before surface preparation and painting.

1. After completing painting operations, use workers skilled in the trades involved to reinstall items that were removed. Remove surface-applied protection.

E. Clean substrates of substances that could impair bond of coatings, including dust, dirt, oil, grease, and incompatible paints and encapsulants.

1. Remove incompatible primers and re-prime substrate with compatible primers or apply tie coat as required to produce coating systems indicated.

F. Remove rust, loose mill scale, and shop primer, if any, on steel substrates. Clean using methods recommended and approved by SEPTA in their document #3001 "MANAGEMENT OF LEAD PAINT ON SEPTA CONSTRUCTION PROJECTS in the Reference Documents and according to SSPC.

3.03 Material Preparation

A. Coating materials shall be mixed and prepared in strict accordance with the manufacturer's directions.

B. Materials not in actual use shall be stored in tightly covered containers. Maintain containers used in storage, mixing, and application of paint in clean condition, free of foreign materials and residue.

C. Mix materials in accordance with the manufacturer's directions for material conditions of each substrate, and/or subsequent coatings.

3.04 Material Application

A. All surfaces to be coated shall be clean, dry and free of all dust, dirt, oil, grease, loose paint, mill scale, old paint or other foreign matter.

B. Use applicators and techniques suited for coating and substrate indicated.

C. The manufacturer's product data sheets are to be followed for mixing, thinning, pot life, application procedure, equipment, coverage, curing, re-coating, dry film thickness and storage, and shall be considered a part of these Specifications and shall be followed.

D. Avoid degradation and contamination of the surfaces and avoid between coat contaminations. Surfaces contaminated shall be cleaned at the expense of the Contractor before supplying next coat. Method of cleaning contaminated surface shall be approved by SEPTA.

E. Each application of material shall be worked into corners, crevices, joints, etc. and distributed evenly over flat surfaces.

F. Painted surfaces shall be allowed to cure prior to allowing traffic or other work to proceed which might damage paint.

G. Scaffolding used for coating work will be:

1. Subject to approval of the SEPTA Project Manager. A plan is to be submitted to SEPTA for approval prior to erection.
2. Should not interfere with application of coating, damage coating previously applied or require brackets, etc. welded to any structure.
3. Such that easy and sufficient access is provided for correct coating and inspection of all surfaces.
4. Subject to direction of the SEPTA Project Manager to avoid interference with SEPTA operations.

H. An operative moisture trap shall be placed between air supply and pressure pot. Water will be continuously bled from moisture trap.

I. Regulators and gauges in good working order shall be provided on both air and material lines. Operating pressure in accordance with those indicated for the particular coating will be used.

J. Apply high performance coatings according to the manufacturer's written instructions and recommendations in "MPI Architectural Painting Specification Manual."

1. Use applicators and techniques suited for coating and substrate indicated.
2. Coat surfaces behind movable equipment and furniture same as similar exposed surfaces. Before final installation, coat surfaces behind permanently fixed equipment or furniture with prime coat only.
3. Coat back sides of access panels, removable or hinged covers, and similar hinged items to match exposed surfaces.

4. Do not apply coatings over labels of independent testing agencies or equipment name, identification, performance rating or nomenclature plates.

K. Apply coats until cured film has a uniform coating finish, color and appearance.

L. Apply coatings to produce surface films without cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness or other surface imperfections. Produce sharp glass lines and color breaks.

3.05 Inspection and Correction of Defects

A. Advisory:

1. The SEPTA Project Manager shall approve all surface preparation prior to the application of new coating.

2. Each coat will be examined prior to the application of the next coat. Areas that show overspray, roughness or other signs of improper application shall be repaired or re-coated in accordance with the manufacturer's recommendations.

3. The completed system shall produce a dry film thickness recommended by the manufacturer, and determine by the Microtest thickness gauge or comparable instrument available to satisfy the SEPTA Project Manager's request for testing. All structures painted will be tested for dry film thickness. Tests are to be performed by the Contractor at its sole expense, in the Presence of the SEPTA Project Manager. Written results of said test shall be submitted to SEPTA.

4. Spray-Applied primer shall not be applied closer than 6 inches to an area.

B. Correction of Defects:

1. The Contractor will be notified of unacceptable work as soon as possible so that correction maybe made.

2. Inadequate surface preparation and rejected painting shall be corrected as agreed upon by the SEPTA Project Manager and the Contractor at no extra cost to SEPTA.

3.06 Cleaning and Protection

A. At end of each workday, remove rubbish, empty cans, rags and other discarded materials from Project site.

B. "Wet Paint" signs shall be provided to protect newly coated finishes.

C. After completing coating application, clean spattered surfaces. Remove spattered coatings by washing, scraping or other methods. Do not scratch or damage adjacent finished surfaces.

D. Protect work of other trades against damage from coating operation. Correct damage by cleaning, repairing, replacing, and recoating, as approved by the SEPTA Project Manager, and leave in an undamaged condition.

E. At completion of construction activities of other trades, touch up and restore damaged or defaced coated surfaces.

3.07 Encapsulation Procedures

A. Apply professional lead encapsulates and sealants as per the manufacturer's written recommendations.

B. Provide 6 inch by 6 inch patch tests for all various site conditions and the "X" cut adhesion method to inspection of the adhesion.

END OF SECTION

SECTION 09965

GRAFFITI RESISTANT COATINGS

PART 1 - GENERAL

1.01 Description

A. Provide graffiti resistant coatings as shown and specified on the Contract Documents, including:

1. All concrete and masonry stone construction that is exposed up to a maximum height of 10 feet above grade, including walls and curbs. This includes all new concrete and masonry, as well as any existing concrete or masonry walls and curbs that are affected by the scope of work.

2. All structural steel members, supports, fasteners, etc. that are exposed up to a maximum of 10 feet above grade. This includes all new structural steel, as well as any existing steel that is affected by the scope of work.

B. Refer to Section 07190 for waterproofing sealer for brick.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01400 – Quality Requirements

C. Section 03300 – Cast-in-Place Concrete

D. Section 05120 – Structural Steel

E. Section 07190 – Water Repellents

F. Section 07620 – Sheet Metal Flashing and Trim

G. Section 09910 – Paints and Coatings

1.03 Submittals

A. Refer to Contract Terms and Provisions, Section 01300.

B. Submit samples if specifically requested.

C. Submit documentation from the paint system manufacturer on the manufacturer’s letterhead stating each paint system and corresponding graffiti resistant coating are compatible.

D. Submit the manufacturer's specifications, data and installation instructions for review.

E. Submit product list to cross reference coating system and locations of application areas. Use same designations indicated on the Contract Drawings and in schedules. Include color designations.

F. Submit the manufacturer's maintenance data instructions.

G. Submit the manufacturer’s standard warranty.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. American Society of Testing Materials (ASTM), materials and testing standards as identified throughout this Section.

B. The installer to be specialized in the work of this Section with documented experience installing coatings of similar size and scope.

C. Apply mockups on each type of substrate indicated and each finish selected to verify preliminary selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.

1. Provide samples of at least 100 square feet for vertical and horizontal surfaces.

2. SEPTA will designate other items or areas as required.

3. Final approval of coating will be based on mockups.

4. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless SEPTA specifically approves such deviations in writing.

5. Subject to compliance with requirements, approved mockups may become part of the completed work if undisturbed at time of Substantial Completion.

D. Graffiti resistant coating is required to be applied at all locations accessible to the public throughout the area of work that are within a minimum of 8 feet height of the finished floor. Graffiti resistant coating shall be applied to the full height and width of each substrate. If a portion of a masonry course is to receive graffiti resistant coating than the entire course shall receive the graffiti resistant coating.

1.05 Delivery, Storage and Handling

A. Schedule delivery of materials at the site at such time as required for proper coordination of the work. Receive materials in the manufacturer's unopened packages and bearing the manufacturer's label.

B. Store materials in a dry and well ventilated place, adequately protected from damage and exposure to the elements.

1. Maintain a minimum temperature of 45°F and a maximum temperature of 90°F.

2. Take necessary precautions to prevent fire; remove paint soiled rags and waste each day or store in metal containers with covers in the storage structure.

1.06 Warranty

A. Provide the manufacturer's standard warranty, in required form, for a period of one (1) year from date of final acceptance by SEPTA.

1.07 Extra Material

A. Deliver 1 percent or a minimum of one (1) full container of specified coating.

PART 2 - PRODUCTS

2.01 Materials

A. Graffiti resistant coating on vertical unpainted surfaces (except brick or wood):

1. Manufacturers:
   a. Sherwin Williams; 2K Waterbased Urethane Anti-Graffiti Coating, satin finish, one (1) coat.
   b. Environmental Coatings, Inc.; ECI-2700, Modified Two (2) Component Clear Aliphatic Urethane Enamel.
   c. Tnemec Co., Inc.
   d. Or Approved Equal.
2. Color to be clear.
3. The manufacturer's standard primer for surface to be treated.

B. Graffiti resistant coating on vertical painted surfaces (except wood):

1. Manufacturers:
   a. Sherwin Williams; 2K Waterbased Urethane Anti-Graffiti Coating, semi-gloss finish, one (1) coat.
   b. Ecological Coatings; EC-1851 Primer, one (1) coat.
   c. Ecological Coatings; EC-1852 Two (2) Component Water-Based Clear Gloss Graffiti Resistant Coating, one (1) coat.
   d. Or Approved Equal.
2. Approved equal product must dry clear with no milky or cloudy appearance and must be compatible with painted surface.
3. Color to be clear.

2.02 Mixing

A. Mix resin components and pigments per the manufacturers' instructions.

PART 3 - EXECUTION

3.01 Preparation

A. Do not apply when temperature is below 40°F.

B. Examine conditions of work in place before beginning work; report defects.

C. Protect adjacent surfaces not scheduled for graffiti resistant finish from damage resulting from coating operations.

D. Prepare surfaces in strict compliance with the manufacturer's instructions.

3.02 Installation

A. Install in conformance with referenced standards, the manufacturer's written directions, as shown, and as specified.

B. Apply minimum two (2) coats; allow adequate drying time between coats.

C. Dry film thickness to be a minimum of 1-2 mils per coat; minimum 3 mils for two (2) coat application.

3.03 Cleaning

A. Keep premises free from accumulation of waste and rubbish. At the completion of work remove surplus materials, rubbish and debris.

END OF SECTION

SECTION 10140

IDENTIFYING DEVICES

PART 1 - GENERAL

1.01 Description

A. Provide and install all identifying devices as indicated on the Contract Drawings and as specified herein, including, but not limited to, the following:

1. Aluminum signs.
2. Acrylic signs.

1.02 Related Sections:

A. Section 01300 – Submittals

B. Section 01400 – Quality Requirements

C. Section 05120 – Structural Steel

D. Section 05500 – Metal Fabrications

E. Section 07900 – Joint Sealers

F. Section 08800 – Glazing

1.03 References

A. All signage shall meet the current version of the SEPTA Standard Manual; the messages indicated on the Contract Drawings are illustrative in nature. The Contractor shall become familiar with full range of messages provided. Signage messages for each sign will be provided by SEPTA.

1.04 Submittals

A. Refer to Section 01300.

B. Submit a complete list of all materials proposed to be furnished and installed under this Section.

C. Submit shop drawings:

1. Provide detailed shop drawings including message layouts, fabrications, mounting, bracketing details, installation details and key plans for installation.
2. Provide a sign schedule including message copy for every sign, by sign number.
    a. Sign messages shall be cross referenced to the appropriate typical layout and the mounting details.
    b. Sign number, quantity, panel dimension, copy height, graphics, artwork, copy color, background color and mounting condition shall be noted for each sign.

3. Provide a colored line for each sign, after approval of shop drawings and prior to fabrication.
    a. Colored line shall be 1/2 inch size showing actual typography and actual colors.
    b. Colored line shall be exact replicas of sign layouts.
    c. Colored line shall be keyed to the approved sign schedule.
    d. Secure SEPTA approval prior to fabrication.

D. Submit samples:

1. Accompanying the material list, submit a sample of each sign material illustrating the actual finish obtained with complete graphics.
2. Submit sample basketry design for typical mounting surfaces wall, pendent, column, etc. (Refer to signage schedule for complete listing.) Also submit a panel sample with frame on two (2) sides for each proposed thickness combination.
3. Provide a production prototype for approval at the place of fabrication. The unit will be reviewed by SEPTA and corrections made. This unit will be used as a model for the line production and will be considered an actual unit to be placed on a site, not a mockup, if acceptable to SEPTA.

1.05 Quality Assurance

A. Refer to Section 01400.

B. Closely coordinate tolerances required in this Section for completely coordinated and smooth installation during the pre-installation conference.

C. For the fabrication of signage, use only mechanics that are thoroughly trained and experienced in skills required for the manufacture and fabrication of the units.

1. In acceptance or rejection of the manufactured units, no allowance will be made for lack of skill on the part of the fabricator/manufacturer.
2. The materials must be in full compliance with Contract Documents and approved shop drawings.

D. An interior sign plaque shall be installed adjacent to each new door. The final room description on each sign shall be determined by SEPTA. A list generated from room names noted on the Contract Drawings shall be submitted to SEPTA for review and comment.

E. Tolerances:

1. Sign Panels and Extrusions:
    a. The Contractor shall note on the shop drawings all fabrication tolerances including, but not limited to plumb, thickness, length, width, squareness, camber and flatness.
    b. Signs shall be free of defects including, but not limited to buckles, dents, warps, wrinkles and burrs.
    c. All extrusions for a given shape shall be fabricated from dies of identical cross section dimensions.
2. Messages:
    a. Message locations to be plus or minus 1/16 inch from the location shown on the Contract Drawings.

b. Line to line to be plus or minus 1/32 inch between each line and plus or minus 1/16 inch over the entire message. Letter to letter or symbol (horizontally and vertically) to be plus or minus 1/32 inch between each letter of symbol and plus or minus 1/16 inch over and entire line.

3. Where multiple panels adjoin, the face and edges shall be milled to a tolerance of a plus or minus 1/32 inch from a straight plane, so that when two (2) adjoining panels are assembled, no gap over 1/16 inch shall be visible between panels.

4. Design components to allow for expansion and contraction for temperatures ranging between minus 20°F and plus 100°F, without causing bucking, opening of joints other than control joints, or overstressing of welds and fasteners.

5. Meet AWS D1.2 for recommended practices in shop welding. Provide welds behind finished surfaces without distortion or discoloration of exposed side. Clean exposed welded joints of all welding flux and dress on all exposed and contact surfaces.

6. Mill joints to a tight, hairline fit. Cope or miter corner joints.

F. The unit must withstand a wind load of 20 lbs./sq. ft. and horizontal/vertical loads of 250 pounds at top center of the sign with a maximum deflection of 1/360 of sign length. Calculations are to be submitted for SEPTA review.

G. The Contractor shall have all mounting and fabrication details and calculations signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

H. Meet the applicable provisions of the most recent issues of the following references:

1. AA ASD-1, Aluminum Standards and Data.

2. AA DAF-45, Designation System for Aluminum Finishes.

3. ANSI A117.1, Accessible and Usable Building and Facilities.

4. ASTM B 209, Standard Specification for Aluminum and Aluminum Sheet and Plate.

5. ASTM B 211, Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire.

6. ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.

7. ASTM B 449, Standard Specification for Chromates on Aluminum.

8. ASTM D 790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.

9. ASTM D 1730, Standard Practices for Preparation of Aluminum and Aluminum-Alloy Surfaces for Painting.

10. AWS D1.2, Structural Welding Code – Aluminum.

11. FS FF-S-92, Screw, Machine, Slotted, Cross Recessed or Hexagon Head.

12. FS TT-P-645A, Primer, Paint, Zinc-Chromatic, Alkyd-Type.

13. MIL-A-21366, Adhesive; Rubber Neoprene.

14. National Association of Architectural Metal Manufactures (NAAMM)

15. SEPTA Signage Manual.

1.06 Delivery, Storage, and Handling

A. Use all means necessary to protect the signs prior to delivery. The pre-assembled units are to be shipped in protective crating and palletized. Each sign package is to bear the identification as noted on the sign schedule.

B. Each sign will come individually shrink-wrapped complete with its own bracketry and attachment hardware.

C. Replacements are SEPTA's sole discretion as to whether replacement or repair will be the procedure for damaged units.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Aluminum Signage:

1. Philadelphia Sign Company, Palmyra, New Jersey, Telephone 609-829-1460.
2. Sweet Sign Systems, Doylestown, Pennsylvania, Telephone 215-340-1600.
3. G.P. Dunphy Co., Ashford CT. (860) 429-2550.
4. Or Approved Equal.

B. Acrylic Signage:

1. East Coast Sign & Supply Inc., Bethel CT, Telephone 203-791-8326.
2. United Sign System, Staten Island, NY, Telephone 718-980-7097.
3. G.P. Dunphy Co., Ashford CT. (860) 429-2550.
4. Or Approved Equal.

2.02 Aluminum Signage Fabrication

A. Face and Back Sheets:

1. Double Sided Graphic Signs:
   a. Face sheets and back sheet to be fabricated in one (1) piece from minimum 0.040 inch thickness aluminum sheets, 3003 H14 alloy.
2. Single Sided Graphic Signs:
   a. Face sheets to be fabricated in one (1) piece 0.040 inch thickness. The back sheet shall be 0.040 inch minimum thickness, aluminum alloy sheet 3003 H14 with an alloy 1230 cladding of approximately 5 percent on both sides.

B. Each panel section shall be provided with an extruded internal perimeter framing and shall be aluminum alloy 6063-T6 with a minimum thickness of 0.080 inches. The perimeter frame shall have mitered corners, reinforced, welded and ground smooth. Intermediate supports shall be included as required.

C. Core material shall be 1 inch thick phenolic impregnated paper honeycomb. Core materials shall be resistant to fungus. The cell size shall be 1/2 inch, weight of Kraft Paper 80 pound; impregnation 18 percent by weight minimum.

D. Lamination shall be achieved by use of 3M Scotch Grip High Performance Contact Adhesive 1357, meeting specification requirements of MIL-A-21366.

E. Space bars shall be solid aluminum 3/4 inch by 2 inch length as required. All exposed surfaces to be primed with zinc chromate alkyd base primer. Provide two (2) finish coats of epoxy oil base paint. Color to be 100 percent black with low sheen finish.

F. Hardware:

1. All bolts and screws shall be made of stainless steel unless otherwise indicated.
2. Exposed fasteners on sign faces shall be not be permitted.
3. Exposed fasteners shall be made tamper proof by an approved method.
4. Hangers, studs, clip angles and filler plates shall be aluminum, mill finish, 6063 T6, unless otherwise indicated.
5. All welds shall be continuous and ground smooth, unless otherwise indicated.

G. Finish:

1. Pre-Treatment:
   a. The aluminum sheets are to be especially prepared for application by pretreatment meeting ASTM D 1730, Type B, Method 5 or 7. Processing shall meet ASTM B 449. Conversation coating weight shall be between 30-100 mgms per square foot.
2. Four (4) Coat System Equal to Kynar 500:
   a. Coating application shall be performed under specifications issued by the manufacturer and an applicator specifically approved by the manufacturer. Said applicator shall provide written notification of approval by the manufacturer to application of finish.
   b. Coating system shall include a primer coat; a background color coat; a graphic coat; a clear coat; with the total minimum dry film thickness to be 1.7 mils. Exposed cap extension shall be aluminum 6063 alloy and coated with system.

H. Mounting to be as specified on signage type detail drawings and per reviewed shop drawings for all signs.

1. Holes shall be pre-drilled in each corner of each sign by the manufacturer. Screws shall be tamper proof.
2. Each sign shall include a complete installation kit with stainless steel, non-removable/clutch head screws.

2.03 Acrylic Signage Fabrication

A. Provide cast methyl methacrylate monomer plastic sheet in sizes and thicknesses indicated on signage schedule.

1. Sheet material to be opaque and of the color indicated on signage schedule.

2. Colors:
    a. Standard colors such as “white,” “blue,” and “black,” shall be selected from the manufacturer’s standard colors.
    b. Where specific Pantone Matching System (PMS) color is specified on the signage schedule, the manufacturer will provide the custom matched color specified.
3. Sheet material to be 0.120 inch injection molded, high impact, UV resistant and surface textured with an eggshell matte finish of less than 15 degrees gloss.
4. Acrylic sheet material to have a minimum flexural strength of 16,000 psi when tested in accordance with ASTM D 790, a minimum allowable continuous service temperature of 176°F.
5. All graphics and text shall be centered on sign material. Graphics shall be separated from text with a visible graphic line.
6. Refer to the Contract Drawings for signage message information.

B. Hardware:
1. All bolts and screws shall be made of stainless steel unless otherwise indicated.
2. Exposed fasteners on sign faces shall be not be permitted.
3. Exposed fasteners shall be made tamper proof by an approved method.

C. Mounting to be as specified on signage type detail drawings and per reviewed shop drawings for all signs.
1. Holes shall be pre-drilled in each corner of each sign by the manufacturer. Screws shall be tamper proof.
2. Each sign shall include a complete installation kit with stainless steel, non-removable/clutch head screws.

2.04 Informational and Directional Signage

A. SEPTA Signage Manual for specific guidelines on sign layout basic sizes.

B. Sign sizes to be as specified on signage schedule.
1. Length to be dependent on sign message.
2. Depth to be 0.125 inch.
3. Height to be dependent on number of lines.

C. Character size to be as specified on signage schedule.

D. Character typeface to be Helvetica Bold.

E. Mounting to be as specified on signage type detail drawings and per reviewed shop drawings for all signs
1. Holes shall be pre-drilled in each corner of each sign by the manufacturer. Screws shall be tamper proof
2. Each sign shall include a complete installation kit with stainless steel, non-removable/clutch head screws.

2.05 Vinyl Graphic Window Film

A. Provide pressure sensitive vinyl graphic window film at all interior door glazing. Vinyl to be applied to the private side of glazing with image facing public side. Vinyl will cover all clear interior glass to provide complete privacy from corridor to interior SEPTA spaces.

B. Basis of design to be LS2700M by LG; Or Approved Equal.

C. Film to be minimum 3.2 mils opaque film with gloss finish.

D. Thickness to be 4.2 mils with adhesive.

E. Adhesive to be acrylic based pressure sensitive (solvent based).

F. Color to be clear.

G. Liner to be double side olefin coated paper.

H. Fabrication to be screen printed with sericol ink; Or Approved Equal.

PART 3 - EXECUTION

3.01 Pre-installation Meeting

A. A meeting with the SEPTA Project Manager is required prior any installation.

3.02 Inspection:

A. Install no work until surfaces on which signage and other work of this Section are to be placed and attached are free of defects and are in a completed condition.

3.03 Preparation

A. All surfaces to receive placement of work of this Section shall be clean and dry.

3.04 Installation

A. Install all signage and other work of this Section level and plumb. Secure to substrate in the manner as detailed on the Contract Drawings and as recommended by the manufacturer.

B. Refer to the Contract Drawings for mounting locations of signs.

C. Attach as detailed on the Contract Drawings.

3.05 Clean-up and Protection

A. General:

1. Clean all surface with suitable materials.
2. Remove all debris from work area.
3. Remove protective covers at Contract completion.

3.06 Sign Schedule

A. See sign schedule on the Contract Drawings.

END OF SECTION

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SECTION 10200

LOUVERS AND VENTS

PART 1 - GENERAL

1.01 Description

A. Requirements for fixed louvers in walls.

1.02 Related Sections

A. Section 04200 – Unit Masonry

B. Section 05120 – Structural Steel

C. Section 05500 – Metal Fabrications

D. Section 07620 – Sheet Metal Flashing and Trim

E. Section 07841 – Penetration Fire Stopping

F. Section 07842 – Joint Fire Stopping

G. Section 07900 – Joint Sealers

H. Section 09910 – Paints and Coatings

1.03 Submittals

A. Submit shop drawings showing material, finish, size of members, method of assembly, and installation and anchorage details. Show plans, elevations, sections, details, field measurements (if applicable), reinforcement, anchorages, attachment to other work and expansion provisions.

1. Show frame profiles and blade profiles, angles and spacing.

2. Show weep paths, gaskets, flashing, sealant and other means of preventing water intrusion.

3. Show mullion profiles and locations.

B. Submit fabrication and installation details for metal louvers.

1. Copies of the manufacturer's catalog cuts, specifications, load tables, dimension diagrams, anchor details, setting diagrams and templates, and the manufacturer's printed installation instructions, including paint products.

2. Installed products indicated to meet the performance requirements and design criteria, including analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

C. Submit samples for verification of finishes for each type and color of finish, submit 12 inch long sections of extrusions or formed sections and 6 inch square sheets. Submit at least two (2) pieces for each color showing full range of color variations.

D. Submit printed louver catalog pages showing specified models with appropriate AMCA Certified Ratings Seals.

E. Submit product test reports based on evaluation of comprehensive tests performed according to AMCA 500-L by a qualified testing agency or by the manufacturer and witnessed by a qualified testing agency, for each type of louver and showing compliance with performance requirements specified.

F. Submit windborne debris impact resistance test reports.

1.04 Quality Assurance

A. A company designing, manufacturing and installing products of this Section which have performed in a satisfactory manner under comparable conditions.

B. Where louver performance requirements are specified, determine compliance in accordance with AMCA Standard 500.

C. Design louvers to safely withstand dead load and live loads prescribed by governing building code.

D. Meet the applicable provisions of the most recent issues of the following references:

1. AAMA 511, Forensic Water Intrusion Testing.
2. AAMA 611, Voluntary Specification for Anodized Architectural Aluminum.
3. AMCA 500-L, Laboratory Methods of Testing Louvers for Rating.
4. AMCA 501, Application Manual for Air Louvers.
5. ASCE/SEI 7, Minimum Design Loads for Buildings and Other Structures.
6. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
7. ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
8. ASTM E 1886, Standard Test Method for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Missile(s) and Exposed to Cyclic Pressure Differentials.
9. ASTM E 1996, Standard Specification for Performance of Exterior Windows, Curtain Walls, Doors, and Impact Protective Systems Impacted by Windborne Debris and Hurricanes.
10. AWS D1.2, Structural Welding Code - Aluminum.
11. AWS D1.3, Structural Welding Code - Sheet Steel.
12. AWS D1.6, Structural Welding Code - Stainless Steel.
13. International Building Code (IBC).
14. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.05 Delivery, Storage and Handling

A. Package so that products will not be damaged during shipping or storage.

B. Clearly label each package of contents. Label shall be on two (2) ends and one (1) face. Contents shall be labeled and coordinated with installation drawings.

C. Store and handle louvers, hardware and appurtenant items in strict compliance with the manufacturers' instructions.

D. Protect units adequately against damage from the elements, construction activities and other hazards before, during and after construction.

E. Ship items to SEPTA's location as described in the purchase requisition.

1.06 Definitions

A. Definitions of terms for metal louvers contained in AMCA 501 apply to this Section unless otherwise defined in this Section or in referenced standards.

B. Horizontal Louver is a louver with horizontal blades (i.e., the axes of the blades are horizontal).

C. Vertical Louver is a louver with vertical blades (i.e., the axes of the blades are vertical).

D. Drainable Blade Louver is a louver with blades having gutters that collect water and drain it to channels in jambs and mullions, which carry it to bottom of the unit and away from the opening.

E. Wind Driven Rain Resistant Louver is a louver that provides specified wind-driven rain performance, as determined by testing according to AMCA 500-L.

1.07 Performance Requirements

A. Design louvers, including comprehensive engineering analysis by a Professional Engineer licensed in the Commonwealth of Pennsylvania, using structural requirements and design criteria indicated.

B. Louvers shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated without permanent deformation of louver components, noise or metal fatigue caused by louver blade rattle or flutter, or permanent damage to fasteners and anchors. Wind pressures shall be considered to act normal to the face of the building.

1. Determine wind loads based on pressures as indicated on the Contract Drawings.

2. Determine wind loads based on a uniform pressure of 20 lbf/square feet acting inward or outward.

C. Louvers located within 30 feet of grade shall pass basic protection, large missile testing requirements in ASTM E 1996 for Wind Zone 2 when tested according to ASTM E 1886. Test specimens shall be no smaller in width and length than louvers indicated for use on the Contract.

D. Louvers, including attachments to other construction, shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

E. Provide louvers meeting the requirements specified, as demonstrated by the testing manufacturer's stock units identical to those provided, except for length and width according to AMCA 500-L.

F. Allow for thermal movements from ambient and surface temperature changes.

1. Temperature change (range) is 120°F, ambient; 180°F, material surfaces.

G. Meet the recommendations in SMACNA's "Architectural Sheet Metal Manual" for fabrication, construction details and installation procedures.

1.08 Field Conditions

A. Verify actual dimensions of openings by field measurements before fabrication.

1.09 Warranty

A. Upon completion of the work and as a condition of its acceptance, deliver to SEPTA two (2) copies of the following "Warranty and Maintenance Agreement", signed by the manufacturer and the installer of the work of this Section.

1. Upon execution of this document by SEPTA, the undersigned hereby propose and agree, for a period of two (2) years after Substantial Completion of the work, to make immediate repairs as required to stop leaks or correct defects in the work of this Section. Said repairs shall be made within twenty-four (24) hours of the receipt of a notice from SEPTA by telephone, telegram or letter. The undersigned further agree to make such repairs without reference to or consideration of the cause or nature of such leaks or defects.

2. The manufacturer shall warrant for a period of two (2) years that the wall system, including louvers and copings, materials and their finishes will be free from defects. The Contractor shall warrant for a period of two (2) years that the installation workmanship will be free from defects in materials and installation.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Obtain louvers from single source from a single manufacturer where indicated to be of same type, design or factory applied finish.

B. Products of the following manufacturers, provided they meet the requirements of the Contract Documents, will be among those considered acceptable:

1. Exterior extruded aluminum louvers:
   a. Arrow United Industries.
   b. Pottorf PCI Industries.
   c. Ruskin Manufacturing Division/Tomkins Industries, Inc.
   d. Or Approved Equal.

2.02 Horizontal, Drainable Blade Louver

A. Coordinate depth with wall thickness.

B. Frame and blade nominal thickness to be not less than 0.080 inch.

C. Mullion type to be exposed.

D. Mark units with AMCA Certified Ratings Seal.

2.03 Materials

A. Aluminum:

1. Aluminum extrusions to meet ASTM B 221, Alloy 6063 T6.
2. Aluminum sheet to meet ASTM B 209, Alloy 5005 with temper as required for forming, or as otherwise recommended by the metal producer for required finish.

B. Fasteners to be of same basic metal and alloy as fastened metal or 316 stainless steel, unless otherwise indicated. Do not use metals that are corrosive or incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.
2. Concealed fasteners shall be used to the greatest extent possible. Where used, exposed fasteners must be tamper proof.
3. Finish exposed to view fastener heads to match adjacent surface.

C. Bituminous paint to be cold applied asphalt mastic to meet SSPC-Paint 12 except containing no asbestos fibers.

D. Anchors and Inserts:

1. Refer to Section 05120 and Section 05500.
2. Type, size and material required for type of loading and installation indicated. Use nonferrous metal or hot dip galvanized anchors and inserts for exterior installations and elsewhere as required for corrosion resistance. Use toothed steel or expansion bolt devices for drilled-in-place anchors.

E. Finish

1. Clear anodic finish to meet AAMA 611, AA-M12C22A41, Class I, 0.018 mm or thicker.

2.04 Fabrication

A. Factory assemble louvers to minimize field splicing and assembly. Disassemble units as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Maintain equal louver blade spacing, including separation between blades and frames at head and sill, to produce uniform appearance.

C. Head, sill and jamb sections shall have formed caulking slots to retain caulking. Head sections shall have exterior drip lip, sill sections and integral water stops. Furnish louvers with sill extension.

1. Provide clearance or recesses as required to accommodate sealant between louver and adjacent construction.

D. Fabricate louver system to withstand the effects of loads and stresses from wind and normal thermal movement without experiencing permanent deformation of components including blades, frames and supports; noise or metal fatigue caused by blade rattle or flutter; or permanent damage to fasteners and anchors.

E. Louvers shall be equipped with bird screens and made to withstand a wind load of not less than 30 PSF. Mount screens in removable, rewireable frames of same material and finish as the louvers.

F. Wall louvers shall bear the AMCA certified ratings program seal for air performance and water penetration in accordance with AMCA 500 and AMCA 511. The rating shall show a water penetration of 0.20 ounces or less per square foot of free area at a free velocity of 800 feet per minute.

G. The louver system shall accommodate various performance criteria including pressure drop requirements, CFM requirements, static pressure drop, water infiltration, free area, and intake/exhaust velocities, etc. while maintaining a consistent exterior architectural line appearance. Louver blade spacing at all elevations shall be consistent regardless of these varying performance criteria. Provide louver profiles as indicated or where shown on the Contract Drawings.

H. Provide shop welded joints between framing components, and between framing components and fixed louver blades, unless otherwise indicated or where field assembly is unavoidable.

PART 3 - EXECUTION

3.01 Examination

A. Verify that substrates and openings to receive louvers are rigidly set, at proper lines and elevation, properly sized and ready to receive louvers.

B. Do not proceed with installation until conditions detrimental to proper installation have been corrected.

C. If substrate preparation is the responsibility of another installer, notify the SEPTA Project Manager of unsatisfactory preparation before proceeding.

3.02 Preparation

A. Coat contact surfaces of dissimilar metals with one (1) or more coats of bituminous paint.

1. Aluminum, stainless steel and zinc are not considered dissimilar metals.

B. Apply one (1) 15 mil dry film thickness coat of bituminous isolation coating to metal surfaces, other than galvanized steel, which will be in contact with cementitious materials.

3.03 Installation

A. Locate and place louver units plumb, level and at indicated alignment with adjacent work.

B. Use concealed anchorages where possible. Provide brass or lead washers fitted to screws where required to protect metal surfaces and to make a weather tight connection.

C. Form closely fitted joints with exposed connections accurately located and secured.

D. Provide perimeter reveals and openings of uniform width for sealants and joint fillers.

E. Provide suitable means of anchorage acceptable to the manufacturer such as dowels, anchor clips, bar anchors, expansion bolts and shields, and toggles.

F. Anchor supports securely with allowance for necessary thermal movement and structural support.

G. Erect metalwork square, plumb, straight and true, accurately fitted, with tight joints and intersections.

H. Repair finishes damaged by cutting, welding, soldering and grinding operations required for fitting and jointing. Restore finishes so there is no evidence of corrective work. Return items that cannot be refinished in the field to the shop, make required alterations, and refinish entire unit, or provide new units.

I. Protect galvanized and nonferrous metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry or dissimilar metals.

J. Install concealed gaskets, flashings, joint fillers and insulation, as louver installation progresses, to make louver joints weather tight.

3.04 Adjusting and Cleaning

A. Clean exposed louver surfaces that are not protected by temporary covering, to remove fingerprints and soil during construction period. Do not let soil accumulate during construction period.

B. Remove protective material from pre-finished surfaces immediately after installation.

C. Wash exposed surfaces using mild detergent; thoroughly clean inside corners. Thoroughly rinse surfaces and dry.

D. Remove excess sealant by moderate use of mineral spirits or other solvent recommended by the sealant manufacturer.

E. Touch up marred or abraded areas of finished elements. If satisfactory touch-up cannot be accomplished, remove and replace element.

END OF SECTION

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SECTION 10520

FIRE PROTECTION SPECIALTIES

PART 1 - GENERAL

1.01 Description

A. This Section covers furnishing and installing the fire extinguishers in the Traction Power Substation (TPSS) building.

B. The Contractor to analyze the risks and regulations, then provide a layout of fire extinguishers to be approved by the SEPTA Project Manager and the Authority Having Jurisdiction (AHJ).

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 16010 - Basic Electrical Requirements

1.03 Submittals

A. Submit shop drawings and product data under provisions of Section 01300.

B. Submit layout plans for proposed fire extinguishers, and after plan review by the SEPTA Project Manager, submit the approved plan to the AHJ for approval. Submit to SEPTA the AHJ decision(s) and final approved plans.

C. Submit product data for fire extinguisher operational features, color and finish, extinguisher cabinets, and operational details.

D. Submit maintenance data including test, refill, or recharge schedules and re-certification requirements.

E. Submit certification of suitability for the application and recommended clean up procedures after using around medium and low voltage electrical equipment and electronic assemblies.

F. Submit to the SEPTA Project Manager each AHJ on-site inspection report that covers fire extinguisher installation review by the AHJ.

1.04 Quality Assurance

A. Provide fire extinguishers by a single manufacturer.

B. Provide the manufacturer's certification that products meet or exceed specified requirements.

C. Meet the applicable provisions of the most recent issues of the following references:

1. NFPA 10, Portable Fire Extinguishers.

2. UL 711, Fire Extinguishers, Rating and Fire Testing.

1.05 Delivery, Storage and Handling

A. Deliver products to Project site in the manufacturer's sealed, undamaged containers and packages.

1.06 Environmental Requirements

A. Do not install fire extinguishers when ambient temperature may cause freezing of extinguisher ingredients.

B. This Section includes the following:

1. Nonstructural steel framing.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Subject to compliance with specified requirements, submit products of one (1) of the following manufacturers:

1. J.L. Industries.
2. Larsen's Manufacturing Company.
3. Potter-Roehmer, Division of Smith Industries, Inc.
4. Or Approved Equal.

B. Products referenced in this Section are products of J.L. Industries and are intended to establish types, materials and quality of fire extinguishers and cabinets. Approved equivalent products of manufacturers listed herein may be used.

2.02 Fire Extinguishers

A. Multi-purpose dry chemical, 10 pound capacity to be Cosmic 10E, steel tank with pressure gauge, UL rating 4A-60BC, nominal capacity 10 pounds.

2.03 Accessories

A. Brackets to be the manufacturer's standard brackets for 10 pound and 20 pound tanks.

B. The appropriate cabinet mounting hardware for the cabinet.

PART 3 - EXECUTION

3.01 Installation

A. Install fire extinguisher cabinets in locations and at heights as indicated in the approved shop drawings.

B. Install fire extinguisher cabinets plumb, level and secured rigidly in place.

C. Check fire extinguishers for proper charge operation.

3.02 Protection

A. Provide protection for installed fire extinguishers and cabinets and maintain fire extinguishers and cabinets in satisfactory operating condition to time of final acceptance. Remove and replace all damaged, defective or under charged units at no additional cost to SEPTA.

END OF SECTION

THIS PAGE NOT USED

SECTION 10800

TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.01 Description

A. This Section includes:

1. Washroom accessories.
2. Underlavatory guards.
3. Custodial accessories.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications Sections, apply to this Section.

B. Section 05500 - Metal Fabrications

1.03 Submittals

A. Submit product data for each type of product indicated. Include the following:

1. Construction details and dimensions.
2. Anchoring and mounting requirements, including requirements for cutouts in other work and substrate preparation.
3. Material and finish descriptions.
4. Features that will be included for the Contract.
5. Manufacturer's warranty.

B. Submit product schedule indicating types, quantities, sizes and installation locations by room of each accessory required.

1. Identify products using designations indicated on the Contract Drawings.

C. Submit maintenance data for toilet and bath accessories to include in maintenance manuals.

1.04 Quality Assurance

A. For products listed together in the same Part 2 in this Section, provide products of same manufacturer unless otherwise approved by SEPTA.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

3. ASTM A 666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
4. ASTM A 1008/A 1008M, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
5. ASTM B 16/B 16M, Standard Specification for Free-Cutting Brass Rod, Bar and Shapes for Use in Screw Machines.
6. ASTM B 19, Standard Specification for Cartridge Brass Sheet, Strip, Plate, Bar and Disks.
7. ASTM B 30, Standard Specification for Copper Alloys in Ingot Form.
8. ASTM C 1503, Standard Specification for Silvered Flat Glass Mirror.
9. ASTM F 446, Standard Consumer Safety Specification for Grab Bars and Accessories Installed in the Bathing Area.

1.05 Coordination

A. Coordinate accessory locations with other work to prevent interference with clearances required for access by people with disabilities, and for proper installation, adjustment, operation, cleaning and servicing of accessories.

B. Deliver inserts and anchoring devices set into concrete or masonry as required to prevent delaying the work.

PART 2 - PRODUCTS

2.01 Materials

A. Stainless steel to meet ASTM A 666, Type 304, 0.0312 inch minimum nominal thickness, unless otherwise indicated.

B. Brass to meet ASTM B 19 flat products; ASTM B 16/B 16M, rods, shapes, forgings and flat products with finished edges; or ASTM B 30, castings.

C. Steel sheet to meet ASTM A 1008/A 1008M, Designation CS (cold rolled, commercial steel), 0.0359 inch minimum nominal thickness.

D. Galvanized steel sheet to meet ASTM A 653/A 653M, with G60 hot dip zinc coating.

E. Galvanized steel mounting devices to meet ASTM A 153/A 153M, hot dip galvanized after fabrication.

F. Fasteners to be screws, bolts and other devices of same material as accessory unit and tamper and theft resistant where exposed, and of galvanized steel where concealed.

G. Mirrors to meet ASTM C 1503, mirror glazing quality, clear glass mirrors, nominal 0.23622 inches thick.

2.02 Public Use Washroom Accessories

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. General Accessory Manufacturing Co. (GAMCO).
6. Or Approved Equal.

B. Toilet Tissue (Roll) Dispenser:
1. Roll-in-reserve dispenser with hinged front secured with tumbler lockset.
2. Surface mounted.
3. Non-control delivery with theft resistant spindle.
4. Designed for 4 1/2 inch or 5 inch diameter tissue rolls.
5. Stainless steel, No. 4 finish (satin).
6. Lockset to be tumbler type.

C. Paper Towel (Roll) Dispenser:
1. Lever-less mechanism pull towel mechanism dispenses 12 inch towel lengths.
2. Surface mounted.
3. Minimum capacity to be 8 inch wide, 800 foot long roll.
4. Stainless steel, No. 4 finish (satin).
5. Lockset to be tumbler type.

D. Waste Receptacle:
1. Surface mounted.
2. Minimum capacity to be 6.4 gallon.
3. Stainless steel, No. 4 finish (satin).
4. Reusable vinyl liner.
5. Lockset to be tumbler type.

E. Liquid Soap Dispenser:
1. Designed for dispensing soap in liquid or lotion form.
2. Vertically oriented, surface mounted.
3. Capacity to be 40 fl-oz.
4. Stainless steel, No. 4 finish (satin).
5. Lockset to be tumbler type.
6. Refill indicator to be window type.

F. Mirror Unit:

1. Frame to be stainless steel channel.
   a. Corners to be the manufacturer's standard.
2. Hangers to produce rigid, tamper and theft resistant installation, using method indicated below.
   a. Wall bracket of galvanized steel equipped with concealed locking devices requiring a special tool to remove.
3. Size as indicated on the Contract Drawings.

2.03 Underlavatory Guards

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Plumberex Specialty Products, Inc.
2. TCI Products.
3. Truebro, Inc.
4. Or Approved Equal.

B. Underlavatory Guard:

1. Insulating pipe covering for supply and drain piping assemblies that prevent direct contact with and burns from piping and allow service access without removing coverings.
2. Antimicrobial, molded plastic, white finish.

2.04 Custodial Accessories

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. A & J Washroom Accessories, Inc.
2. American Specialties, Inc.
3. Bobrick Washroom Equipment, Inc.
4. Bradley Corporation.
5. General Accessory Manufacturing Co. (GAMCO).
6. Or Approved Equal.

B. Utility Shelf:

1. With exposed edges turned down not less than 1/2 inch and supported by two (2) triangular brackets welded to shelf underside.
2. Size to be 16 inches long by 6 inches deep.
3. Not less than nominal 0.05 inch thick stainless steel, No. 4 finish (satin).

C. Mop and Broom Holder:

1. Unit with shelf, hooks, holders and rod suspended beneath shelf.
2. Length to be 36 inches.
3. Three (3) hooks.
4. Four (4), spring loaded, rubber hat, cam type mop/broom holders.
5. Stainless steel, No. 4 finish (satin).
   a. Shelf to be not less than nominal 0.05 inch thick stainless steel.
   b. Rod to be approximately 1/4 inch diameter stainless steel.

2.05 Fabrication

A. Fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with full length, continuous hinges. Equip units for concealed anchorage and with corrosion resistant backing plates.

B. Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six (6) keys to the SEPTA Project Manager.

PART 3 - EXECUTION

3.01 Installation

A. Install accessories according to the manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by the unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

B. Install grab bars to withstand a downward load of at least 250 pounds, when tested according to method in ASTM F 446.

3.02 Adjusting and Cleaning

A. Adjust accessories for unencumbered, smooth operation. Replace damaged or defective items.

B. Remove temporary labels and protective coatings.

C. Clean and polish exposed surfaces according to the manufacturer's written recommendations.

END OF SECTION

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SECTION 13700

INTRUSION ALARM SYSTEM

PART 1 - GENERAL

1.01 Description

A. This Section covers the furnishing, installing and testing of an intrusion alarm system in the existing Traction Power Substation (TPSS) building.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01810 – Commissioning of Systems

C. Section 16950 – Testing

1.03 Submittals

A. The Contractor shall submit the following in accordance with Section 01300.

1. The Contractor shall submit wiring diagrams, data sheets, equipment ratings, layout, dimensions and finishes. Equipment submissions must include a minimum of the following:
    a. Complete descriptive data indicating UL listing for all system components.
    b. Copy of the device compatibility listing with the system product specification sheets.
    c. Drawings indicating the location of each device.
    d. Complete sequence of operations of the system.
    e. Complete system wiring diagrams for components capable of being connected to the system and interfaces to associated equipment.
    f. Zone and/or point listing.
2. Submit user training course outline and copy of all instruction documentation.
3. Submit Operational and Maintenance Data:
    a. Submit to SEPTA three (3) sets: Full size, PDF and AutoCad 2023. The drawings shall include the location of all devices, appliances, wiring sequences, wiring methods and connections of the system components. Devices shall also indicate the device address or zone as applicable. These drawings shall show the locations of raceways and the number and color codes of the conductors installed in the raceway.
    b. Submit to SEPTA three (3) sets of the zone and/or point listing.
    c. Submit to SEPTA a parts list for all components of the system.
    d. Submit to SEPTA four (4) sets (all originals, no copies) of the operating and installation manuals for all system equipment.
    e. Submit to SEPTA two (2) copies of the database used to program (for listing, changes, general reprogramming, etc.) the site data. This database shall become the property of SEPTA.
    f. Submit to SEPTA two (2) copies of the program record that records the system programming information.

1.04 Quality Assurance

A. Products for and the execution of, the work of this Section shall satisfy the applicable requirements of the National Electrical Code, Regulations of Jurisdictional Authorities and the Occupational Safety and Health Act. Products shall satisfy the applicable requirements of ANSI, ASTM, IEEE, NEMA and UL.

B. Meet the applicable provisions of the most recent issues of the following references:

1. NFPA 70, National Electrical Code (NEC).
2. UL Mercantile Burglary Listings, local grade A, police connect grade A, grade AA, central station grade B.
3. UL 634, Standard for Connectors and Switches for Use with Burglar-Alarm Systems.

1.05 Design Requirements

A. Prior to installation, the Contractor shall obtain approval from SEPTA for the exact system that will be installed. This request for approval shall include product specification sheets and programming sequence of operation.

B. All equipment shall be approved by Underwriters Laboratories, Inc. for its intended purpose. All intrusion alarm equipment shall be listed for its intended purpose and compatibility listed to assure the integrity of the complete system.

1.06 Qualifications

A. The manufacturer shall be a company specializing in intrusion detection and alarm systems with sufficient previous experience to successfully manufacture the products indicated.

B. The installer shall be a company specializing in intrusion detection and alarm systems with sufficient previous experience to conduct satisfactorily the installation indicated.

1.07 Maintenance Service and Extra Material

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to SEPTA. Provide one (1) per Contract unless otherwise noted.

1. Four (4) sets of all keys to all control panels for each TPSS.
2. One (1) fully operational control panel and keypad.
3. Hardware for one (1) fully operational door.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Intrusion Panel Manufacturer:

1. Ademco (Honeywell), Model Vista 128BPT.
2. Or Approved Equal.

B. Keypad Manufacturer:

1. Ademco (Honeywell), Vista 6160.
2. Or Approved Equal.

C. Door Contact Manufacturer:

1. Honeywell, Model # 968XTP.
2. Or Approved Equal.

D. Motion Sensor Manufacturer:

1. Honeywell, Model DT8050.
2. Or Approved Equal.

E. Battery Manufacturer:

1. Power Sonic.
2. Or Approved Equal.

F. Wire Manufacturer:

1. Honeywell Genesis Series Cable.
2. Or Approved Equal.

2.02 Control Panel

A. Features:

1. Eight (8) Zone Electrically Erasable Programmable Read-Only Memory (EEPROM) control/communicator expandable to seventy-two (72) zones.
2. Commercial burglary panel.
3. Supervision of dual telephone lines and bell output.
4. Eight (8) zone hardwire capability.
5. Partitioning (up to eight (8) separate subsystems).
6. Sixty-four (64) user codes with seven (7) authorization levels.
7. Keypad and remote programming.
8. Remote uploading/downloading and remote commands.
9. System log retains past one hundred and twenty-eight (128) events with option to automatically transmit log to remote or local printer.
10. Fuse-less design to eliminate unnecessary service calls.
11. Sheet metal enclosure with lock.
12. Status and alarm report through SEPTA approved Supervisory Control and Data Acquisition (SCADA) system.

B. Programming:

1. Programmable locally through Liquid Crystal Display (LCD) keypads or remotely through PC downloading software.

2. Default lockout option to prevent hostile account takeovers.
3. Option to inhibit keypad programming.
4. Local programming secured through installer code.
5. EEPROM memory retains programmable features and current status.
6. Factory default characteristics that simplify installation.

C. Zones:

1. Eight (8) fully programmable End of Line (EOL) supervised hardwired zones on circuit board.
2. Expansion through plug in module:
   a. Eight (8) zone hardwire expander.
3. Zone programming flexibility including type and reporting characteristics.
4. Four (4) programmable keypad emergency conditions.
5. Programmable sixteen (16) character descriptors for each of the sixteen (16) zones.
6. Selectable sixteen (16) alarm types and eight (8) trouble types.
7. Programmable SCADA reporting and restore codes by zone.
8. Key switch capability through any zone.
9. Chime option by zone.
10. Pulse count option by zone.
11. Commands to view zone descriptions on LCD keypad.
12. Zone grouping capability that allows creation of groups within each partition for the purpose of bypassing and alarm transmission.

D. System Features:

1. Programmable dialer and bell lockout feature.
2. Accurate real time clock, time programmable by the installer or the authorized user.
3. Flexible system test function with programmable frequency (twelve (12) hours, twenty-four (24) hour or weekly transmission) and selectable time of day.
4. Two (2) programmable entry/exit delay times.
5. Status and alarm reports through SEPTA approved SCADA system.
6. Sounder ring back and bell test at arming options.
7. Auto-unbypass option.

E. Partitions:

1. Eight (8) partitions (subpanels) per control panel.
2. Zones and keypads are assigned to the desired partition.
3. User’s codes can be assigned to multiple partitions.

4. Partition descriptor, sixteen (16) characters, uniquely identifies each subsystem.
5. Multi-partition feature allows secure operation of the system through any keypad by authorized users.
6. Arm or disarm all partitions through a single keypad by the authorized user.
7. Authorized users can alter partition assignments through the keypad.

F. User Codes:

1. Sixty-four (64) user codes, with seven (7) authorization levels.
2. Four (4) digit or seven (7) digit user codes, system-wide option.
3. Programmable open/close Identification Number (ID's) for each user.
4. Programmable partition access by user, access to partitions.
5. Option to transmit Optical Carrier (O/C) signals by user by partition.
6. Ambush code capability.
7. Arm or disarm all partitions through any keypad by authorized users.
8. Quick arm, bypass, forced arming commands available.
9. Arm only user code.
10. Trigger outputs (eight (8) voltage level triggers).

G. SCADA System Communications:

1. Transmission to two (2) separate Customer Service (CS) telephone numbers.
2. Three (3) or four (4) digit account numbers.
3. Transmission formats include 10PPS, 20PPS, 40PPS 4x2, FBI Superfast, BFSK, ADEMCO express and point ID formats.
4. Pulse, touch tone or adaptive dialing (tone backed up by pulse).
5. Dial tone detection option.
6. The installer options for each of the remote command capabilities.

H. Keypads:

1. Up to eight (8) LCD keypads per system.
2. Backlit keypads.

I. Power Specifications:

1. Special watchdog circuitry ensures integrity of microprocessor.
2. Battery backup with battery charger shall be provided within Intrusion Detection System (IDS) enclosure.
3. Battery shall be sized for twenty-four (24) hours.
4. Twenty-four (24) hour battery load test and continuous low battery monitoring.

5. Total control auxiliary power to be 12 V DC, regulated at 900 mA.
6. Keypad current to be 250 mA, maximum. Smoke current to be 150 mA maximum.
7. Auxiliary current to be 500 mA maximum if keypad and smoke power is used, or 900 mA maximum if keypad and smoke power is not used.
8. Alarm power to be 12 V DC, regulated at 2 A.

J. Remote Commands:

1. Answering Machine Detection (AMD) for secure communications with the alarm company without interruption to the premise telephone.
2. Programmable callback scheme prevents unauthorized access.
3. Remote downloading and uploading from the alarm company location.
4. Interactive programming sessions permit control panel to remain on-line with the downloading computer during remote communications.
5. Remotely arm, disarm, bypass, read system status and device control.

K. System Log:

1. Panel retains activity log (one hundred and twenty-eight (128) events max).
2. System log viewable locally at LCD keypad or from the alarm company.
3. Programmable transfer of system activity to a remote or local printer, automatically on either a daily, weekly or monthly basis.

L. Auxiliary Contacts:

1. One (1) form-C alarm relay rated for a minimum of 5 A at 28 V DC.
2. One (1) form-C trouble relay rated for a minimum of 5 A at 28 V DC.

M. Listings:

1. UL mercantile burglary listings to be local grade A, police connect grade A, grade AA, central station grade B.

2.03 Keypads

A. Zones to be determined by control panel.

B. Type to be an LCD.

C. Mounting to be surface or partial recess.

D. Two (2) line by sixteen (16) character display for English zone descriptors and system status indications.

E. Large supertwist backlit LCD display provides wide viewing angle and exceptional readability.

F. Dedicated function keys to minimize keystrokes.

G. Four (4) wire installation.

2.04 Motion Detectors

A. Features:

1. Selectable sensitivity.
2. Look down zone.
3. Sabotage resistant lens design.
4. Tamper switch.
5. White light immunity.
6. Temperature compensation.
7. Switchable range.

B. Optimum Catch Performance:

1. Provide adjustable sensitivity to match installation requirements, using a look down mirror provides for optimum detection pattern directly beneath the sensor. Provide a wide Fresnel lens for improved catch performance in a range of applications.
2. Provide temperature compensation to allow for no loss of sensitivity as room temperature approaches body temperature.

C. False Alarm Reduction:

1. The Fresnel lens allows optimum performance while reducing false alarms. Provide a carbon filled black bug guard to increase white light immunity.
2. Provide controls so the installers can adjust the sensitivity of the sensor to suit the environment; a "standard" setting for general security applications and a "harsh" setting for tough applications, such as rooms with many windows.

D. Sabotage Resistant Design:

1. Provide a lens that wraps around a retainer, making it more stable and difficult to sabotage. Provide a sealed tamper switch that signals before any enclosure access is possible.

E. Mounting Flexibility:

1. Provide a unit that easily mounts on walls or in corners for a full range of coverage.

F. Approvals/Listings:

1. UL Listed.

G. Power Requirements:

1. Current consumption to be 20 mA at 12 V DC.
2. Tamper switch to be rated 25 mA at 24 V DC.
3. Voltage operating range to be 10-14 V DC.

H. Alarm Relay:

1. Form A (normally closed) to be rated 100 mA at 24 V DC.

I. LED Enable:

1. Enabled by cutting a jumper wire.

J. Operating Temperature:

1. 32°F to 120°F.

K. Optics:

1. Wide Fresnel lenses.
2. Look down mirror/lens.

L. Passive Infrared Reader (PIR) Fields of View:

1. Long range to be twenty-two (22).
2. Intermediate to be six (6).
3. Lower to be three (3).
4. Look down to be (2).

M. Ranges:

1. 50 feet by 70 feet.
2. 32 feet by 50 feet.

N. PIR Sensitivity:

1. Jumper selectable (standard and harsh).

O. Radio Frequency (RF) Immunity:

1. 20 V/m at 10-1000 MHz.

P. White Light Immunity:

1. 3,500 lux.

2.05 Door Contacts

A. High Security:

1. Provide high security magnetic contacts with triple-biased reeds that are highly resistant to defeat by external magnets.
2. Provide magnetic field tamper and pry tamper features.
3. Provide contact and actuation magnet sets that have been factory compensated for the effects of steel.
4. Form-C contact.
5. Voltage to be 30 V AC/DC maximum.
6. Current to be 0.25 A maximum.
7. Power to be 3.0 W maximum.
8. To meet UL 634.

9. 3 foot stainless steel armored cable.
10. Manufacturers:
    a. Sentrol 2700 Series.
    b. Or Approved Equal.

2.06 Siren/Strobe

A. Indoor/Outdoor Self-Contained Armored Siren/Strobe Combination:

1. Indoor/outdoor, self-contained, 15 watt armored siren, consisting of a single tone that delivers a warble sound output, light weight rust proof aluminum die-cast housing, a 122dB output siren driver and dual action normally open reed plunger switch for normally closed loop.
2. Strobe to be 60,000 candlepower strobe with lens color of amber.

2.07 Intrusion Alarm Wire and Cable

A. Wire and cable shall be type and gauge recommended by the intrusion alarm equipment manufacturer.

B. All conductors shall be stranded.

C. Use No. 18 AWG minimum size conductors for alarm detection conductors.

D. Use No. 14 AWG minimum size conductors for signal circuit conductors.

PART 3 - EXECUTION

3.01 Installation

A. Installation shall be in accordance with the NFPA 70, local and state codes, as shown on the Contract Drawings, and as recommended by the major equipment manufacturer.

B. All wire and cable shall be installed in conduit, minimum size is 3/4 inch.

C. Provide all device back boxes, junction boxes, pull boxes or enclosures, other fittings and any other devices to accommodate the wiring system.

D. Wires shall be tagged at junction points and shall test free from grounds or crosses between conductors.

E. Wiring shall be color coded.

F. The wiring system shall be through-wired to the equipment. Pigtail type connections are not permitted.

G. Conductor shall be home run installed without splices.

H. Terminals within cabinets shall be properly labeled.

I. Final connections between control equipment and the wiring system shall be made under direct supervision of a representative of the equipment manufacturer.

J. Final connections to the SCADA/ Remote Terminal Unit (RTU) shall be made under direct supervision of a representative of the SCADA/RTU equipment manufacturer and SEPTA substations SCADA/RTU personnel.

K. Provide complete identification/labeling of all intrusion alarm devices and related components. Conduit (every 25 feet) and conduit boxes shall be identified by affixing waterproof and permanent decal with the words “SECURITY”. Conduits and boxes for power, communications, alarm, etc. for the intrusion alarm system shall be similarly identified. All devices shall be neatly, clearly, and permanently marked as to zone or point number.

L. Stamp or mark the date of installation on each battery.

M. Program control panel and other programmable devices and equipment. SEPTA shall receive an intrusion signal and the Audible Visual (A/V) strobe shall activate during the following scenarios. The system will report to SEPTA via the SCADA/RTU connection. The intrusion panel shall be programmed to provide the SCADA/RTU independent and discrete output signals and activate the horn/strobe devices, for each partition, upon the following alarm conditions:

1. If a door contact is broken and the code requirement is not fulfilled at the keypad within sixty (60) seconds.
2. If a motion detector is activated while the system is in alarm mode.

N. In addition, program the control panel and other programmable devices and equipment to provide the SCADA/RTU independent and discrete signals, for each partition, upon the following alarm conditions.

1. Arm.
2. Disarm.
3. Alarm.
4. Trouble.

O. Furnish and install, next to the control panel, a mounted frame with Plexiglas that is weatherproof, lockable and capable of posting changes. The frame shall contain an easily removable visual site plan that depicts the Contractor supplied “as-built” drawings. Further, the frame shall contain the Contractor supplied operator instructions for applicable basic system operations, including alarm acknowledgement, system reset and interpreting system output, such as LED's and displays.

3.02 Field Quality Control

A. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the intrusion alarm equipment to technically supervise and participate in all of the adjustments and tests for the system.

B. Consult Section 16950 for requirements for field inspection and testing of intrusion alarm systems.

C. At the final inspection, demonstrate that the systems function properly in every respect.

3.03 Demonstration

A. Provide the service of a competent, factory trained engineer or technician authorized by the intrusion system manufacturer to perform system demonstration.

B. Provide instruction in the form of a formalized training course to the building personnel and security personnel. "Hands-on" demonstrations of the operation of the system shall be provided. The demonstration shall include a walking tour of the intrusion alarm system, briefly identifying and describing location, function, operation and maintenance of each item.

C. Provide one on one instruction for up to eight (8) students to individually qualify them in the system operation, fifteen (15) minutes dedicated per student.

END OF SECTION

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SECTION 13850

FIRE ALARM AND DETECTION SYSTEM

PART 1 - GENERAL

1.01 Description

A. The Contractor shall design and install a completely functional Fire Alarm System, in full compliance with all codes, regulations, SEPTA Standards, FM Global requirements and guidance as stated in this scope of work and shown on contract drawings. The Contractor is responsible to apply for and obtain all required permits.

B. The existing Fire Alarm System shall remain in service, until the new system has been accepted by SEPTA 3rd party Fire Alarm Maintenance & Monitoring Company (currently JCI/TycoIS). Any modifications to the existing system required due to construction activity must be approved by SEPTA's Fire Systems Manager.

C. The Contractor shall utilize SEPTA's 3rd party Fire Alarm Maintenance & Monitoring Company (currently JCI/TycoIS) for all fire alarm equipment and devices for this project.

D. The Contractor is responsible for running temporary wires for the existing fire alarm system as required to keep the fire alarm system functioning normally and code compliant to support construction activity by the GC & MC.

E. The Fire Alarm System shall include, but not be limited to, control panel, power supply, remote power supplies, alarm initiating and notification devices, connections to supplementary systems, conduit, wire, and accessories to provide a complete and fully operational system.

F. The contractor shall install duct detectors as needed. It is the contractors responsible to determine the necessity of HVAC and /or make-up air handler shutdown requirements as dictated by local and national code agencies.

G. The contactor must provide an independent power supply for each duct detector. Power cannot be taken from the air handling unit.

H. The contractor shall provide an emergency shutdown for all high voltage generation equipment. The equipment must be de-energized with all alarms. A fire alarm monitored by-pass switch must be installed at the fire alarm control panel.

I. The Contractor shall install a monitored fire alarm by-pass switch adjacent the fire alarm control panel. This bypass switch shall disable the gate release relay via the Securitron panel to prevent the Pass Gates, Fare Line Gates & Turnstiles Gates from releasing. A Trouble signal must be set to the FACP when switch is activated.

J. The Contractor must install all State of Pennsylvania elevator code required fire alarm interfaces. Coordination with the elevator contractor is essential. Any additions to the design to provide a state approved, code compliant elevator shall be done at the Fire Alarm Contractors expense.

K. The Fire Alarm System shall be an addressable system. The Silent Knight 6820XL or SEPTA approved equal is required.

L. Each addressable point shall be programmed to transmit its individual address (Point ID) back to the Central Monitoring Station. If multiple SLC loops are utilized each device address cannot be duplicated. (e.g., cannot have 97:004 & 4:004 device addresses).

M. All Fire Alarm System components shall be non-proprietary. The alarm equipment must be readily available for purchase, installation, and service, by any reputable contractor regularly engaged in the fire alarm installation and service business. Additionally, the equipment must be capable of being readily monitored, without losing type alarm (fire, supervisory, and trouble) and specific zone or point, by any non-proprietary receiver. Further, replacement parts and system training must be readily available at a reasonable cost to whoever maintains the alarm equipment for SEPTA. This may include SEPTA personnel or a third-party contractor.

N. The Fire Alarm contractor shall specify, for SEPTA approval, the specific Fire Alarm System components that will be used in the design. The contractor is expected to ensure high quality in all components of the system that is specified.

O. The Fire alarm system must be "turn-key" to SEPTA. This includes complete operation and communication to SEPTA's Power Dispatcher.

P. The Fire Alarm System shall meet all the current fire alarm code requirements at the facility.

Q. SEPTA may require additional fire alarm devices above and beyond current NFPA, local codes and regulations.

R. Fire Alarm devices shown on the bid documents represent SEPTA's minimum requirements. The Contractor must design and install a code compliant system.

S. The Contractor must submit a sealed set of fire alarm shop drawings for SEPTA's review and approval prior to starting construction on any portion of the fire alarm system.

1.02 Codes and Standards

A. The Fire Alarm System and installation shall comply with all current relevant codes and government regulations.

B. The Fire Alarm System and installation shall comply with all current National Fire Protection Association (NFPA) Codes. In all cases, the Fire Alarm System and Installation shall comply with NFPA 70, National Electrical Code; NFPA 72, National Fire Alarm Code; NFPA 101 Life Safety Code, and NFPA 170 Standard for Fire Safety and Emergency Symbols.

C. The Fire Alarm System and installation shall comply with all relevant Local, State, and International Code Council Codes adopted by the Local Authority Having Jurisdiction.

D. The Fire Alarm System and installation shall comply with all requirements of the Local Authority Having Jurisdiction. Within SEPTA, the Authority Having Jurisdiction is jointly shared between SEPTA Fire Systems Manager and SEPTA Fire Marshal.

E. In all cases, the Fire Alarm system must be installed in accordance with the most stringent applicable code, regulation, and SEPTA standards.

F. The fire alarm system and all components shall be listed by Underwriters Laboratories, Inc. and Factory Mutual for use in Fire Protection Systems.

G. Any element of the fire alarm system that is not designed according to code must be addressed through a request for variance with the Local Authority Having Jurisdiction. A

variance is the responsibility of the Fire Alarm Designer and requires the written approval of SEPTA Project Manager and the SEPTA Fire Marshal. A copy of the variance, approved by the local Authority Having Jurisdiction must be submitted to SEPTA Fire Systems Manager upon acceptance.

1.03 Environmental Conditions

A. The Fire Detection and Alarm System shall be capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. System components shall be rated for continuous operation in ambient temperatures of 32 to 120 degrees F and 20 to 90 percent relative humidity, non-condensing.
2. System components installed in unconditioned spaces, exposed to weather, or on above ground platform levels shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 degrees F and 20 to 100 percent relative humidity, condensing, and shall also be rated for continuous operation when exposed to rain as specified in NEMA 250, wind up to 85 mph and snow cover up to 24 inches thick.
3. System components shall function between 150 feet below and 250 feet above sea level.

1.04 Fire Detection and Alarm System Performance

A. Signaling Line Circuits (SLC)

1. SLC's shall be wired to meet the Style 4 performance.
2. T-Tapping is permitted with limitations. (T-Tapping shall occur at a final device and not in mid-stream of any circuit)
3. Splicing of the cable is not permitted.
4. All wire connections shall be under a screw (no wire nuts).
5. A maximum of 2 wires under a single screw are allowed.
6. The zoning of the Fire Detection and Alarm System shall be configured as described in the specification in later sections.

B. Notification Appliance Circuits

1. Notification Appliance shall be wired to meet the Style Y performance.
2. T-Tapping is **not** permitted.
3. Splicing of the cable is not permitted.
4. All wire connections shall be under a screw.
5. No more than 2 wires are allowed under a single screw.
6. End of line resistor compatible with the FACP is required for supervision.
7. Notification Devices circuits shall be run alternately throughout the location to provide balanced notification in the event a circuit is compromised.

C. UL Central Station Monitoring Circuits

1. UL Central Station Monitoring Circuits shall be wired to meet the Style C performance.

D. Sprinkler systems shall be monitored by the main FACP for water flow, tamper valve and low air pressure if applicable.

E. Control interface devices such as equipment shutdown, smoke evacuation fans, etc. shall be shown on the “As-Builts” to include a description of the action.

1.05 Submittals

A. Submit manufacturers' catalog cut sheets, compatibility listings, and other descriptive information (prior to purchasing equipment) to provide SEPTA sufficient detail in determining compliance with this Specification for **every** installed component, including but not limited to:

1. Manual Pull Stations
2. Weatherproof Protective Manual Pull Shield
3. Notification Appliances (i.e., Horn/Strobes)
4. All Initiating Devices, including supplementary system device monitor modules.
5. Output Relays
6. Fire Alarm Control Panel
7. Remote Annunciator Panel
8. Rechargeable Batteries
9. Wire & Cables
10. Wire, Device and Back box Labels
11. Conduit and Hangers
12. Conduit & Device Back box Attachment Methods
13. NEMA 4X cabinet for sprinkler and annunciator
14. Document Cabinet
15. Cellular Communicator

B. Shop Drawing for Fire Alarm System

1. A sealed and code compliant Fire Alarm Shop drawings shall be submitted to SEPTA concurrently when the drawings are submitted to City L&I for permitting.
2. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
3. Include plans, elevations, sections, details, and attachments to other work.
4. All rooms must be labeled and numbered with their function.
5. The proposed devices numbering system must be depicted on the drawing. Detection Devices should list SLC-Device Number (97-003, 04-019). Notification Devices should indicate Power Booster-Circuit -Device Number (B1-C2-D4, CP-01-D6 EOL).

6. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
7. Detail assembly and support requirements.
8. Include voltage drop calculations for notification-appliance circuits.
9. Include ampere-hour calculations for system operation by battery.
10. Include input/output matrix.
11. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
12. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
13. Include performance parameters and installation details for each detector.
14. Provide program report showing that air-sampling detector pipe layout balances pneumatically within the airflow range of the air-sampling detector.
15. Include plans, sections, and elevations of heating, ventilating, and air conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.
    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' control system.
    d. Show field wiring and equipment required for HVAC unit shutdown on alarm and override by firefighters' smoke-evacuation system.
    e. Locate detectors according to manufacturer's written recommendations.
    f. Show air-sampling detector pipe routing.
16. Single-line Riser diagram showing **ALL** equipment & devices, all connections and number and size of all conductors and conduits. All equipment & devices shall indicate the proposed device address.
17. Riser diagram shall show a cross section indicating floor levels.
18. Include floor plans to indicate final device locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams showing the percentage of allowable National Electric Code fill used.
19. Any/All the systems that will connect to the Fire Alarm System must be graphically depicted on the Fire Alarm drawings and wiring diagrams. A detailed circuit schematic diagram showing how each device and equipment is wired will be required.
20. Submit detail for any supplemental and/or auxiliary shutdown circuits.
21. Include proposed Zone List for every fire alarm device.

C. Fire Alarm System Manual

1. The Fire Alarm System Manual shall be compiled and developed for use by SEPTA location personnel and technicians (SEPTA or 3rd Party Contractor) during operation and maintenance activities over the useful life of the system.
2. The Fire Alarm System Manual shall be a three-ring binder that is labeled with the SEPTA property name and the make and model of the Fire Alarm System.
3. Individual sheets of the Fire Alarm System Manual must be typed (unless the manufacturer prints them) and should be protected by top-loading, heavyweight, clear sheet protectors.
4. The Fire Alarm System Manual shall be indexed and include the following:
    a. **INDEX A – SYSTEM DESCRIPTION:** A detailed narrative description of the system inputs, evacuation signaling, ancillary functions, annunciation, sequence of operations, expansion capability, application considerations, and limitations.
    b. **INDEX B – OPERATING INSTRUCTIONS:** Operating instructions for basic system operations, including alarm acknowledgement, silence alarm, silence trouble signals, silence a supervisory signal, system reset, interpretation of applicable system output (LED's, CRT display, and printout, operation of controls and functions, and change of printer paper (if applicable).
    c. **INDEX C – FACP MANUAL:** Operating and Installation Manual.
    d. **INDEX D – INSTALLED COMPONENTS:** Catalog cut sheets for every installed component.
    e. **INDEX E – MAINTENANCE:** A detailed description of routine maintenance and testing as required and recommended to include testing and maintenance instructions for each type of device installed. This information should include the following:
        1) Listing of the individual system components that require periodic testing and maintenance.
        2) Step-by-step instructions detailing the requisite testing and maintenance procedures and the intervals at which these procedures shall be performed, for each type of device installed.
    f. **INDEX F – TROUBLESHOOTING:** Detailed troubleshooting instructions for each trouble condition generated from the monitored field wiring, including opens, grounds, and loop failures. These instructions should include a list of all trouble signals annunciated by the system, a description of the condition(s) that cause such trouble signals, and step-by-step instructions describing how to isolate such problems and correct them. The instructions should focus on guiding technicians in identifying the sources of problems in specific subsystems and in locating, replacing, and testing specific modular components.
    g. INDEX G - CERTIFICATIONS: Include the following:
        1) Record of Completion
        2) Record of Fire Alarm Inspection
        3) L&I Certification Sealed
        4) Electrical Inspection Certification
        5) UL certificates or FM placards
        6) Fire Alarm permit submittal and approval by the Local AHJ
        7) Microsoft Excel versions of the fire alarm system zone list with descriptions
    h. **INDEX H – FACP PROGRAM:** A print out of the entire Silent Knight fire alarm program and final SEPTA approved Zone List (Zone descriptions shall be reviewed and approved by the SEPTA Fire Systems Manager only).

i. **INDEX I – AS-BUILTS:** As-Built Drawings of the entire fire alarm system. Including the As-Built **Point-to-Point** wiring diagram of the entire installation both input and output device circuiting.

j. **INDEX J – DIGITAL FILES:** The following items shall be placed on a CD:

1) As-Built Drawings in ACAD & PDF formats.

2) Copy of the fire alarm system program

3) Copy of all documents listed above.

5. Submit one set of preliminary versions of the Fire Alarm System Manual for approval by SEPTA Fire Systems Manager. Following approval of the Fire Alarm System Maintenance Manual, four sets of the manual shall be provided at acceptance.

1.06 Quality Assurance

A. Qualifications

1. The Contractor shall provide a qualified and experienced person in the installation, inspection, and testing of fire alarm systems who shall supervise installation personnel. Examples of qualified personnel shall include, but not be limited to, the following:

a. Factory trained and certified personnel.

b. National Institute of Certification in Engineering Technologies (NICET) fire alarm level II certified personnel.

c. Personnel licensed or certified by a state or local authority.

2. The Contractor shall examine the design specifications and drawings in detail and take responsibility to complete the installation and ensure that all system performance requirements are met.

B. Quality of Materials

1. All the Fire Alarm System materials shall meet the following requirements:

a. All materials and equipment supplied by the Contractor shall be new and meet or exceed the latest published specifications of the equipment manufacturer.

b. All products must be listed for the specific fire alarm system application for which they are used.

c. Underwriter's Laboratories, Inc. and Factory Mutual shall approve all equipment for its intended purpose and compatibility.

d. The Contractor shall certify that the proposed Fire Alarm equipment shall comply completely with all the Fire Alarm Code requirements of this Contract.

e. All Fire Alarm equipment suppliers shall be authorized dealer/distributors of the major equipment components supplied and certification of such shall be provided to the SEPTA Project Manager.

1.07 Warranty

A. All major Fire Alarm equipment shall be installed, adjusted, and serviced by authorized representatives of the equipment manufacturers.

B. The Contractor shall warrant the entire system and each of the individual components of the system. All system components warranty must be for a minimum of one (1) year. The warranty shall require the Contractor to provide all equipment, material, and labor at no charge to SEPTA during the warranty period.

C. All manufacturers' warranties shall be in SEPTA's name. If the Contractor modifies any equipment to void any manufacturer's warranty, the Contractor shall provide a warranty equivalent to that of the original manufacturer's warranty.

D. The Contractor shall provide, a maximum, **two-hour response time** for service calls during the warranty period.

E. The warranty period starts the day when the SEPTA 3rd Party Fire Alarm Maintenance, Monitoring and Inspection Company has accepted the fire alarm system installation to their central monitoring station for monitoring.

F. SEPTA reserves the right to have their 3rd party fire alarm maintenance contractor make repairs and to replace parts they deem defective. The Contractor shall reimburse SEPTA for any parts replaced. Work perform by the 3rd party fire alarm maintenance contractor shall not affect the warranty provided under this contract.

1.08 Training

A. The Fire Alarm contractor shall provide formal training to SEPTA employees and contractor personnel on the operations and points of the system. The contractor shall coordinate with the SEPTA Project Manager for a list of the specific groups that shall attend the training. The training shall be completed prior to acceptance.

B. The training must consist of two sessions of four hours each to allow attendance by different groups. The sessions shall begin in a classroom setting and be followed by an on site walk through and demonstration of the system and its restoral from alarm activation. A roster of intended attendees shall be provided by the Project Manager

C. The training must include identification of activated initiating devices and corrective action to restore the system. These actions include the clearing of smoke detectors, reset of manual pull stations, and activation of supplementary systems. The training must also include proper response to all the control panel and annunciator indicators.

1.09 Duty To Inform Employees Of Conditions

A. The contractor shall thoroughly instruct and has the responsibility to fully inform all his/her workers and agents of the fact that they are working and adjacent to active rail service tracks and high voltage.

B. The contractors' employees, and their supervisor, who work on the job site must attend all SEPTA's Roadway Worker Track Safety Classes (not required if workers already have current certifications, 8 hours class time for an initial certification, 4 hours class time if a renewal).

1.10 Clearances

A. The contractor must conduct all his operations in connection with this contract so that no part of his equipment (to include ladders) may foul an operating track, electrical transmission line, or communication lines or damage any others.

1.11 Workmanship

A. The contractor shall supply all necessary tools, equipment, and material required for the accomplishment of this contract.

B. Competent personnel under the supervision and employment of the contractor shall perform all work. The contractor, and all parties employed on the work, shall perform their work in a good and workmanlike manner. The contractor must furnish labor, which can work in harmony with all other elements of labor employed or to be employed by the Authority.

C. The contractor must remove and dispose of all trash from the installation.

D. Contractor shall clean up any construction related debris on the job site upon completion of the individual task that generated the debris.

E. Work area must be cleaned of all work debris at the end of each workday.

1.12 Accidents Or Incidents

A. Any accidents or incidents occurring to the contractor's employees while performing work for this contract on SEPTA premises must be immediately reported to SEPTA's Project Manager or his designee. A follow-up written report must be submitted to the Project Manager or his designee within 24 hours of the accident or incident.

1.13 Visit To Job Site

A. It is the bidder's responsibility to familiarize himself/herself with the existing conditions of the location. The acceptance of this bid shall presuppose the bidder's entire familiarity with the conditions, and no extra cost will be allowed due to the bidder having failed to visit the sites and / or noting the conditions affecting the work.

1.14 Scheduling

A. Access to the work area must be coordinated with SEPTA's Project Manager; normally 48 hours minimum notice is required.

B. Existing Fire Alarm System Equipment:

1. Contractor shall maintain existing equipment fully operational until new equipment is installed.

2. Label all new equipment “NOT IN SERVICE” until accepted and placed in service.

C. When contractor requires access to high voltage areas, the deenergizing of power must be coordinated with the Project Manager a minimum of 48 hours in advance.

D. Work in any electrical Sub-Station area will require accompaniment by a SEPTA Electrical Sub-Stations employee and must be coordinated with the Facilities Manager a minimum of 48 hours in advance. All safety protocols required by SEPTA’s electrical department must be observed. Including wearing SEPTA approved PPE and FR clothing at all times.

E. Location management may require work to be performed during specific hour to avoid interfering with the daily operation of the shop. This could include 2nd and 3rd shifts as well as weekends.

1.15 Construction Inspection

A. The Contractor shall allow SEPTA’s Fire Systems Manager to inspect the entire fire alarm installation prior to the Contractor installing any devices or covering any junction boxes or

condulets. All conduit and junction box covers should have the appropriate “Fire Alarm System” decals installed and all wires must be installed and labeled.

B. Splices found during the inspection must be removed and wire replaced at no cost to SEPTA.

C. Violations of installation specifications will require a re-inspection prior to the contractor continuing work.

1.16 Non-Performance By Contractor

A. If the contractor fails to perform services in accordance with contract requirements. SEPTA shall obtain those services through other means including the use of internal resources or issuing a contract or purchase order to another contractor for the service.

B. Additionally, SEPTA’s increased cost to have the services performed by another means will be deducted from the contractor’s invoice.

1.17 Project Conditions

A. Perform a full test on the existing fire alarm system prior to starting work. Document equipment or components not functioning as designed.

B. The existing system must not be modified without approval from SEPTA Fire Systems Manager.

C. The existing system must be always kept in service. Any trouble found on the fire alarm system because of work performed by the contractor shall be repaired at the contractor’s expense within 4 hours.

PART 2 - PRODUCTS

2.01 Fire Alarm Control Panel

A. The Fire Alarm System shall be a Silent Knight 6820XL or SEPTA approved equal.

B. The main control panel shall be surface mounted and installed where indicated on drawings.

C. The control panel shall include a communication device for monitoring that is programmable by any reputable contractor regularly engaged in the Fire Alarm installation, maintenance, and monitoring business.

D. FACP shall include four (4) Silent Knight Model 5815XL Loop Expanders or SEPTA approved equal.

E. The fire alarm panel shall utilize a substantially large panel to control the system. Spare points, equal to 25% of the total points of each SLC Loop, must be provided.

F. The four (4) SLC loops shall be thoughtfully divided through the building (floor, platforms, mezzanine). SEPTA’s Fire Systems Manager must approve SLC distribution prior to construction.

G. The control must be a 24-volt system.

H. The control panel must allow for a minimum of three (3) sets of outputs (separate from the connection to the monitoring center) that will allow secondary monitoring (for general Fire, Trouble & Supervisory only) by SEPTA’s Power Dispatcher.

I. The control panel shall have a distinct tone for alarm, trouble, and supervisory conditions.

J. Control panel shall be field programmable.

K. All programmed device point descriptions must be approved by SEPTA Fire Systems Manager.

L. Database (site specific software) is the property of SEPTA. Passwords shall NOT be placed on the panel software to restrict access to SEPTA for future modifications.

M. Contractor shall provide 120 Volt power to the new fire alarm system main panel and any other panel or devices as required to complete the system. (NOTE: The 120 Volt power connected to the existing fire alarm system may be re-used to power the new fire alarm panel.)

N. Contractor shall provide conduit and wiring back to the designated communications room.

O. The FACP shall not have any penetration through the top of the cabinet

2.02 Remote Power Module

A. If a remote power module is required, it shall be a Silent Knight 5895XL or SEPTA approved equal of the same manufacturer as the Main FACP as specified in section 2.01.

B. The power module must have 6.0 amps of output power, Flexput I/O circuits rated 3.0 amps each, and two Form C relay contacts rated at 2.5 amps at 24 VDC. The power module shall connect to the main FACP via an RS-485 system bus (SBUS). The power module shall contain an additional RS-485 bus that is completely compatible with all add-on modules, including SLC's expander's, remote annunciators, and serial/parallel printer interface modules.

C. The power module RS-485 bus shall be optically isolated providing ground loop isolation and transient protection. The unit shall be an SBUS repeater that conditions the signal driving up to 6,000 feet of additional wiring.

2.03 Initiating Circuit Expander

A. The Contractor shall install four (4) SLC Expander Card (Silent Knight 5815XL or SEPTA approved equal) must be of the same manufacturer as the main FACP as specified in section 2.01.

B. Each must allow the addition of 127 addressable devices to the main FACP

C. The signaling circuit card must have the same functionality as the SLC that is built into the main FACP and support the same addressable devices as the main panel.

D. The SLC Expander Card must connect to the panel via the RS 485 bus and is housed in the remote power supply cabinet.

E. The SLC Expander Card cannot reside in its own separate cabinet.

2.04 Remote Annunciator

A. Remote annunciators shall be installed for the fire alarm system at locations shown on drawings. The exact locations shall be determined after award of the contract by the Project Manager.

B. FAAP shall be a Silent Knight Model SK-5860R or SEPTA approved equivalent.

C. FAAP shall be UL Listed and FM Approved with the main FACP.

D. FAAP shall indicate FACP Fire, Trouble and Supervisory alarm status.

E. FAAP shall control the FACP Acknowledge, Silence and Reset functions.

F. FAAP shall be surface mounted using matching manufacturer approved back box and trim ring.

G. FAAP shall be protected by a NEMA 4X Cabinet with a hinged door or SEPTA approved equivalent.

2.05 Battery Backup And Panel

A. The system must have a backup battery system. Power-Sonic Sealed Batteries or SEPTA approved equivalent. The battery back-up power supply shall be capable of operating the system under normal load for a period of at least twenty-four (24) hours followed immediately by a period of five minutes in alarm condition. Battery charger shall be capable of recharging the batteries in a 48-hour period as required by NFPA 72.

B. The notification appliance circuits shall be installed to ensure full functioning of appliances under all permissible voltage conditions for the fire alarm control panel. In other words, appliances must function at 27 VDC, 24VDC, and even as low as 20.4 VDC (control panel low battery condition as defined by UL).

C. Backup batteries must be of the type that only requires annual charger and discharge tests as required by NFPA 72.

D. The backup batteries must be in a cabinet separate from the alarm control panel. The panel should be located below or to the side of the alarm control panel. The panel shall be painted red and locked with a cabinet type CAT30 lock system.

E. The backup batteries shall be marked with the month and year of manufacture. Batteries shall be no more than 6 months old at time of acceptance testing.

2.06 Manual Pull Stations

A. Fire alarm pull stations shall be Silent Knight Model SD-500PSDA with a PS-SMBB back box or SEPTA approved equivalent.

B. Fire alarm pull stations shall be dual-action and ADA Compliant.

C. Pull stations shall be mounted at be mounted at ADA compliant height of 48 inches from the finished floor height to the center of activation handle.

D. Fire alarm pull stations shall be equipped with a CAT30 system lock prior to installation. NOTE: Contractor shall provide and install the CAT30 lock cylinders. Fire alarm pull stations that require glass breakage or that have crushable tubes to activate are not acceptable.

E. **All** Fire alarm manual pull stations installed shall be provided with a clear protective weatherproof vandal resistant removable shield with gaskets at all penetrations.

F. Protective shield shall be a Signal Communications Corp (SigCom) Sentry Station Cover (ST-series model), or SEPTA approved equivalent. The covers shall be fully compliant with all applicable ADA requirements (ADA; 28 CFR Part 36).

G. Protective shield shall not be equipped with a pre-alarm sounder that indicates cover removal.

H. Pull station final mounting locations shall be determined in the field with concurrence from SEPTA Fire Systems Manager. Unless a pull station final location has been agreed to with SEPTA Fire Systems Manager it can be subject to relocation at no cost to SEPTA.

I. If the installation is in an area that requires an explosion proof system, the installation shall be in accordance with NFPA 69. Explosion Proof Manual Pull Station shall be Wheel-Lock Model MPS-400X or SEPTA approved equivalent.

2.07 Detectors

A. Detectors shall be installed so that they can be safely and easily accessible by ladder or lift.

B. Detectors shall not be installed in locations that make it difficult or impossible to comply with periodic inspection and cleaning requirements. This requires careful consideration of space for ladder or lift movement, positioning, and installation. Use of an extension ladder requires a safe anchor point for the ladder. Further, pipes, air vents, ducts, etc. should be considered for their impact on Fire Alarm Device accessibility. Detectors in stairways should be positioned to allow safe access by ladder. The provision for accessibility may require additional detectors, such as in a small room where duct work is placed in the center of the room.

C. Where a ladder or lift will not be feasible, the design must include an installed ladder, platform, catwalk, or other method of accessing the detector.

D. Detectors shall be installed in information and/or communication equipment rooms, mechanical rooms, electrical rooms and within the vicinity of any electrical transformer equipment, electrical vacuum switches, or other high voltage electrical equipment. In general, detectors should be placed over the aisles in areas containing this type of equipment.

E. In all cases, the selection and mounting location of detectors shall be influenced by the ease of maintenance to include sensitivity testing.

F. Smoke detectors shall be Silent Knight Model SD505-PHOTO or SEPTA approved equivalent.

G. The selection and placement of smoke detectors shall consider both the performance characteristics of the detector and the areas into which the detectors are to be installed to prevent nuisance alarms or improper operation after installation. The Contractor shall consult with SEPTA Fire Systems Manager regarding any potentially questionable device locations.

H. The smoke detectors shall be provided with dust covers, which could be used as temporary covers when workmen are working in an area. These covers must be turned over to SEPTA Fire Systems Manager upon turnover of the system.

I. Smoke detectors shall have a visual indicator to indicate the status of the detector.

J. Heat detectors shall be Silent Knight Model SD505-HEAT or SEPTA approved equivalent.

K. Heat detectors used in unconditioned spaces, subject to wash-down, in elevator lobbies for recall, and elevator shafts shall be Edwards 302-ET-135 or SEPTA approved equivalent and be mounted on an Edwards Stonco27 waterproof back box or SEPTA approved equivalent.

L. Fixed temperature heat sensors should be considered in areas where the temperature fluctuations are common, i.e., kitchens, garages, attics, heater rooms, small rooms with wall mounted electric heaters.

M. Rate-of-Rise heat sensors should be considered in areas where the temperature is consistent, i.e., storage rooms, electrical rooms, maintenance areas, workshops, etc.

N. Detectors are not required in high bay shop areas.

O. Detectors are required in any electrical substation areas and/or electrical distribution area and above branch circuit breaker panels.

P. If the installation is in an area that requires an explosion proof system, the installation should be in accordance with NFPA 69.

Q. All heat detectors must be testable.

R. No devices shall be installed until all construction activity has been completed or approved by SEPTA Fire Systems Manager.

2.08 Duct Smoke Detectors

A. If a Duct Smoke Detector is not integrated into the HVAC unit by the manufacturer, the Duct detector shall be Silent Knight Model SD505-ADHR, or SEPTA approved equivalent.

B. Duct smoke detectors shall be provided and installed where shown on contract drawings by the Fire Alarm contractor on any HVAC air handler and/or make up air handler.

C. Duct detector housings shall be UL listed with the respective smoke detector.

D. Keyed test switches must be installed for all duct detectors and accessible from the ground level.

E. Contractor is responsible for designing, installing, and submitting for approval all components and methods of accomplishing HVAC and/or make-up air handler shutdowns.

F. Contractor shall provide and install all parts and material required to perform the shutdown of the air handler unit(s) and/or actuation of any smoke evacuation fans.

G. Contractor shall provide independent power supply to each duct detector. Power cannot be taken from the air handling unit.

H. Duct Detector must be easily and safely accessed by ladder or scissor lift, so it can be cleaned, replaced, or tested when needed. Any Duct Detectors installed that cannot be accessed safely as noted above will require the Contractor to install an OSHA approved catwalk or platform at the Contractors expense.

2.09 Beam Smoke Detectors

A. If required, Beam Smoke Detectors shall be System Sensor Model BEAM1224S, or SEPTA approved equivalent.

B. Beam Detector must be mounted on a factory approved bracket.

C. If the Beam Detector range exceeds 230', the Contractor shall install a System Sensor model BEAMLRK, or SEPTA approved equivalent.

D. Heater kits shall be installed on both Transmitter/Receiver and Reflector on all detectors. System Sensor model BEAMHK and model BEAMHKR or SEPTA approved equivalent. Contractor is responsible for providing power to each unit.

E. Remote Test switches shall be installed for each beam detector. Remote Test Switch shall be System Sensor model RTS-451.

F. Contractor must provide and install a permanent wall mounted OSHA & SEPTA approved ladder and platform to access to each beam detector to facilitate regular service and cleaning.

2.10 Addressable Monitoring Modules

A. Monitoring Modules shall be Silent Knight SD500-AIM / SD500-MIM or SEPTA approved equivalent.

B. Monitoring Modules used for elevator recall must be mounted in the elevator machine room.

C. Monitoring modules must be accessible from ground level and installed in conditioned spaces.

2.11 Output Relay Module

A. Relay Module SHALL BE Silent Knight Model SD500-ARM OR SEPTA APPROVED EQUIVALENT.

B. Fire Alarm System Output Relay Modules Shall Be Used To Control The Shutdown And/Or Operational Inputs To Supplemental Equipment (I.E., Elevators Or HVAC Systems).

C. Relay Module Shall Be UL Listed, And FM Approved With The Main FACP.

D. Relay Module shall be mounted in a 4-inch square box within three (3) feet of the connected equipment.

E. Fire alarm contractor shall provide and install all conduit and wiring from the output relay module to the connected equipment.

F. Output relay modules must be accessible from ground level and installed in conditioned spaces.

G. Fire Alarm contractor shall make final termination to the connected equipment.

2.12 Notification Appliances

A. The fire alarm signaling appliance shall be a horn/strobe unit unless a “strobe only” is more feasible or required by code for the specific application.

B. Notification Appliances shall be manufactured by System Sensor, or approved equal as specified below:

1. All notification appliances are to be of tamper proof design. Any tool required to remove these devices are to be turned over to SEPTA upon completion of the project.

2. All Horn/strobe units (wall mounted) shall be a weatherproof System Sensor Model P2RK with red metal SA-WBB back box or SEPTA approved equivalent.

3. All Strobe units (wall mounted) shall be a weatherproof System Sensor Model SRK with red metal SA-WBB back box or SEPTA approved equivalent.

C. Notification appliances shall be installed to satisfy national, state, and local code requirements throughout the complex.

D. Contractor shall provide and install a strobe in each Women's or Men's Restroom.

E. Contractor shall provide and install a horn strobe in each Locker Room.

F. Each manual pull station shall have a horn/strobe above the pull station unless it is not feasible for the specific location. Any manual pull station location that will not have a Horn/Strobe install over it **must be reviewed** with SEPTA Fire Systems Manager for concurrence.

G. A horn/strobe shall be placed on the exterior of the building to signal the Fire Department entering the complex via the main access point. This horn strobe shall be weatherproof and installed in a weatherproof back box. The exact location of this device shall be coordinated with the SEPTA Fire Systems Manager.

H. If the installation is in an area that requires an explosion proof system, the installation should be in accordance with NFPA 69. Explosion proof horns shall be MEDC Model DB1 or SEPTA approved equivalent. Explosion Proof Strobes Shall be MEDC Model XB11or SEPTA approved equivalent.

I. All horn/strobes are to be synced to comply with ADA requirements.

J. Upon fire alarm system silencing the horns shall go silent BUT the strobes will continue to flash until the fire alarm system has been reset.

K. The notification devices must alternate a minimum of four (4) loops throughout the facility to provide sufficient coverage if a loop is not functioning. Horn strobes and strobes need to be marked to indicate booster number, circuit number and device number (e.g., CP-C2-D1, B1-C3-D4 EOL).

2.13 Surge Protection Modules

A. Contractor Shall Provide And Install Surge Protection For The Incoming Power To The Fire Alarm Main Panel And All Remote Power Supply Panels. Protection Device Shall Be Mounted Either In Or Adjacent (2 Feet Or Less) To Each Fire Alarm Panel **Not** To Exceed 6 Feet From Floor And **Not** At The Electrical Distribution Panel Serving The Fire Alarm Panel(S).

B. Provide Surge Protection For Panel Communication, SLC And NAC Circuits Where They Extend Beyond Any Building Enclosure.

C. The Surge Protection Shall Be A Ditek Model DTK-120SR module Or SEPTA Approved Equivalent For Incoming Fire Alarm Panel Power Circuits.

D. The Surge Protection Shall Be A Ditek Model 2MHLP36B-WB Module And Base Or SEPTA Approved Equivalent For All Communication, SLC And Notification Circuits.

E. Surge Protector Ground Wires Shall Be Run As Straight As Possible And Have A Minimum Separation Distance Of 3 Feet From FACP And FSSCP.

F. Surge Protection Shall Be UL 497B Listed And Be Compatible With The FACP.

G. Surge Protection Shall Be Installed In Accordance With Manufacturer's Installation Instructions.

H. Wire Connections Shall Utilize Screw Type Terminal Connections Only.

2.14 Cellular Communicator

A. The Cellular Dual-Path Communicator Shall Be A Starlink Fire Model SLE-LTE-CFB-PS Or SEPTA Approved Equivalent. The Cellular Provider Will Be Determined Based On Signal Strength At The Installation Location Of The FACP. If SEPTA's Fire Systems Manager Determines An Extended Antenna Is Required, It Shall Be At An OMNI X Model SLE-ANTEXT30/50/75/100 Or SEPTA Approved Equivalent. The Contractor Must Confirm Length With Septas Fire Systems Manager Prior To Installation.

2.15 Document Cabinet

A. A cabinet shall be provided to hold the Fire Alarm System Manual. The cabinet shall be a Space Age Electronics Model SSU00645, or SEPTA approved equivalent.

B. The cabinet should be located below or to the side of the alarm control panel. The cabinet shall be painted red, labeled with "Fire Alarm System Manual", and locked with a cabinet type lock keyed to CAT30 system. The cabinet must be able to hold a 3" 3 ring binder and a set of as-built drawings.

2.16 Supplementary And Other Fire Alarm System Devices

A. Sprinkler System fire alarm monitoring modules shall be installed in one enclosure in each sprinkler room for easier troubleshooting of these devices. Enclosure must be NEMA 4x construction with a cat 30 lockable hinged door. SD500-MIM Monitoring Modules must be mounted on DIN rails within this enclosure. All wires must be run neatly in the box and each module must be labeled clearly with SLC device number. A waterproof index listing SLC device number and a description of each modules function (97:002 - Tamper Switch Riser 1, 97:012 - Water flow Riser 2, etc.) must be mounted on the inside cover of the NEMA 4X box.

B. If required, the fire alarm system will be required to shut down the building emergency generator. Contractor shall provide and install an output relay from the fire alarm system to shut down the emergency generator upon activation of any heat detector in the electrical room area where the generator resides. Contractor shall also provide and install any/all monitoring modules required to monitor the emergency shutdown circuit to satisfy NFPA 72 requirements.

C. If required, a single manual by-pass switch shall be installed, immediately adjacent to the main fire alarm panel and/or other location approved by the SEPTA Fire Systems Manager, to disable the emergency generator shut down circuit for fire alarm system testing purposes. The by-pass function cannot be accomplished via the fire alarm software; it is to be accomplished by shunting the relay output contacts. This by-pass switch shall be required to report into the fire alarm system as a "Trouble" condition when placed in the by-pass mode.

2.17 Fire Alarm System Power, Raceway, Wiring And Labeling

A. Design must provide for the complete labeling of the raceway as "FIRE ALARM SYSTEM". Red Label with White text must be waterproof (peel-off type). These labels shall be placed

on every connection box. Connection box labels should be octagon shaped and measure 3" across. Conduit shall be labeled a minimum of every 20 feet; shorter lengths of conduit between connection boxes should be labeled at the midway point. Conduit labels should be rectangular shaped and measure ¾" wide by 5 ½" long. The raceway shall be installed in a manner that considers the effects of electrical and Radio Frequency noise to prevent electromagnetic interference.

B. Conduits and/or wiring shall not be installed **less than 12 inches** from any conduit or exposed electrical bus work and/or distribution panel containing 480Volt or higher voltage electrical conductors.

C. **Cast boxes** (not 1900 Style or octagon sheet metal boxes) with detector deflector plate shall be used for surface mounting any device(s) to any exposed wall surface **or** support beam (i.e., in the ceiling, station area, electrical substations, mechanical rooms, etc.).

D. Standard sheet metal (1900 Style) back boxes shall be permitted for use on non-surface mounted devices.

E. Existing conduits and/or suspended ceiling support systems cannot be used to mount new conduits or device back boxes.

F. The distance between connection (junction) boxes for the Fire Alarm system should not exceed 100 feet.

G. The Fire Alarm conduit shall be a minimum of ¾" (Rigid) threaded or with compression fittings (set screw type connectors are not permitted) and appropriately sized for the cable it will carry and allow for 25% expansion. Non-fire alarm cable shall not be installed in any fire alarm conduit.

H. FMC (Flexible Metal Conduit) conduit shall be permitted to be used **ONLY** above suspended ceiling and/or within walls and shall be 100% concealed from eyesight during normal operating conditions and shall be a minimum of ¾" **and shall not exceed 10 feet. (NOTE: Must be metal lined type)**

I. Conduits connecting wet or dry sprinkler system water flow, tamper and/or low air switches shall be Flexible Liquid Tight (i.e.: Seal-Tite) style from the wall to each fire alarm device(s).

J. All Alarm Modules near sprinkler systems, in a sprinkler /fire pump room or in any area susceptible to water damage shall be installed in a single NEMA 4X cabinet.

K. Any/all penetration into the buildings shall be properly and professionally sealed to prevent water/weather infiltration into the buildings.

L. The Fire Alarm System notification circuit shall be a minimum of FPLR 12 gauge; the initiating circuit shall be a minimum of FPLR 16 gauge.

M. Conductors and Wiring material and methods shall meet all SEPTA, NFPA, NEC and local code requirements.

N. The Contractor shall label all fire alarm wires at their cut end indicating what device the wire is coming from and what device it is going to. (e.g., IN 97:003, OUT 97:004, IN CP-C1-D2, CP-C1, D3, etc.)

O. Splices and wire nuts are NOT allowed anywhere in the system.

P. All wires for detection and notification devices shall be labeled at each junction point throughout the system. The label shall indicate “IN” or “OUT” along with the programmed device number (e.g., IN 97-004, OUT 97:005, IN CP-C1-D2) to allow zone identification at terminal and junction locations. Zone identification labels must be of high quality and equal to the Brady Label Printer.

Q. If the installation is in an area that requires an explosion proof system, the installation should be in accordance with NFPA 69.

R. Ground Fire Alarm Control Panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to FACP. Ground shielded cables at the FACP only, Insulate shield at device location.

2.18 Spare Parts

A. Contractor shall supply spare parts equal to 20% of **ALL** fire alarm equipment and devices installed with no less than one (1) of each item and 50% of all installed Manual Pull Weatherproof Shields.

2.19 Fire Alarm Activation Sequence

A. The fire alarm system shall go into full fire alarm (**all** notification devices in the building will activate and **all** output relays will activate) upon activation of **any** fire alarm initiating device water flow, pull station, heat detector and/or smoke detector in the building.

B. Exception to Part A above; if HVAC shutdown is installed then the HVAC system shall shutdown upon activation of any heat, smoke, or duct smoke detector only.

C. Exception to Part A above; any elevator recalls, and fire hat device relays are to only respond to an activation of the respective hoist way, lobby and/or machine room detection devices only. These relays shall **not** operate upon a trouble and/or supervisory signal on any detection and/or output device.

D. Contractor shall provide a fire alarm activation matrix in the pre-construction shop drawings and as-built documentation describing the activation of any/all input devices with respect to all the fire alarm output devices.

2.20 Fire Alarm System Identification

A. All the below required system identification techniques shall be incorporated into the shop drawings and as-builts.

B. Design must provide for the complete labeling (with waterproof labels) of all Fire Alarm system devices (horn strobes, strobes, detectors, pull stations, relays, etc.) with an address.

C. Field devices shall be labeled with their address both on the device and on the back box and/or mounting plate. Address labels must be easily seen without the use of a ladder. (e.g., SLC 97:002) Horn strobes and strobes need to be marked to indicate booster number, circuit number and device number (e.g., CP-C2-D1, B1-C3-D4 EOL).

D. Device address labels are to be typed letters (P-Touched) not handwritten and must be legible from the ground level.

2.21 Fire Alarm System Functional Tests

A. A full 100% functional test must be performed by the contractor and witnessed by the SEPTA Fire Systems Manager prior to Final Acceptance testing by SEPTA's 3rd party Fire Alarm Maintenance & Monitoring Company (currently JCI/TycoIS).

B. General Testing Requirements – Ensure notification to the SEPTA Project Manager in writing of the date, time, and location of the scheduled date and time of all fire alarm system testing. This notification must be at least two (2) weeks prior to each test, so the SEPTA Project Manager & SEPTA Fire Systems Manager or his authorized representative may witness the test.

C. The Fire Alarm System must be functionally tested in accordance with the current edition of NFPA 72.

D. Issues discovered during the 100% functional test must be corrected and verified prior to scheduling the Final Acceptance.

PART 3 - EXECUTION

3.01 Final Acceptance

A. Final Acceptance will not take place until the Fire Alarm System is completely and satisfactorily installed, the facility work is completed, all training has been provided, and documentation as contained in this specification is provided to the SEPTA Fire Systems Manager. The system must remain powered down until accepted by SEPTA's 3rd party monitoring company and SEPTA Fire Systems Manager.

B. Once Final Acceptance takes place, the contractor is not permitted to perform any fire alarm system work without the specific approval of SEPTA Fire Systems Manager.

C. The equipment transferred from the Contractor to SEPTA must be free of dust, dirt, metal shavings, etc.

D. When ready for acceptance, the alarm contractor is to provide a separate overview briefing to SEPTA management (to include but not limited to: Fire Marshal, SEPTA Fire Systems Manager and Facilities personnel) at a mutually agreed time. This briefing will be followed by a "walk-through" of the system to physically view the system devices and an activation of the Fire Alarm.

E. At the above overview briefing, the contractor must supply SEPTA Fire Systems Manager the below items and documentation. All the items must be formally and professionally presented to SEPTA. Further, all items requiring signature must contain the printed or typed signature block of the signatory.

1. Provide installing contractor's written statement stating that the system has been installed in accordance with approved plans and tested in accordance with the manufacturer's specifications and the appropriate NFPA requirements.

2. Provide four copies of the previously approved Fire Alarm System Maintenance Manual. (1.05.B)

3. Provide a hardcopy and Microsoft Excel versions of the zone list with its descriptions as installed in the fire alarm system. (NOTE: Final Zone list descriptions must be approved by the SEPTA Fire Systems Manager prior to being installed in the fire alarm system.)
4. Provide a "Record of Completion" for each independent alarm system as defined in NFPA 72.
5. Provide a "Record of Alarm Inspection, Testing, and Certification." For each independent fire alarm system. This record must include all applicable items contained in NFPA 72 plus include an audibility record that provides a record of ambient and alarm level dBA. This audibility record must be identified for each section, room, etc. of the facility.
6. Provide four sets of all keys to the Fire Alarm system.
7. Provide dust covers for smoke detectors in a quantity equal to the number of smoke detectors.
8. Provide a record of the installed Operating System Software (sometimes referred to as firmware, BIOS, or Executive Program) and site-specific software (runs at a level below the operating system software and is specific to the Fire Alarm System installation) version numbers.
9. Provide two copies of the site-specific software.
10. Provide four sets of the field marked up contractor's "shop drawings" and final project As-Built Drawings. These drawings must contain the following minimum information as indicated below.
    a. At a minimum, Shop **and** As-Built Drawings must include floor plan drawings, riser diagrams, control panel wiring diagrams, **point-to-point wiring diagrams**, and typical wiring diagrams as described herein.
    b. Floor plan drawings shall be drawn to an indicated scale and should include the following information
        1) Property name and address
        2) Device Legend (NOTE: Heat Detectors shall be separately identified as to "Rate-of-Rise" or "Fixed.")
        3) Date
        4) Floor identification.
        5) Point of Compass.
        6) Graphic Scale.
        7) All walls and doors.
        8) All partitions extending to within 18 inches of the ceiling.
        9) Room (and Bay if applicable) descriptions (and use) and numbers.
        10) Closets (that allow walk-in) shall be included in the drawings.
        11) Fire Alarm controls, annunciators, initiating and notification device/component locations (must include connections to suppression systems, elevators, HVAC, etc.). The Fire Alarm Identification System described in this document shall be utilized to record the address of devices on the drawings.
        12) Location of fire alarm primary and remote power connection(s).
        13) Location of expansion controls.
        14) Locations of monitor/control interfaces to other and/or supplementary systems.

15) All Riser locations

c. Fire alarm system riser diagrams shall include the following information:
   1) General arrangement of the system, in building cross-section.
   2) Number of risers.
   3) Point-to-Point Wiring Diagram
   4) Type and number of circuits in each riser.
   5) Type and number of fire alarm system components/devices on each circuit.

d. Control panel wiring diagrams shall be provided for all control equipment (i.e., equipment listed as either a control unit or control unit accessory), power supplies, battery chargers, and annunciators and shall include the following minimum information:
   1) Identification of the control equipment depicted.
   2) Physical Location(s) of all equipment.
   3) All field wiring terminals and terminal identification.
   4) Details of all circuits connected to field wiring terminals and circuit identifications and color-coding schemes.
   5) All indicators and manual controls, including the full text of all labels.
   6) All field connections to supervising station signaling equipment, releasing equipment, and fire safety control interfaces.
   7) Location of wiring and junction boxes.
   8) Type of Cable or wiring method used on each circuit (to include manufacturer).
   9) Cable routing.

e. Typical wiring diagrams shall be provided for all initiating devices, notification appliances, remote alarm light emitting diodes (LED'S), remote test stations, and end-of-line and power supervisory devices.

11. Provide As-Built Drawings in ACAD and PDF format (on a CD).

F. Upon satisfactory completion of the acceptance requirements, the contractor shall coordinate with SEPTA Fire Systems Manager, the exact date of cut over of system monitoring to the current fire alarm monitoring contractor. Successful programming of the system to the fire alarm monitoring contractor will complete the acceptance process.

G. Contractor shall provide qualified personnel to support the fire alarm system cut over to the monitoring service.

3.02 Cutting And Patching

A. Work included: This Section covers general requirements pertaining to cutting (including excavating), fitting, and patching of the work required to:

1. Make the installation fit properly in the existing and new structure.
2. Installing conduits
3. Uncover work to provide for installing, inspecting, or both.
4. Remove and replace work not conforming to requirements of the Contract Documents; and
5. Removed and/or replace defective or changed work.
6. Coordinate the Work with other separate contractors.

7. Repair holes and cracks caused by selective Demolition and/or removal of accessories and equipment.
8. All repairs must be painted to match the existing finishes.

B. Responsibilities: Contractor shall be responsible to perform their own cutting, fitting and patching work for the components of this project.

C. Request for Approval: Prior to cutting any element, submit written request to the SEPTA Project Manager for permission to proceed with cutting. The request shall include (but not limited to) the following:
1. A description of the extent of cutting and patching required, the method for performing the cutting and patching and an explanation for why cutting and patching is required.
2. Description of the anticipated results in terms of changes to existing construction, including related changes to structural elements and functional components as well as changes in the structure's appearance and other significant visual elements.
3. A list of products to be used and firms or entities that will perform work.

E. All patchwork and repairs must be finished in a professional manner and performed by a skilled Professional tradesperson (mason, carpenter, tile setter, painter, etc.).

D. Areas to be cut and/or drilled that are exposed to publicly visible or in occupied spaces shall not be cut or patched in a manner that would, in the opinion of SEPTA's Project Manager, negatively affect the aesthetic qualities of the building's structural and architectural elements or result in permanent, visual evidence of cutting and patching. The responsible Contractor shall remove and replace work cut and patched in a manner deemed to be visually unsatisfactory by any of the above parties.

F. Cut holes and slots neatly to the size required with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.

G. Cut concrete and masonry using a cutting machine such as a diamond core drill.

H. Restore all patched areas in a manner to eliminate evidence of patching.

I. Do not cut and patch operational elements or safety related components in a manner that would result in a reduction of their capacity to perform in the manner intended, or that would result in increased maintenance, or decreased operational life and/or decreased safety.

3.03 Site and Equipment Clean Up

A. Contractor shall clean up any debris left at the site due to their construction efforts (i.e., packing materials from products used, concrete dust from core drilling holes and/or anchors, metal shavings from drilling into metallic material, etc.)

3.04 Fire Alarm Monitoring Cutover

A. The Contractor shall be solely responsible for coordinating with SEPTA's 3rd party Fire Alarm Maintenance & Monitoring Company (currently JCI/TycoIS) and confirming that their monitoring practices and protocols are compliant with the fire alarm system design and final installation.

B. SEPTA Fire Systems Manager shall be responsible for coordinating the installation with SEPTA's 3rd party Fire Alarm Maintenance & Monitoring Company (currently JCI/TycoIS)

3.05 Demolition

A. Contractor shall remove and dispose of any/all existing fire detection, alarm notification, alarm equipment, conduit, and wire from the building (all devices are to be removed as per NFPA 72 requirements whether shown on the SEPTA supplied drawings or not) upon Central Station monitoring of the new fire alarm system.

B. SEPTA reserves the right to keep any or all old alarm equipment removed. The contractor must confirm with SEPTA Fire Systems Manager what equipment SEPTA would like to keep prior to the contractor removing the equipment from the site.

C. Existing fire alarm equipment not described, i.e., detection devices, batteries, conduit, and cable raceway infrastructure shall be removed in accordance with this Section.

END OF SECTION

SECTION 15010

BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.01 Description

A. This Section covers basic mechanical requirements specifically applicable to Division 15 Sections.

B. Specific work elements include permits, project staffing and coordination, record documents, commissioning of systems and instruction manuals for operation and maintenance.

C. The Contractor is responsible to detail and construct the mechanical systems as part of the existing Traction Power Substation (TPSS) building.

D. The Contractor is tasked with making the final field adjustments and commissions to the mechanical and HVAC systems indicated on the Contract Drawings.

1.02 Submittals

A. Organize each manual with index and thumb tab marker for each section of information including flow diagrams, maintenance instructions, operating instructions, parts listings and copies of other submittals indicated for inclusion; bind in 1 inch, three (3) ring vinyl covered binders with pockets to contain folded sheets, properly labeled on spine and face of binders.

B. Submit copies of shop drawings on all items of equipment and materials to be furnished and installed. Where same items, such as fixtures are involved; submit descriptive literature in a bound brochure form; individual piecemeal submittals shall not be accepted; fixture cuts (all types specified) shall be submitted at one (1) time.

C. Report before or at the time when shop drawings are submitted, any discrepancies or contradictions as applied to their instructions for each piece of equipment.

D. Submit the manufacturer's printed installation instructions for each piece of equipment.

E. Install, test, start and operate equipment as instructed by the manufacturer. Submit written evidence from the equipment manufacturer's that their equipment and systems have been installed strictly in accordance with the manufacturer's recommendation and properly aligned, adjusted and tested.

1.03 Quality Assurance

A. All items of work in Division 15 shall meet all requirements of the International Mechanical Code as referenced by the PA Uniform Construction Code.

B. Meet the applicable provisions of the most recent issues of the following references:

1. Associated General Contractor of America, Inc. (AGCA).
2. American Institute of Architects (AIA).
3. American National Standards Institute (ANSI).

4. Air-Conditioning and Refrigeration Institute (ARI).
5. American Society Heating, Refrigeration and Air-Conditioning Engineers (ASHRAE).
6. American Society of Mechanical Engineers (ASME).
7. American Society for Testing Materials (ASTM).
8. National Fire Protection Association (NFPA).
9. Underwriter's Laboratories, Inc. (UL).

C. All materials and equipment shall be produced in a plant of recognized reputation and regularly engaged in the production of equipment meeting the specified standards. Materials and equipment shall be new, of makes and kinds specified herein, or as indicated on the Contract Drawings, without exceptions.

1.04 Job Conditions

A. Interferences:

1. Construct mechanical systems when and in a manner not to delay or interfere with other operations of work in the Contract.

B. Electrical Interface:

1. Power, control and thermostat wiring, including final connections, from the electrical service devices to the electrical components of the apparatus shall be performed as work of Division 16.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Not Used

END OF SECTION

SECTION 15050

BASIC MECHANICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 Description

A. This Section describes the work consisting of services and work of an administrative nature as well as general requirements concerning certain products and operations common to Division 15.

1. Dielectric fittings.
2. Mechanical sleeve seals.
3. Equipment nameplate data requirements.
4. Mechanical identification.
5. Field painting, touchup painting and finishing.
6. Joint sealants.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. All other sections of Division 15.

E. Section 16010 – Basic Electrical Requirements

F. All auxiliary power related sections of Division 16 that power mechanical equipment.

1.03 Submittals

A. Submit product data applicable to items listed under submittals in each Section of Division 15 and such items as may be scheduled on the Contract Drawings.

B. Include in submittals the manufacturer's descriptive literature, product specifications, published details, performance or capacity rating schedules or charts, and installation instructions, as applicable to items under submittals in each Section of Division 15 and such items as may be scheduled on the Contract Drawings.

C. Submit shop drawings certified for construction by the manufacturers of various products, and approved by the Contractor, which includes location of electrical connections, wiring diagrams, anchor bolt layout, details indicating construction, materials of construction, diameter of shafting, dimensions, rated horsepower of motors, gear and bearing ratings, service factors, and the weights of principal parts and the completely assembled item. Shop drawings applicable to items listed under submittals in each Section of Division 15 and such items as may be scheduled on the Contract Drawings.

1.04 Quality Assurance

A. Meet the construction requirements of state, county and such other local political subdivision's specifications as may exceed the requirements of the codes, standards and approving bodies referenced herein.

B. Meet the requirements of the National Fire Protection Association (NFPA) Standards referenced in the various Specifications Sections, and as directly appropriate to the work and workmanship.

C. Meet the requirements for both the Underwriters' Laboratories, Inc. (UL) Listings, Labels, and Approvals and the National Electrical Manufacturers' Association's (NEMA) Stamps or Seals as applicable to electrical equipment or apparatus forming parts of the mechanical equipment.

D. Upon completion of work, and prior to final payment, furnish to SEPTA formal certification of final inspections from authorities having jurisdiction and secure required permits, if any, from such authorities. Additionally, prepare detailed diagrams and drawings, which may be required by those authorities having jurisdiction.

E. The term "Manufacturer" as used throughout the Division 15 Specifications is understood to apply to a company of established reputation in the manufacture of the particular materials, equipment or apparatus from products of their own make, or products of others, and who assumes full responsibility for products used in said outfits which are not manufactured completely by them, and with replacement parts available.

F. Products used throughout the Division 15 Specifications, and as indicated on the Contract Drawings, are those of companies having established reputations in the manufacture of the particular materials, equipment or apparatus specified. Such products may be of their own make, or products of others for which they assume full responsibility when used in said outfits (which are not manufactured completely by them) and with replacement parts available.

   1. The manufacturer's names and model numbers are given for purpose of establishing a standard of quality, style, size and type and shall not be construed to exclude equipment or materials of other manufacturers.

G. Electrical Components:

   1. The Contractor to provide all starters and disconnects as well as the wiring and conduit from the starters and disconnects to the mechanical equipment. Refer to Division 16 Specifications for requirements regarding conduit and wire.

   2. Motor starters shall be minimum NEMA size 1. Electrical enclosures to be NEMA 12 for indoor units and NEMA 4 for outdoor units unless otherwise specified or indicated on the Contract Drawings.

   3. Starters shall be complete with two (2) sets of auxiliary contacts; one (1) set normally open; one (1) set normally closed.

H. Meet the applicable provisions of the most recent issues of the following references:

   1. SSPC-SP 2, Hand Tool Cleaning.

1.05 Delivery, Storage and Handling

A. Deliver materials and equipment to the Project site in a clean condition with openings plugged or capped (or otherwise sealed by packaging) both during shipping and during temporary storage.

B. Delivered equipment crating and/or packaging shall clearly identify pick points or lift points. In the absence of crating or packaging, pick points or lift points must be identified on the equipment.

C. When unloading materials and equipment provide special lifting harness or apparatus as may be required by the manufacturer. Handle materials and equipment in accordance with the manufacturer's written instructions.

D. The Contractor shall determine the required equipment needed for unloading operations and have such equipment on site to perform unloading work on the date of equipment delivery.

E. Store materials and equipment, both on and off site, in accordance with the manufacturer's written instructions.

PART 2 - PRODUCTS

2.01 Materials

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Dielectric Unions:
    a. Central Plastics Co.
    b. Epco Sales Inc.
    c. Hart Industries International, Inc.
    d. Watts Industries, Inc.
    e. Zurn Industries, Inc.
    f. Or Approved Equal.
2. Dielectric Flanges:
    a. Central Plastics Co.
    b. Epco Sales Inc.
    c. Watts Industries, Inc.
    d. Or Approved Equal.
3. Dielectric Flange Insulating Kits:
    a. Calpico, Inc.
    b. Central Plastics Co.
    c. Or Approved Equal.
4. Mechanical Sleeve Seals:
    a. Metraflex Co.
    b. Thunderline/Link-Seal.
    c. Or Approved Equal.

B. Dielectric Fittings:

1. Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

2. Combination of copper alloy and ferrous; threaded, solder, plain, and weld neck end types and matching piping system materials.

3. Insulating material shall be suitable for system fluid, pressure and temperature.

C. Mechanical Sleeves and Seals:

1. Modular design, with interlocking rubber links shaped to continuously fill annular space between pipe and sleeve. Include connecting bolts and pressure plates.

PART 3 - EXECUTION

3.01 Installation

A. Painting and Finishes:

1. Factory Finishes and Field Painting:

a. Painting of the materials, equipment, apparatus and items installed as work of this Contract will be factory painted with touch ups as indicated below. Refer to Division 9 for reference.

1) Painting factory finished items will be required in the cases where the factory finish is damaged.

b. The quality of the repaint work will be subject to SEPTA's approval.

1) Perform surface preparation of damaged areas meeting the Steel Structures Painting Council Standard SSPC-SP 2.

2) Where a damaged area occurs on one (1) surface of an item having several surfaces, that entire surface where the damage occurs shall require repainting. The surface preparation for outside the damaged area shall consist of a light sanding to profile the existing paint.

c. Apply paint in such a manner so that the finished appearance will match as nearly as possible the factory finish.

1) Use paint material matching the composition of the factory applied products. When possible obtain touch up paint directly from the manufacturer to ensure paint is compatible and color matched.

d. Meet the paint manufacturer's label instruction for mixing, thinning, proper spreading rate, drying time and environmental limitations concerning application.

END OF SECTION

SECTION 15060

HANGERS AND SUPPORTS

PART 1 - GENERAL

1.01 Description

A. This Section covers the minimum requirements for providing supports, anchors and seals for equipment that are included herein.

1.02 Submittals

A. Submit product data in sufficient detail to show full compliance with the Contract Documents.

1. Submit the manufacturer's product data for each product and material.
2. Indicate the manufacturer, trade names, and model numbers, components, arrangement and accessories being provided.
3. Submit applicable literature, catalog material or technical brochures.
4. Submit material and equipment specifications, sizes, types, dimensions, weights, rated capacities and performance curves.
5. Submit utility requirements for wiring and service connection data, motor sizes complete with electrical characteristics.

B. Submit shop drawings to show full compliance with the Contract Documents:

1. Submit dimensional data for rough in and installation instructions.
2. Indicate typical layout including dimensions and utility connections.

C. Submit quality assurance/control submittals:

1. Design data.
2. Certificates.
3. Manufacturer’s instructions and field reports.

1.03 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. American Concrete Institute (ACI).
2. American Iron and Steel Institute (AISI).
3. American National Standards Institute (ANSI).
4. ASME B31.1, Power Piping.
5. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
6. ASTM A 181/A 181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.

7. ASTM A 576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
8. American Welding Society (AWS).
9. Cast Iron Soil Pipe Institute.
10. MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
11. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
12. National Electrical Manufacturers' Association (NEMA).
13. National Fire Protection Association (NFPA).
14. Sheet Metal and Air-Conditioning Contractors' National Association, Inc. (SMACNA).
15. Underwriters' Laboratories, Inc. (UL) and Factory Mutual (FM).

1.04 Design Requirements

A. Pipe hangers and supports to meet the requirements of ASME B31.1, MSS SP-58, MSS SP-69 and other requirements specified herein.

B. Design and size equipment suspension systems and base supports units based on installation instruction or information as obtained from the equipment manufacturers and other requirements as specified herein.

1.05 Warranty

A. All work and materials shall be warranted for one (1) year after acceptance by SEPTA.

B. Submit the manufacturer's warranty and verify that forms are completed in SEPTA's name and registered with the manufacturer.

C. Correct defective work within a one (1) year period after date of final acceptance.

PART 2 - PRODUCTS

2.01 Materials

A. Manufacturers:

1. The use of trade names on the Contract Drawings or other documents is to establish a basis of design, constructability and level of quality. It is not intended to exclude other manufacturers whose products are equivalent to those named, subject to compliance with Contract requirements.
2. Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:
    a. B-Line Systems, Inc.
    b. National Pipe Hanger Corp.
    c. Unistrut Corp.
    d. Hilti, Inc.
    e. Or Approved Equal.

3. All indoor steel materials will be galvanized coated except those identified as stainless steel or copper plated. All outdoor steel materials or those exposed to outside conditions will be stainless steel.

B. Beam Clamps:

1. For upper attachments on structural steel provide beam clamps of carbon steel ASTM A 36/A 36M or forged steel ASTM A 181/A 181M.
2. Holes drilled in structural steel for hanger support rods will not be permitted.
3. Provide clamps with hardened steel cup point set screw and locknut for anchoring in place.
4. Base clamp size selection on required load being supported.

C. Hanger Rods

1. Carbon steel to meet ASTM A 576.
2. Diameter of rods for piping system support to meet ASME B31.1.
   a. In no case shall hanger rods less than 3/8 inch diameter be provided for support of pipe sizes 2 inches and smaller, or less than 1/2 inch diameter rod for supporting pipe sizes 2 1/2 inch and larger.
3. Size hanger rods for ductwork systems to meet SMACNA standards.
4. Size hanger rods for mechanical equipment support based on installation instructions as obtained from the equipment manufacturers.
   a. All thread hanger rods not permitted for equipment supports.

D. Auxiliary Steel:

1. Provide auxiliary steel where support of piping systems and equipment is required between building structural elements. Provide light gauge and structural steel shapes to meet the requirements of ASTM A 36/A 36M.
2. The Contractor shall have the option to use pre-engineered support systems of electro-galvanized steel products. MIXTURE OF SUPPORT SYSTEM MANUFACTURER'S PRODUCTS NOT PERMITTED.
3. Where auxiliary steel is indicated as stainless steel, provide AISI Type 304 stainless steel in No. 1 Finish.

E. Vibration Isolators:

1. Suspended application design, composed of either a steel spring and glass fiber isolator placed in series and encased in a welded steel bracket; or rubber in shear isolator placed in a welded steel bracket.
2. Select isolators to provide 50 percent overload capacity with operating static deflections as recommended by the isolator manufacturer.

F. Sleeves and Seals:

1. Seals and Plates:
   a. Wall seal to be hydrostatic modular compression link seal designed to seal opening between pipes and a through structure opening. Provide Link-Seal by Thunderline Corp.; Or Approved

Equal. Caulking, mastic sealants, lead/oakum, continuous (solid) gaskets are not acceptable as equal.

b. Wall and ceiling plates to be cast metal with integral set screw or similar anchoring screw. Hinged or split design plates may be provided.

c. Provide chrome plated stamped steel hinged plate escutcheons to close pipe penetrations through structure interior in finished areas. Provide plates designed to lock on pipes using setscrews.

2. Provide a factory pre-fabricated roof penetration seal system of materials acceptable to or by the existing roofing system membrane manufacturer.

a. The pre-fabricated system design shall accommodate multiple pipes and conduits in a single fabricated curb and EPDM pipe portal unit.

2.02 Source Quality Control

A. Factory tests:

1. Provide factory certification.

B. Performance Verification:

1. Provide factory certification.

PART 3 - EXECUTION

3.01 Preparation

A. Examine job site conditions prior to proceeding with work.

3.02 Installation

A. General:

1. Saddles and shields will be installed in accordance with industry standards or in accordance with the manufacturer's recommendations where applicable to prevent damage to insulation.

2. Perforated strap iron and wire will under no circumstances be acceptable as hanger material.

3. In corrosive conditions or wet areas, provide corrosion resistant supports.

B. Spacing of Hangers and Supports:

1. General:

a. Space hangers and supports as stated herein and in ASME B31.1, MSS SP-58, MSS SP-69, and as indicated on the Contract Drawings.

C. Equipment supports and penetrations seals for materials and equipment exposed to weather to be stainless steel fasteners for both exposed and concealed attachments in exterior locations.

D. Equipment Supports:

1. Fabricate structural steel stands to suspend equipment from structure above or to support equipment above floor.

E. Seals and Plates Installation:

1. Install wall and ceiling plates to close sleeve openings.
2. Install escutcheons to close sleeve openings in finished areas.

3.03 Field Quality Control

A. Protect installed work from subsequent construction activities.

END OF SECTION

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SECTION 15062

HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. Section Includes:

1. Metal pipe hangers and supports.

1.02 Related Sections

A. The Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section

B. Section 05500 – Metal Fabrications

C. Section 09910 – Paints and Coatings

1.03 Submittals

A. Submit product data for each type of product indicated.

B. Submit shop drawings showing the fabrication and installation details and include calculations for the following; include product data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Fiberglass strut systems.
4. Pipe stands.
5. Equipment supports.

C. Submit trapeze hanger analysis data signed and sealed by a Professional Engineer licensed in the Commonwealth of Pennsylvania responsible for their preparation.

1. Detail fabrication and assembly of trapeze hangers.
2. Calculate requirements for designing trapeze hangers.

D. Submit welding certificates.

1.04 Quality Assurance

A. Structural steel welding qualifications, qualify procedures and personnel according to AWS D1.1.

B. Pipe welding qualifications, qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASCE/SEI 7, Minimum Design Loads for Buildings and Other Structures.

2. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
3. ASTM A 780/A 780M, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
4. ASTM C 1107/C 1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
5. AWS D1.1, Structural Welding Code - Steel.
6. MFMA-103, Guidelines for the use of Metal Framing.
7. MSS SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.
8. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
9. MSS SP-89, Pipe Hangers and Supports - Fabrication and Installation Practices.
10. SSPC-PA 1, Shop, Field, and Maintenance Painting of Steel.

1.05 Definitions

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry Inc.

1.06 Performance Requirements

A. Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a Professional Engineer licensed in the Commonwealth of Pennsylvania, using performance requirements and design criteria indicated.

B. Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents and test water.
2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

PART 2 - PRODUCTS

2.01 Metal Pipe Hangers and Supports

A. Carbon Steel Pipe Hangers and Supports:

1. MSS SP-58, Types 1 through 58, factory fabricated components.
2. Galvanized metallic coatings to be pre-galvanized or hot dipped.
3. Nonmetallic coatings to be plastic coating, jacket or liner.
4. Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger rods to be continuous thread rod, nuts and washer made of stainless steel.

2.02 Miscellaneous Materials

A. Structural steel to meet ASTM A 36/A 36M, carbon steel plates, shapes and bars; black and galvanized.

B. Grout to meet ASTM C 1107/C 1107M, factory mixed and packaged, dry, hydraulic cement, non-shrink and nonmetallic grout; suitable for interior and exterior applications.

1. Non-staining, noncorrosive and nongaseous.

2. Design mix to be 5000 psi, twenty-eight (28) day compressive strength.

PART 3 - EXECUTION

3.01 Hangers and Support Installation

A. Metal pipe hanger installation to meet MSS SP-69 and MSS SP-89. Install hangers, supports, clamps and attachments as required to properly support piping from the building structure.

3.02 Painting

A. Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Meet the SSPC-PA 1 requirements for touching up field painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

B. Cleaning and touchup painting of field welds, bolted connections and abraded areas of shop paint on miscellaneous metal are specified in Section 09910.

C. Clean welds, bolted connections and abraded areas and apply galvanizing repair paint to meet ASTM A 780/A 780M.

3.03 Hangers and Support Schedule

A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

B. Meet MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

D. Use stainless steel pipe hangers and stainless steel or corrosion resistant attachments for hostile environment applications.

E. Use copper plated pipe hangers and attachments for copper piping and tubing.

F. Use padded hangers for piping that is subject to scratching.

G. Use thermal hanger shield inserts for insulated piping and tubing.

H. Unless otherwise indicated and except as specified in piping system Sections, install the following vertical piping clamp types:

1. Use extension pipe or riser clamps (MSS Type 8) for support of pipe risers NPS 3/4 to NPS 24.
2. Use carbon or alloy steel riser clamps (MSS Type 42) for support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.

I. Unless otherwise indicated and except as specified in piping system Sections, install the following types of equipment for building attachments:

1. Use steel or malleable concrete inserts (MSS Type 18) for upper attachment to suspend pipe hangers from concrete ceiling.
2. Use top beam c-clamps (MSS Type 19) for under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Use side beam or channel clamps (MSS Type 20) for attaching to bottom flange of beams, channels or angles.
4. Use center beam clamps (MSS Type 21) for attaching to center of bottom flange of beams.
5. Use welded beam attachments (MSS Type 22) for attaching to bottom of beams if loads are considerable and rod sizes are large.
6. Use c-clamps (MSS Type 23) for structural shapes.
7. Use top beam clamps (MSS Type 25) for top of beams if hanger rod is required tangent to flange edge.
8. Use steel beam clamps with eye nuts (MSS Type 28) for attaching to bottom of steel I-beams for heavy loads.
9. Use linked steel clamps with eye nuts (MSS Type 29) for attaching to bottom of steel I-beams for heavy loads, with link extensions.
10. Use malleable beam clamps with extension pieces (MSS Type 30) for attaching to structural steel.
11. Use welded steel brackets for support of pipes from below or for suspending from above by using clip and rod. Use one (1) of the following for indicated loads:
    a. Light (MSS Type 31) to be 750 pounds.
    b. Medium (MSS Type 32) to be 1500 pounds.
    c. Heavy (MSS Type 33) to be 3000 pounds.
12. Use side beam brackets (MSS Type 34) for sides of steel or wooden beams.
13. Use plate lugs (MSS Type 57) for attaching to steel beams if flexibility at beam is required.
14. Use horizontal travelers (MSS Type 58) for supporting piping systems subject to linear horizontal movement where headroom is limited.

J. Unless otherwise indicated and except as specified in piping system Sections, install the following types of saddles and shields:

1. Use steel pipe covering protection saddles (MSS Type 39) to fill interior voids with insulation that matches adjoining insulation.

2. Use protection shields (MSS Type 40) of length recommended in writing by the manufacturer to prevent crushing insulation.
3. Use thermal hanger shield inserts for supporting insulated pipe.

K. Trapeze pipe hanger selections and applications that are not specified in piping system Sections to meet MSS SP-69.

L. Metal framing system selections and applications that are not specified in piping system Sections to meet MFMA-103.

M. Use powder actuated fasteners or mechanical expansion anchors instead of building attachments where required in concrete construction.

END OF SECTION

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SECTION 15075

MECHANICAL IDENTIFICATION

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of the following equipment to be furnished under this Contract:

1. Nameplates.
2. Tags.
3. Stencils.
4. Labels.
5. Lockout devices.

1.02 Submittals

A. Submit product data in the form of manufacturers catalog literature for each product required.

B. Submit shop drawings containing the list of wording, symbols, letter size and color coding for mechanical identification.

C. Submit two (2) samples of each type and size used on the Contract.

D. Submit installation instructions and special procedures for installation.

E. Certify products meet or exceed specified requirements.

F. Record actual locations of tagged equipment; include tag numbers.

1.03 Quality Assurance

A. Meet ASME A13.1 and ANSI Z535.4 requirements for labeling and identification.

B. Maintain one (1) copy of each document on site.

C. Meet the applicable provisions of the most recent issues of the following references:

1. American Society of Mechanical Engineers (ASME).
2. ASME A13.1, Scheme for the Identification of Piping Systems.
3. ANSI Z535.4, Product Safety Signs and Labels.

1.04 Qualifications

A. Company specializing in manufacturing products specified in this Section.

B. Company specializing in performing work of this Section.

PART 2 - PRODUCTS

2.01 Materials

A. Nameplates:

1. Manufacturers:
   a. Craftmark Identification Systems Model.
   b. Safety Sign Company.
   c. Seton Identification Products.
   d. Or Approved Equal.
2. Nameplates shall be of laminated three (3) layer plastic with engraved letters on light contrasting background color.

B. Tags:

1. Plastic tags shall be laminated three (3) layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1 1/2 inches.
2. Metal tags shall be of brass, aluminum or stainless steel with stamped letters; tag size minimum 1 1/2 inches with finished edges. Mixing of types is not permitted.
3. Information tags shall be of clear plastic with printed "Danger," "Caution" or "Warning" and message; size 3 1/4 inches by 5 5/8 inches with grommet and self-locking nylon ties.
4. Provide a tag chart with typewritten letter size list of applied tags and location in anodized aluminum frame with plastic cover or plastic laminated. Provide a copy for reference in the operations and maintenance manual.

PART 3 - EXECUTION

3.01 Preparation

A. Degrease and clean surfaces to receive adhesive for identification materials.

3.02 Installation

A. Install identifying devices after completion of coverings and painting.

B. Install plastic nameplates with corrosion resistant mechanical fasteners or adhesive.

C. Install labels with sufficient adhesive for permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.

D. Install tags using corrosion resistant chain. Number tags consecutively by location.

E. Identify air handling units, pumps, heat transfer equipment, tanks and water treatment devices with plastic nameplates. Identify in-line pumps and other small devices with tags.

F. Identify control panels and major control components outside panels with plastic nameplates.

G. Identify air terminal units and radiator valves with numbered tags.

H. Tag automatic controls, instruments and relays.

I. Identify ductwork with plastic nameplates.

J. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure and at each obstruction.

END OF SECTION

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SECTION 15080

MECHANICAL INSULATION

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of the various insulation systems required in the Contract.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 15060 – Hangers and Supports

1.03 Submittals

A. Submit the following product data:

1. Pipe insulating materials.
2. Duct insulating materials.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM C 177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Grounded-Hot-Plate Apparatus.
2. ASTM C 518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
3. ASTM C 534/C 534M, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
4. ASTM C 553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
5. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
6. ASTM E 96/E 96M, Standard Test Methods for Water Vapor Transmission of Materials.
7. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.
8. NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
9. Underwriters Laboratories Inc. (UL).

1.05 Delivery, Storage and Handling

A. Deliver insulation products to the site in unbroken shipping cartons bearing a label. Show on the label the list of contents and the appropriate ASTM, NFPA and UL flame and smoke hazard ratings as specified herein.

B. Deliver and store insulation products protected from the weather. Store insulation on the site elevated off wet and otherwise contaminating surfaces.

PART 2 - PRODUCTS

2.01 Materials

A. Pipe Insulation:

1. Flexible insulation (For pipe sizes 1/2 inch thru 5 inches) to be expanded, closed cell, elastomeric structure or unicellular polyolefin foam insulation manufactured to meet requirements of ASTM C 534/C 534M, Type I, in pre-slit or unslit tubing form.
   a. Basic Physical Properties:
      1) Density to be 5 to 6 pounds per cubic foot.
      2) Thermal conductivity to be 0.28 BTUH or less per square foot per degree per inch at 75°F mean temperature when tested according to ASTM C 177.
      3) Water vapor permeability to be 0.10 perm-inch or less when tested according to ASTM E 96/E 96M.
      4) Fire rating not exceeding 25 flame spread and 50 smoke developed when tested according to ASTM E 84.
      5) Temperature limits to be minus 40°F to plus 220°F.
   b. Provide the insulation manufacturer's companion joint making/sealing adhesive to make permanent insulation joints.
   c. Insulate flexible fittings and valve bodies with sleeves of same insulation thickness used on adjacent piping and having an inside diameter large enough to fit over the insulation on adjacent piping.
   d. Provide the manufacturer’s recommended weather resistant protective coating or finish for outdoor installations. Coating to be a water based latex enamel or similar sealer.
   e. Manufacturers:
      1) Armstrong World Industries, Inc., AP Armaflex.
      2) Rubatex Corporation.
      3) Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Apply insulation on clean, dry surfaces only. Perform cleaning required for removal of construction debris, spills, etc.

B. Personnel protective equipment may be necessary when working with insulation materials. Refer to the manufacturer’s Safety Data Sheet (SDS) for recommendations.

3.02 Installation

A. Install insulation continuous through structure penetration of surfaces being insulated.

B. Apply insulation on cold surfaces, where vapor barrier is integral with insulation in a continuous unbroken vapor seal. Adequately seal hanger, support and anchor penetrations of insulation.

C. Apply specified insulation adhesive, sealers and coatings at the manufacturer's recommended minimum coverage per gallon.

D. Protect material from weather damage until weather protective jacket is applied.

E. Pipe Insulation:

1. Apply insulation materials on piped services listed and in accordance with thicknesses listed in Part 2 in this Section or in the following paragraphs. Insulate fittings and valve bodies and in-line control devices, except gauge and thermometer faces, setting or measuring scales integral with in-line devices and control handles.

2. Install flexible insulation on piping according to the manufacturer's instructions, using specified adhesive to seal both longitudinal and butt joints. Insulate in-line appurtenances to the same thickness as adjoining insulation.

a. Install 1/2 inch thick insulation on the following piping:

1) Domestic hot, cold and tempered water piping.

3.03 Field Quality Control

A. Carefully inspect installed work of other trades in connection with insulating work and verify such work to be complete, including system or equipment testing, to such point where insulating work may begin.

END OF SECTION

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SECTION 15120

SLEEVES AND SLEEVE SEALS

PART 1 - GENERAL

1.01 Description

A. Section includes:

1. Sleeves.
2. Stack sleeve fittings.
3. Sleeve seal fittings.
4. Grout.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 07620 - Sheet Metal Flashing and Trim

C. Section 07841 - Penetration Fire Stopping

D. Section 07842 - Joint Fire Stopping

E. Section 07900 - Joint Sealers

1.03 Submittals

A. Submit product data for each type of product indicated.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 53/A 53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
2. ASTM C 1107/C 1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

PART 2 - PRODUCTS

2.01 Sleeves

A. Cast iron wall pipes to be cast or fabricated of cast or ductile iron and equivalent to ductile iron pressure pipe, with plain ends and integral water stop unless otherwise indicated.

B. Galvanized steel wall pipes to meet ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.

C. Galvanized steel pipe sleeves to meet ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

D. Galvanized steel sheet sleeves to be 0.0239 inch minimum thickness; round tube closed with welded longitudinal joint.

2.02 Stack Sleeve Fittings

A. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:

1. Jay R. Smith Mfg. Co.
2. Zurn Industries, LLC.
3. Or Approved Equal.

B. Manufactured, cast iron sleeve with integral clamping flange. Include clamping ring, bolts and nuts for membrane flashing.

1. Underdeck clamp to be a clamping ring with setscrews.

2.03 Sleeve Seal Systems

A. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:

1. Advance Products & System, Inc.
2. CALPICO, Inc.
3. Metraflex Company (The).
4. Pipeline Seal and Insulator, Inc.
5. Proco Product, Inc.
6. Or Approved Equal.

B. Modular sealing element unit, designed for field assembly, for filling annular space between piping and sleeve.

1. Sealing elements to be EPDM rubber NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
2. Pressure plates to be carbon steel or stainless steel.
3. Connecting bolts and nuts to be carbon steel, with corrosion resistant coating, stainless steel of length required to secure pressure plates to sealing elements.

2.04 Sleeve Seal Fittings

A. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:

1. Presealed System.
2. Or Approved Equal.

B. Manufactured plastic, sleeve type, water stop assembly made for imbedding in concrete slab or wall. Unit has plastic or rubber water stop collar with center opening to match piping outside diameter.

2.05 Grout

A. Grout to meet ASTM C 1107/C 1107M, Grade B, post hardening and volume adjusting, dry, hydraulic cement grout.

B. Nonshrink; recommended for interior and exterior applications.

C. Design mix to be 5000 psi, twenty-eight (28) day compressive strength.

D. Packaging to be premixed and factory packaged.

PART 3 - EXECUTION

3.01 Sleeve Installation

A. Install sleeves for piping passing through penetrations in floors, partitions, roofs and walls.

B. For sleeves that will have sleeve seal system installed, select sleeves of size large enough to provide 1 inch annular clear space between piping and concrete slabs and walls.

1. Sleeves are not required for core drilled holes.

C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.

1. Permanent sleeves are not required for holes in slabs formed by molded-PE or -PP sleeves.

2. Cut sleeves to length for mounting flush with both surfaces.

a. Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.

3. Using grout, seal the space outside of sleeves in slabs and walls without sleeve seal system.

D. Install sleeves for pipes passing through interior partitions.

1. Cut sleeves to length for mounting flush with both surfaces.

2. Install sleeves that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation.

3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth and location of joint. Meet the requirements for sealants specified in Section 07900.

E. Maintain indicated fire rating of walls, partitions, ceilings and floors at pipe penetrations. Seal pipe penetrations with fire stop materials per Section 07841 and Section 07842.

3.02 Stack Sleeve Fitting Installation

A. Install stack sleeve fittings in new slabs as slabs are constructed.

1. Install fittings that are large enough to provide 1/4 inch annular clear space between sleeve and pipe or pipe insulation.

2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Meet the requirements for flashing specified in Section 07620.

3. Install section of cast iron soil pipe to extend sleeve to 2 inches above finished floor level.
4. Extend cast iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
5. Using grout, seal the space around outside of stack sleeve fittings.

B. Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with fire stop materials per Section 07841 and Section 07842.

3.03 Sleeve Seal System Installation

A. Install sleeve seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.

B. Select type, size, and number of sealing elements required for piping material and size and for sleeve inner diameter or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.04 Sleeve Seal Fitting Installation

A. Install sleeve seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position water stop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve seal fittings.

3.05 Sleeve and Sleeve Seal Schedule

A. Use sleeves and sleeve seals for the following piping penetration applications.

1. Exterior Concrete Walls above Grade:
   a. Piping smaller than NPS 6 to be cast iron wall sleeves, galvanized steel wall sleeves or galvanized steel pipe sleeves sleeve seal fittings.
2. Exterior Concrete Walls below Grade:
   a. Piping smaller than NPS 6 to be cast iron wall sleeves with sleeve seal system, galvanized steel wall sleeves with sleeve seal system or galvanized steel pipe sleeves with sleeve seal system or sleeve seal fittings.
      1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve seal system.
3. Concrete Slabs-on-Grade:
   a. Piping smaller than NPS 6 to be cast iron wall sleeves with sleeve seal system, galvanized steel wall sleeves with sleeve seal system or galvanized steel pipe sleeves with sleeve seal system or sleeve seal fittings.
      1) Select sleeve size to allow for 1 inch annular clear space between piping and sleeve for installing sleeve seal system.

4. Concrete Slabs above Grade:
    a. Piping smaller than NPS 6 to be galvanized steel pipe sleeves, stack sleeve fittings or sleeve seal fittings.
5. Interior Partitions:
    a. Piping smaller than NPS 6 to be galvanized steel pipe sleeves, stack sleeve fittings or sleeve seal fittings.

END OF SECTION

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SECTION 15130

PUMPS

PART 1 - GENERAL

1.01 Description

A. Section includes:

1. Submersible sump pumps.
2. Wet pit volute sump pumps.
3. Sump pump basins and basin covers.
4. Packaged drainage pump units.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 02220 – Excavation, Backfill and Compaction

C. Section 15160 – Storm Drainage Piping

1.03 Submittals

A. Submit product data for each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Submit wiring diagrams for power, signal and control wiring.

C. Submit operations and maintenance data for pumps and controls, to include operation and maintenance manuals.

1.04 Quality Assurance

A. Electrical components, devices, and accessories to be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 48/A 48M, Standard Specification for Gray Iron Castings.
2. ASTM B 584, Standard Specification for Copper Alloy Sand Castings for General Applications.
3. HI 1.1-1.2, Rotodynamic Centrifugal Pumps for Nomenclature and Definitions.
4. HI 1.3, Rotodynamic Centrifugal Pumps for Design and Application.
5. HI 1.4, Rotodynamic Centrifugal Pumps for Manuals Describing Installation, Operation and Maintenance.

6. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
7. UL 778, Motor-Operated Water Pumps.

1.05 Delivery, Storage & Handling

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Meet the pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.01 Submersible Sump Pumps

A. Submersible, Fixed Position, Double Seal Sump Pumps:

1. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:
   a. BJM Pumps, LLC.
   b. EBARA Fluid Handling.
   c. ITT Flygt Corporation.
   d. PACO Pumps; Grundfos Pumps Corporation, U.S.A.
   e. Liberty Pumps.
   f. Little Giant Pump Co.
   g. Or Approved Equal.
2. Factory assembled and tested sump pump unit.
3. Pump type to be submersible, end suction, single stage, close coupled, overhung impeller, centrifugal sump pump as defined in HI 1.1-1.2 and HI 1.3.
4. Pump casing to be cast iron, with strainer inlet, legs that elevate pump to permit flow into impeller, and vertical discharge for piping connection.
5. Impeller to be statically and dynamically balanced, ASTM A 48/A 48M, Class No. 25 A cast iron and ASTM B 584, cast bronze, semi-open design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and motor shaft to be stainless steel or steel, with factory sealed, grease lubricated ball bearings.
7. Seals to be mechanical.
8. Internal moisture sensor and moisture alarm.
9. Motor to be hermetically sealed, capacitor start type; with built-in overload protection; lifting eye or lug; and three (3) conductor, waterproof power cable of length required and with grounding plug and cable sealing assembly for connection at pump.
   a. Motor housing fluid to be air.
10. Controls:
    a. Enclosure to be NEMA 250, Type 1.
    b. Switch type to be pedestal mounted float switch with float rods and rod buttons.

c. Automatic alternator to start pumps on successive cycles and start multiple pumps if one (1) cannot handle load.

d. Float guides to be pipe or other restraint for floats and rods in basins of depth greater than 60 inches.

e. High water alarm to be cover mounted, compression probe alarm, with electric bell; 120 V AC, with transformer and contacts for remote alarm bell.

11. Control Interface Features:

a. Remote alarm contacts for remote alarm interface.

b. Building automation system interface to be auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:

1) On-off status of pump.

2) Alarm status.

2.02 Sump Pump Capacity and Characteristics

A. Refer to the Contract Drawings for details.

2.03 Sump Pump Basins and Basin Covers

A. Basins to be factory fabricated, watertight, cylindrical, basin sump with top flange and sidewall openings for pipe connections.

1. Material to be cast iron.

2. Reinforcement to be mounting plates for pumps, fittings and accessories.

3. Anchor flange to be of the same material as or compatible with basin sump, cast in or attached to sump, in location and of size required to anchor basin in concrete slab.

B. Fabricate metal basin cover with openings having gaskets, seals and bushings; for access to pumps, pump shafts, control rods, discharge piping, vent connections and power cables.

1. Reinforcement to be steel or cast iron, capable of supporting foot traffic for basins installed in foot traffic areas.

C. Capacities and Characteristics:

1. Existing basin to be used.

2.04 Motors

A. Meet NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Minimum motor size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.01 Earthwork

A. Excavation and filling are specified in Section 02220.

3.02 Examination

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.03 Installation

A. Meet HI 1.4 for installation of sump pumps.

3.04 Connections

A. Meet the requirements for piping specified in Section 15160. The Contract Drawings indicate general arrangement of piping, fittings and specialties.

3.05 Field Quality Control

A. Engage a factory authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Perform Tests and Inspections:

1. Engage a factory authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Pumps and controls will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports.

3.06 Startup Service

A. Engage a factory authorized service representative to perform startup service.

1. Complete installation and startup checks according to the manufacturer's written instructions.

3.07 Adjusting

A. Adjust pumps to function smoothly, and lubricate as recommended by the manufacturer.

B. Adjust control set points.

3.08 Demonstration

A. Engage a factory authorized service representative to train SEPTA's maintenance personnel to adjust, operate, maintain, controls and pumps.

END OF SECTION

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SECTION 15140

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.01 Description

A. The work in this Section consists of constructing the piping systems including the basic control devices within the piping systems.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 02220 - Excavation, Backfill and Compaction

C. Section 15060 - Hangers and Supports

D. Section 15080 - Mechanical Insulation

1.03 Submittals

A. Submit the following product data:

1. Submit data on pipe materials, fittings and accessories. Submit manufacturer's catalog information.
2. Submit manufacturer's catalog information with valve data and ratings for each service.
3. Submit manufacturers catalog information, component sizes, rough-in requirements, service sizes and finishes for domestic water specialties.
4. Valves and cocks.
5. Mechanical pipe couplings.
6. Pipe and fittings.
7. Meters and gauges.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
2. ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
3. ASTM B 32, Standard Specification for Solder Metal.
4. ASTM B 62, Standard Specification for Composition Bronze or Ounce Metal Castings.
5. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
6. ASTM B 584, Standard Specification for Copper Alloy Sand Castings for General Applications.

7. AWS A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
8. MSS SP-70, Gray Iron Gate Valves, Flanged and Threaded Ends.
9. MSS SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.

PART 2 - PRODUCTS

2.01 Materials

A. In the following piping system specifications, product manufacturers are specified for certain items. By naming such manufacturers no intent is implied to eliminate from consideration equivalent products made by other manufacturers.

B. Provide valves of the same basic type, by the same product manufacturer, except where specified otherwise. A mixture of valve types is not acceptable. Each valve shall bear the manufacturer's trademark, flow direction indication and reference symbol indicating conditions for which it is guaranteed. Provide valves of pressure and temperature ratings of not less than the design criteria as applicable to the pipe system components.

1. Provide ball valves with blow out proof stems, suitable for quarter turn operation from shut to open.

C. Pipe line support materials to meet Section 15060 requirements.

D. Potable Water Expansion Tank:

1. Construction to be welded steel outer shell with rigid polypropylene liner mechanically bonded with heavy duty butyl rubber diaphragm and pre-charged air chamber.
2. Accessories to be stainless steel system connection and air charging fitting.
3. Size as indicated on the Contract Drawings.
4. Manufacturers:
   a. Amtrol.
   b. Therm-X-Trol.
   c. Or Approved Equal.

E. Underground or Below Slab Domestic Water Piping:

1. Service Requirements:
   a. Cold water supply to have a maximum operating pressure of 100 psig and maximum operating temperature of 100°F.
   b. Pipe to be Type K copper, annealed ASTM B 88. Nominal size to be 3 inches or smaller.
   c. Fittings to meet ASME B16.18, cast copper, or ASME B16.22, wrought copper.
   d. Joints to be brazed, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy with melting range 1190°F to 1480°F.

F. Above Grade inside Structure Domestic Water Piping:

1. Service Requirements:
   a. Cold water supply to have a maximum operating pressure of 100 psig and maximum operating temperature of 100°F.

b. Hot water supply to have a maximum operating pressure of 100 psig and maximum operating temperature of 150°F.

c. Pipe to be Type L copper, drawn ASTM B 88. Nominal size to be 2 inches or smaller.

d. Joints to be soldered and wiped.

e. Nipples to be same as pipe.

f. Fittings to be wrought copper or bronze solder joint pressure ASME B16.22.

g. Unions to be cast bronze ASME B16.18 or wrought copper ASME B16.22 sweat type.

h. Solder to be lead free type ASTM B 32.

i. Flux to be chlorides of zinc and ammonium in petroleum based paste.

j. Thread lubricant to be graphite/oil compound or Polytetrafluoroethylene (PTFE) tape. On male threads ONLY.

k. Ball valves ends may be either threaded or solder, but mixtures of end types in a system not acceptable. Provide vales and accessories per the following requirements:

1) Ball valves to be blowout proof stem, 600 PSI WOG/150 PSI S-steam, bronze body and trim ASTM B 584, full port, TFE seat. Provide ball vales from one (1) of the following manufacturers:

a) Apollo Model 77-100 threaded and Model 77-200 soldered.

b) Or Approved Equal.

2) Check valves to be class 125 solid bronze ASTM B 62, horizontal swing, regrinding type, Y-pattern, renewable disc and hinge pin, Buna-N seat disc. Provide check vales from one (1) of the following manufacturers:

a) NIBCO Fig. T-413-W threaded and Fig. S-413-W solder.

b) Or Approved Equal.

3) Strainers to be class 250 bronze body ASTM B 62, 316 S.S. 20 mesh (0.033 inch openings) removable screen, threaded cap with blow off, threaded ends. Provide strainers from one (1) of the following manufacturers:

a) Sarco Type BT.

b) Or Approved Equal.

2. Fill aboveground inside structure piping system being tested with potable water. Hydrostatically test at 50 percent over system operating pressure but not less than 100 psig.

a. Locate test pressure source on upstream sides on lines containing check valves and set control valves in open position for test duration.

b. Do not subject equipment, piping specialties or plumbing fixtures to test pressures.

c. Isolate in-line items that may be damaged by test pressures.

d. Maintain test pressure to within 3 psi of initial test pressure, without introduction of additional pressure, until an examination is made to determine each joint and connection leak free, but in no case less than four (4) hours actual test time.

3. After testing flush entire system until free of sediment and other foreign matter.

4. After system flushing perform system disinfection from source of supply through entire system.

a. Fill system with disinfection solution of calcium hypochlorite or sodium hypochlorite at a concentration of 50 parts available chlorine per million parts of water. Proof test solution concentration of system outlet.

b. Retain solution in system for a minimum of twenty-four (24) continuous hours, then drain and thoroughly flush system until potable water is test proven comparable to water quality from supply source.

PART 3 - EXECUTION

3.01 Preparation

A. The Contract Drawings are in general indicative of the work, with symbols and notations for clarity. However, the Contract Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.

1. No extra compensation will be made for work due to difference between indicated and actual dimensions.
2. Submit to SEPTA for approval, details of proposed departures necessitated by field conditions or other causes.

B. Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels or similar electrical apparatus.

3.02 Installation

A. The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.

1. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Contract Drawings.
2. Clean piping prior to installation and following installation to prepare for painting. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.
3. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.
4. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
5. Install unions and flanges in accessible locations and whether indicated or not, install union adjacent to equipment and wherever removal of equipment for repair or replacement is required.
6. Provide dielectric unions at points of connection of copper tubing and piping to ferrous metal piping or equipment.
7. Provide reducing fittings where reduction in pipe sizes is necessary. Bushings will not be accepted.
8. Install ball valves at inlets and outlets to each piece of equipment.
9. Place and support piping runs as specified in Section 15060.

B. Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.

1. Install piping a sufficient distance from other work to permit clearance of not less than 1 inch between the piping, insulated piping and adjacent work.

2. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.

C. Perform earthwork involving trenching for buried pipe runs as specified in Section 02220.

1. Keep trenches dewatered until pipe joints have been made and concrete bedding and blocking, if any, have hardened. Under no circumstances lay pipe in water or on sub-grade containing frost.

2. Rest each section of pipe on pipe bedding for the full length of its barrel, with recesses excavated for pipe bells so joints can easily be made. Backfill recesses with bedding material immediately following pipe joining operations.

3. Lay pipe proceeding upgrade true to line and grades given. Lay bell and spigot pipe with bell end upgrade.

4. Take up and relay pipe that is not laid true to required alignment of grade or has its joints disturbed after laying. No deviations from the required line and grade permitted, except with approval of SEPTA.

D. Pipe Joining:

1. Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.

a. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.

b. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.

2. Cut tubing and piping ends square, deburr and ream to size of original bore for copper tubing and pipe joints.

a. Prior to sweating and soldering, clean pipe ends and fitting surfaces involved in the joint, to bright metal without marring surfaces. Finished joints shall show no evidence of hard temper due to overheating, no evidence of improper solder draw, and excess solder must be removed.

b. Prior to flaring, cut tubing and piping ends square, deburr and ream to size of original bore. Finished joints shall show evenness of flaring and proper seating of joining parts.

c. Prior to brazing, clean the surfaces involved in the brazing to remove oxides and surface soil. Exercise care so as not to remove excess material to result in a loose fit of the joint. Perform brazing in accordance with recommendations of the Copper Development Association Inc. Copper, Brass, Bronze and Product Handbook.

3.03 Field Quality Control

A. Conduct tests specified under piping system specifications so that each piping system installed in the Contract is tested.

1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
2. Free piping systems of trapped air for tests involving water.
3. Perform tests involving water in the test only when there is no danger of water freezing during the test time period.
4. When a piping system fails to meet test requirements specified herein, repair and retest to meet the following:
   a. Determine source or sources of leakage.
   b. Repair or replace defective material and if a result of improper workmanship, correct such.
   c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
   d. Perform repair and retest work at no increase in Contract price.
5. Furnish acceptable accuracy proof to SEPTA that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Contract.

END OF SECTION

SECTION 15150

SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 Description

A. The work in this Section consists of constructing the sanitary and vent piping systems including the basic control devices within the piping systems.

B. Existing sanitary waste pipe is to remain between the existing sanitary sewer main and the existing storm water pipe and the tie-ins at the Traction Power Substation (TPSS). The existing sanitary sewer and the existing storm water pipe shall have a camera line inspection performed to check integrity of the pipes.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 02220 - Excavation, Backfill and Compaction

C. Section 15060 - Hangers and Supports

1.03 Submittals

A. Submit the following product data:

1. Pipe and fittings.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASME B16.1, Gray Iron Pipe Flanges and Flanged Fittings.
2. ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings - DWV.
3. ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings - DWV.
4. ASTM A 53/A 53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
5. ASTM A 74, Standard Specification for Cast Iron Soil Pipe and Fittings.
6. ASTM A 126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
7. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
8. ASTM B 32, Standard Specification for Solder Metal.
9. ASTM B 88, Standard Specification for Seamless Copper Water Tube.

10. ASTM C 564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
11. ASTM D 1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
12. ASTM D 2466, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
13. ASTM D 2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
14. ASTM D 2665, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
15. CISPI 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
16. CISPI HS-67.
17. FS QQ-C-40, Caulking: Lead Wool and Lead Pig.
18. GGG40/ASTM 65-45-12/SAE D4512, Gray Ductile Iron.

PART 2 - PRODUCTS

2.01 Materials

A. Pipeline support materials to meet Section 15060 requirements.

B. Aboveground Inside Structure Sanitary Waste, Vent and Combustion Air Intake Piping:

1. Service Requirements:
   a. Sanitary and soil piping to have a maximum operating temperature of 140°F.
   b. Sanitary vent piping to have a maximum operating temperature of 140°F.
   c. Vent and outside air piping to have a maximum operating temperature of 140°F.
2. Pipe to be galvanized steel schedule 40 and couplings ASTM A 53/A 53M. Nominal size to be 1 1/2 inches and smaller.
   a. Joints to be threaded.
   b. Nipples to be same as pipe.
   c. Fittings to be galvanized cast iron drainage 125 pound threaded ASTM A 126, ASTM A 153/A 153M and ASME B16.1.
   d. Thread lubricant to be graphite/oil compound or Polytetrafluoroethylene (PTFE) tape. Use ONLY on male threads.
3. Pipe to be Type DWV copper, drawn ASTM B 88. Nominal size to be 1 1/2 inches and smaller.
   a. Fittings to be wrought copper ASME B16.29 or cast bronze ASME B16.23.
   b. Solder to be 95/5 tin antimony ASTM B 32.
   c. Flux to be chlorides of zinc and ammonium in petroleum based paste.
4. Pipe to be service weight hubless design (No-Hub) cast iron ASTM A 74. Nominal size to be 2 inches and larger.

a. Joints to be neoprene sleeve/300 Series stainless steel clamp and shield assembly CISPI 301.
b. Fittings to be same as pipe.

5. Test piping with 10 foot hydrostatic head; fifteen (15) minute test duration time, and until an examination is made to determine each joint and connection leak free.
   a. Plug all system openings except highest opening and fill system with water to point of overflow.
   b. When testing by sections plug all openings except highest opening in section under test and fill section with water; no section tested with less than 10 foot head of water. In testing successive sections, include the upper 10 feet of next preceding section in the test so no joints are tested at less than 10 foot head of water.
6. Flush out system using test water with sediment collection at lowest point in system.

C. Sanitary Waste and Piping Underground to 5 Feet Outside Structure and Under on Grade Structure Slab:

1. Service Requirements:
   a. Sanitary and soil piping to have a maximum operating temperature of 140°F.
   b. Sanitary vent piping to have a maximum operating temperature of 140°F.
2. Pipe to be service weight hub and spigot design cast iron ASTM A 74, bitumastic coated. Nominal size to be 2 inches and larger.
   a. Joints to be compression type, positive double seal, neoprene gasket joints ASTM C 564.
   b. Fittings to be same as pipe.
   c. Joint lubricant to be designed for use in making compression joints and formulated to impart no chemical attack to the gasket.
3. Pipe to be service weight hub and spigot design cast iron ASTM A 74, bitumastic coated.
   a. Joints to be picked oakum gasket and caulked with lead FS QQ-C-40 and CISPI 301.
   b. Fittings to be same as pipe.
4. Test piping with 10 foot hydrostatic head; fifteen (15) minute test duration time, and until an examination is made to determine each joint and connection leak free.
   a. Plug all system openings except highest opening and fill system with water to point of overflow.
   b. When testing by sections plug all openings except highest opening in section under test and fill section with water; no section tested with less than 10 foot head of water. In testing successive sections, include the upper 10 feet of next preceding section in the test so no joints are tested at less than 10 foot head of water.
5. Flush out system using test water with sediment collection at lowest end of system.

D. Low Head Check Valves:

1. Provide clog free design, ball type check valve suitable for use in sewage system.
2. Valve construction to be high quality cast type iron GGG40/ASTM 65-45- 12/SAE D4512.
3. Manufacturer:
   a. Flygt ball Check valves.
   b. HDL.
   c. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. The Contract Drawings are in general indicative of the work, with symbols and notations for clarity. However, the Contract Drawings are not an exact representation of all conditions involved, therefore, layout piping to suit actual field measurements.

1. No extra compensation will be made for work due to difference between indicated and actual dimensions.

2. Submit to SEPTA for approval, details of proposed departures necessitated by field conditions or other causes.

B. Layout piping systems to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment. Do not install piping with joints and fittings over motors, switchboards, panels or similar electrical apparatus.

3.02 Installation

A. Sanitary and Waste Piping:

1. The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe fittings, adapters, etc. as required to construct complete piping systems.

   a. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Contract Drawings.

   b. Clean piping prior to installation and following installation to prepare for painting.

   c. Keep open ends of piping and pipe attachment openings on equipment capped or plugged until actual connections.

   d. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.

   e. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.

   f. Provide increasing fittings where increases in pipe sizes are necessary.

   g. Place and support piping runs as specified in Section 15060.

   h. Unless otherwise indicated, pitch piping not less than 1 inch in 8 feet.

2. Soil or Waste Piping Installation Requirements:

   a. Make changes in direction in soil or waste piping using the appropriate sanitary fittings according to the adopted Plumbing Code; except that sanitary tees may be used on vertical stacks, and short quarter bends or elbows may be used where the change in direction of flow is from horizontal to vertical.

   b. Slip joints permitted only in factory fabricated chrome plated trap seals for fixtures. Use drainage fitting unions for making union connections wherever practicable. The use of continuous thread bushings is prohibited.

   c. Provide a trap at the connection of each plumbing fixture, drain and piece of equipment requiring connection to soil or waste piping except where noted on the Contract Drawings. Install traps as close as possible to the fixture, drain or piece of equipment; double trapping not permitted.

   d. Sleeve and seal penetration through foundation wall.

e. Install test tees at the base of vertical soil or waste piping runs and at the base of vertical rainwater conductor runs. Install threaded brass or bronze plug to close test opening. Test tees may be omitted where cleanouts are required at test tee locations.

3. Install exposed piping parallel or perpendicular to the lines of the building structure and to compensate for structural interferences, to preserve headroom, and not to interfere with openings, passageways and equipment.
   a. Install piping a sufficient distance from other work to permit clearance of not less than 1 inch between the piping, insulated piping and adjacent work.
   b. Install piping as close as possible to walls, overhead construction, columns, and similar to facilitate insulating work and removal of piping later.
4. Perform earthwork involving trenching for buried pipe runs as specified in Section 02220 and as follows:
   a. Keep trenches dewatered until pipe joints have been made and concrete bedding and blocking, if any, have hardened. Under no circumstances lay pipe in water or on sub-grade containing frost.
   b. Rest each section of pipe on pipe bedding for the full length of its barrel, with recesses excavated for pipe bells so joints can easily be made. Backfill recesses with bedding material immediately following pipe joining operations.
   c. Lay pipe proceeding upgrade true to line and grades given. Lay bell and spigot pipe with bell end upgrade.
   d. Take up and relay pipe that is not laid true to required alignment or grade or has its joints disturbed after being laid. No deviations from the required line and grade permitted, except with approval of SEPTA.

B. Vent Piping:

1. The schematic drawings do not necessarily indicate every piping size or alignment. Provide the required pipe sizes, fittings, adapters, etc. as required to construct complete piping systems.
   a. Install piping concealed in those areas of the structures having hung ceilings and exposed in all other areas, except where indicated otherwise on the Contract Drawings.
   b. Clean piping prior to installation.
   c. Construct pipe runs from full lengths of pipe using short sections only for runs of less than full pipe length. Make changes in directions of pipe runs with fittings only.
   d. Cut pipes accurately to measurements established in the field and assemble in place without springing, forcing, excessive cutting or weakening of the structure.
   e. Provide increasing fittings where increases in pipe sizes are necessary.
   f. Place and support piping runs as specified in Section 15060.
2. Vent Piping Installation Requirements:
   a. Extend vent pipes to not less than 10 inches or more than 16 inches above the roof. Coordinate the installation of vent pipe in accordance with current Plumbing Codes or as follows:
      1) Where vents are taken on horizontal runs of soil or waste piping make such connections above the center line of the piping, either on the top or at 45 degree angle.

C. Pipe Joining:

1. Exercise care when making pipe joints and make joints in accordance with the pipe material manufacturer's recommendations and the following additional requirements.
   a. In each instance of pipe joining, those portions of pipes involved must be absolutely clean just prior to assembly.
   b. If a joint is extremely difficult to assemble or is not completely sealed, disassemble the joint and correct the difficulty if possible. Remake the joint using new materials when necessary.
2. Cut tubing and piping ends square, de-burr and ream to size of original bore for copper tubing and pipe joints.
3. Prior to sweating and soldering, clean pipe ends, and fitting surfaces involved in the joint, to bright metal without marring surfaces. Finished joints shall show no evidence of hard temper due to overheating, no evidence of improper solder draw and excess solder must be removed.
4. Cast Iron Soil Pipe Joints:
   a. Make compression (gasket) joints in cast iron hub and spigot pipe in accordance with procedures outlined in CISPI 301.
   b. Cast iron hub and spigot pipe ends must be fully entered prior to making oakum/lead joint. Make oakum/lead caulk joints in accordance with procedures outlined in CISPI 301.
5. Cast iron no hub pipe joint ends must be properly entered in the gasket shield/clamp assembly prior to tightening. Make no hub joints in accordance with procedures outlined in Pamphlet No. 100 of CISPI 301.

3.03 Field Quality Control

A. Conduct tests specified under Part 3 in this Section, so that each piping system installed in the Contract is tested.

1. Provide tools, materials (including clean water), apparatus and instruments necessary for piping system testing.
2. Free piping systems of trapped air for tests involving water.
3. Perform tests involving water when there is no danger of water freezing during the test time period.
4. When a piping system fails to meet test requirements specified herein, repair and retest to meet the following:
   a. Determine source or sources of leakage.
   b. Repair or replace defective material and if a result of improper workmanship, correct such.
   c. Conduct additional tests to demonstrate that piping system meets specified test requirements.
   d. Perform repair and retest work at no increase in Contract price.
5. Furnish acceptable accuracy proof to SEPTA that testing apparatus, pressure gauges, etc. have been recently checked and calibrated, as applicable, prior to use on this Contract.

B. Testing piping with 10 foot hydrostatic head; fifteen (15) minute test duration time, and until an examination is made to determine each joint and connection are leak free.

1. Plug all system openings except the highest opening and fill system with water to the point of overflow.
2. When testing by sections plug all openings except the highest opening in the section under test and fill sections with water. No section shall be tested with less than 10 foot head hydrostatic and a fifteen (15) minute test duration time. In testing successive sections, include the upper 10 feet of the next preceding section in the test so no joints are tested at less than 10 foot of head of water.

C. Hydrostatic tests are specified; however, when there is danger of water freezing during the test time period conduct such tests using air pressure.

1. Introduce compressed air in any suitable opening, after closing all other inlets and outlets, until there is a uniform gauge pressure of 5 psi or sufficient to balance a column of mercury 10 inches in height. Maintain pressure without introduction of additional air for a period of at least fifteen (15) minutes and until a soap suds solution test/examination is made to determine such joint and connection leak free.
2. Flush out system using test water with sediment collection at lowest point in system.

END OF SECTION

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SECTION 15160

STORM DRAINAGE PIPING

PART 1 - GENERAL

1.01 Description

A. Section includes:

1. Pipe, tube and fittings.
2. Specialty pipe fittings.

B. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:

1. Storm drainage piping to withstand 10 foot head of water.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 15060 - Hangers and Supports

C. Section 15165 - Storm Drainage Piping Specialties

1.03 Submittals

A. Submit product data for each type of product indicated.

B. Submit field quality control reports.

1.04 Quality Assurance

A. Piping materials shall bear label, stamp or other markings of specified testing agency.

B. MEET NSF/ANSI 14 for plastic piping components. Include marking with "NSF drain" for plastic drain piping and "NSF sewer" for plastic sewer piping.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASCE/SEI 7, Minimum Design loads for Buildings and Other Structures.
2. ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
3. ASME B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
4. ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
5. ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings: DMV.
6. ASME B16.24, Cast Copper Alloy Pipe Flanges, Flanged Fittings, and Valves: Classes 150, 300, 600, 900, 1500, and 2500.
7. ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder-Joint Drainage Fittings - DMV.

8. ASME B 18.2.1, Square, Hex, Heavy Hex, and Askew Head Bolts and Hex, Heavy Hex, Hex Flange, Lobed Head, and Lag Screws (Inch Series).
9. ASTM A 48/A 48M, Standard Specification for Gray Iron Castings.
10. ASTM A 674, Standard Practice for Polyethylene Encasement for Ductile Iron Pipe for Water or Other Liquids.
11. ASTM A 888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
12. ASTM B 32, Standard Specification for Solder Metal.
13. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
14. ASTM B 306, Standard Specification for Copper Drainage Tube (DMV).
15. ASTM B 813, Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube.
16. ASTM C 564, Standard Specification for Rubber Gaskets for Cast Iron Coil Pipe and Fittings.
17. ASTM C 1173, Standard Specification for Flexible Transition Couplings for Underground Piping Systems.
18. ASTM C 1277, Standard Specification for Shielded Coupling Joining Hubless Cast Iron Soil Pipe and Fittings.
19. ASTM C 1460, Standard Specification for Shielded Transition Couplings for Use With Dissimilar DMV Pipe and Fittings Above Ground.
20. ASTM D 2235, Standard Specification for Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
21. ASTM D 2661, Standard Specification for Acrylonitrile-Butadiene-Styrene (ABS) Schedule 40 Plastic Drain, Waste, and Vent Pipe and Fittings.
22. ASTM D 2665, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
23. ASTM D 2855, Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
24. ASTM D 5926, Standard Specification for Poly (Vinyl Chloride) (PVC) Gaskets for Drain, Waste, and Vent (DWV), Sewer, Sanitary, and Storm Plumbing Systems.
25. ASTM F 402, Standard Practice for Safe Handling of Solvent Cements, Primers, and Cleaners Used for Joining Thermoplastic Pipe and Fittings.
26. ASTM F 477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
27. AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
28. AWWA C600, Installation of Ductile Iron Water Mains and Their Appurtenances.

29. CISPI 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
30. MSS SP-69, Pipe Hangers and Supports - Selection and Application.
31. MSS SP-123, Non-Ferrous Threaded and Solder Joint Unions for Use With Copper Water Tube.
32. NSF/ANSI 14, Plastics Piping System Components and Related Materials.

1.05 Project Condition

A. Do not interrupt service to facilities occupied by SEPTA or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify the SEPTA Project Manager no fewer than two (2) days in advance of proposed interruption of storm drainage service.
2. Do not proceed with interruption of storm drainage service without the SEPTA Project Manager's written permission.

PART 2 - PRODUCTS

2.01 Piping Materials

A. Meet the requirements in this Section for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations and pipe sizes.

2.02 Hubless, Cast Iron Soil Pipe and Fittings

A. Pipe and fittings to meet ASTM A 888 or CISPI 301.

B. Cast Iron, Hubless Piping Couplings:

1. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following or equal:
   a. MG Piping Products Company.
   b. Or Approved Equal.
2. Cast iron, hubless piping coupling to meet ASTM C 1277.
3. Two (2) piece ASTM A 48/A 48M, cast iron housing; stainless steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.03 Copper Tube and Fittings

A. Copper DWV tube to meet ASTM B 306, Type L, recommended using at least "M" wall thickness DWV, can be dented by hand. "L" wall type tube is preferred. Drainage tube, drawn temper.

B. Copper drainage fittings to meet ASME B16.23, cast copper fittings or ASME B16.29, wrought copper, solder joint fittings.

C. Hard copper tube to meet ASTM B 88, Type L, water tube, drawn temper.

D. Copper Pressure Fittings:

1. Copper fittings to meet ASME B16.18, cast copper alloy fittings or ASME B16.22, wrought copper, solder joint fittings. Furnish wrought copper fittings if indicated.

2. Copper unions to meet MSS SP-123, copper alloy, hexagonal stock body with ball-and-socket, metal-to-metal seating surfaces, and solder joint or threaded ends.

E. Copper flanges to meet ASME B16.24, Class 150, cast copper with solder joint end.

1. Flange gasket materials to meet ASME B16.21, full face, flat, nonmetallic, asbestos free, 1/8 inch maximum thickness unless thickness or specific material is indicated.

2. Flange bolts and nuts to meet ASME B18.2.1, carbon steel unless otherwise indicated.

F. Solder to meet ASTM B 32, lead free with ASTM B 813, water flushable flux.

2.04 Specialty Pipe Fittings

A. Transition Couplings:

1. Fitting or device for joining piping with small differences in outside diameters or of different materials. Include end connections same size as and compatible with pipes to be joined.

2. Fitting type transition couplings to be manufactured piping coupling or specified piping system fitting.

3. Unshielded, Non-Pressure Transition Couplings:

a. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:

1) Dallas Specialty & Mfg. Co.

2) Fernco Inc.

3) Mission Rubber Company; a division of MCP Industries, Inc.

4) Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

5) Or Approved Equal.

b. Unshielded, non-pressure transition couplings to meet ASTM C 1173.

c. Elastomeric, sleeve type, reducing or transition pattern. Include shear ring and corrosion resistant metal tension band and tightening mechanism on each end.

d. Sleeve Materials:

1) Cast iron soil pipe sleeve materials to meet ASTM C 564, rubber.

2) Plastic pipe sleeve materials to meet ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

3) Dissimilar pipes to meet ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-Pressure Transition Couplings:

a. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:

1) Cascade Waterworks Mfg. Co.

2) Mission Rubber Company; a division of MCP Industries, Inc.

3) Or Approved Equal.

b. Shielded, non-pressure transition couplings to meet ASTM C 1460.

c. Elastomeric or rubber sleeve with full length, corrosion resistant outer shield and corrosion resistant metal tension band and tightening mechanism on each end.

PART 3 - EXECUTION

3.01 Piping Installation

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations from layout are approved on coordination drawings.

B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Make changes in direction for storm drainage piping using appropriate branches, bends and long sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

J. Install storm drainage piping at the following minimum slopes unless otherwise indicated.

1. Building storm drain to have a 1 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.

2. Horizontal storm drainage piping to have a 2 percent downward in direction of flow.

K. Install cast iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

L. Install steel piping according to applicable plumbing code.

M. Install engineered controlled flow or siphonic drain specialties and storm drainage piping in locations indicated.

N. Install underground, ductile iron, force main piping according to AWWA C600. Install buried piping inside building between wall and floor penetrations and connection to storm sewer piping outside building with restrained joints. Anchor pipe to wall or floor. Install thrust block supports at vertical and horizontal offsets.

1. Install encasement on piping according to ASTM A 674 or AWWA C105.

O. Install force mains at elevations indicated.

P. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers in storm drainage gravity flow piping. Install cleanout fitting with closure plug inside the building in storm drainage force main piping. Meet the requirements for cleanouts specified in Section 15165.

2. Install drains in storm drainage gravity flow piping. Meet the requirements for drains specified in Section 15165.

Q. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

R. Install sleeves for piping penetrations of walls, ceilings and floors. Meet the requirements for sleeves as per applicable codes.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Meet the requirements for sleeve seals as per applicable codes.

T. Install escutcheons for piping penetrations of walls, ceilings and floors. Meet the requirements for escutcheons as per applicable codes.

3.02 Joint Construction

A. Join hubless, cast iron soil piping coupled joints according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless piping coupling joints.

B. Clean and dry plastic, non-pressure piping, solvent cemented joint surfaces. Join pipe and fittings according to the following:

1. Meet ASTM F 402 for safe handling practice of cleaners, primers and solvent cements.

2. Join ABS piping according to ASTM D 2235 and ASTM D 2661 appendixes.

3. Join PVC piping according to ASTM D 2855 and ASTM D 2665 appendixes.

3.03 Specialty Pipe Fitting Installation

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in outer diameters.

2. In drainage piping provide shielded, non-pressure transition couplings.

3. In aboveground force main piping provide fitting type transition couplings.

3.04 Hanger and Support Installation

A. Meet the requirements for pipe hanger and support devices and installation specified in Section 15060.

1. Install carbon steel pipe hangers for horizontal piping in noncorrosive environments.

2. Install stainless steel or fiberglass pipe hangers for horizontal piping in corrosive environments.

3. Install carbon steel pipe support clamps for vertical piping in noncorrosive environments.
4. Install stainless steel pipe support clamps for vertical piping in corrosive environments.
5. Vertical piping to be MSS Type 8 or Type 42, clamps.
6. Individual, Straight, Horizontal Piping Runs:
    a. 100 feet and less to be MSS Type 1, adjustable, steel clevis hangers.
    b. Longer than 100 feet to be MSS Type 43, adjustable roller hangers.
    c. Longer than 100 feet if indicated to be MSS Type 49, spring cushion rolls.
7. Multiple, straight, horizontal piping runs 100 feet or longer to be MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
8. Base of vertical piping to be MSS Type 52, spring hangers.

B. Support horizontal piping and tubing within 12 inches of each fitting, valve and coupling.

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced one (1) size for double rod hangers, with 3/8 inch minimum rods.

E. Install hangers for cast iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1 1/2 and NPS 2 to be 60 inches with 3/8 inch rod.
2. NPS 3 to be 60 inches with 1/2 inch rod.
3. NPS 4 and NPS 5 to be 60 inches with 5/8 inch rod.
4. Spacing for 10 foot pipe lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.

F. Install supports for vertical cast iron soil piping every 15 feet.

G. Support piping and tubing not listed above according to MSS SP-69 and the manufacturer's written instructions.

3.05 Connections

A. The Contract Drawings indicate general arrangement of piping, fittings and specialties.

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

1. Meet the requirements for backwater valves, cleanouts and drains specified in Section 15165.

D. Connect force main piping to the following:

1. Storm sewer to exterior force main.
2. Sump pumps to sump pump discharge.

E. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

F. Make connections according to the following unless otherwise indicated:

1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2 1/2 and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3.06 Identification

A. During installation, notify authorities having jurisdiction at least twenty-four (24) hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

C. Prepare inspection reports and have them signed by authorities having jurisdiction.

D. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test storm drainage piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From fifteen (15) minutes before inspection starts until completion of inspection, water level must not drop. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

E. Test force main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and

allow to stand for four (4) hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.07 Cleaning

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.08 Piping Schedule

A. Flanges and unions may be used on aboveground pressure piping unless otherwise indicated.

B. Aboveground storm drainage piping NPS 6 and smaller shall be the following:

1. Hubless, cast iron soil pipe and fittings.

END OF SECTION

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SECTION 15165

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.01 Description

A. Section includes:

1. Roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Through penetration fire stop assemblies.
4. Flashing materials.

1.02 Related Sections

A. The Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 07841 - Penetration Fire Stopping

C. Section 07842 - Joint Fire Stopping

D. Section 15160 - Storm Drainage Piping

1.03 Submittals

A. Submit product data for each type of product indicated.

1.04 Quality Assurance

A. Drainage piping specialties shall bear label, stamp or other markings of specified testing agency.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ASME A112.6.4, Roof, Deck, and Balcony Drains.
2. ASTM A 48/A 48M, Standard Specification for Gray Iron Castings.
3. ASTM A 653/A 653M, Standard Specification for Sheet Steel, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
4. ASTM B 32, Standard Specification for Solder Metal.
5. ASTM B 152/B 152M, Standard Specification for Copper Sheet, Strip, Plate, and Rolled Bar.
6. ASTM D 4068, Standard Specification for Chlorinated Polyethylene (CPE) Sheeting for Concealed Water-Containment Membrane.
7. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.

PART 2 - PRODUCTS

2.01 Metal Roof Drains

A. Cast Iron, Small Sump, General Purpose Roof Drains:

1. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:
    a. Jay R. Smith Mfg. Co.
    b. Josam Company.
    c. Wade; a subsidiary of McWane Inc.
    d. Zurn Industries, LLC.
    e. Or Approved Equal.
2. Meet ASME A112.6.4, for general purpose roof drains.
3. Body material to be cast iron.
4. Dimension of body to be nominal 9 inch diameter.
5. Combination flashing ring and gravel stop is required.
6. Outlet to be at the bottom.
7. Extension collars are required.
8. Underdeck clamp is required.
9. Expansion joint is required.
10. Dome material to be cast iron.
11. Wire mesh to be brass over dome.
12. Vandal proof dome is required.

2.02 Flashing Materials

A. Copper sheet to meet ASTM B 152/B 152M, 12 oz./square foot.

B. Zinc coated steel sheet to meet ASTM A 653/A 653M, with 0.20 percent copper content and 0.04 inch minimum thickness unless otherwise indicated. Include G90 hot dip galvanized, mill phosphatized finish for painting if indicated.

C. Elastic membrane sheet to meet ASTM D 4068, flexible, chlorinated polyethylene, 40 mil minimum thickness.

D. Fasteners to be metal compatible with material and substrate being fastened.

E. Metal accessories to be sheet metal strips, clamps, anchoring devices and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder to meet ASTM B 32, lead free alloy.

PART 3 - EXECUTION

3.01 Installation

A. Install roof drains at low points of roof areas according to the roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
2. Install expansion joints, if indicated, in roof drain outlets.
3. Position roof drains for easy access and maintenance.

B. Install downspout adapters on outlet of back outlet parapet roof drains and connect to sheet metal downspouts.

C. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

D. Install through penetration fire stop assemblies in plastic conductors at concrete floor penetrations per Section 07841 and Section 07842.

E. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

3.02 Connections

A. Meet the requirements for piping specified in Section 15160. The Contract Drawings indicate general arrangement of piping, fittings and specialties.

3.03 Flashing Installation

A. Fabricate flashing from single piece of metal unless large pans, sumps or other drainage shapes are required. Join flashing according to the following if required:

1. Burn joints of 6.0-lb/square foot lead sheets, 0.0938 inch thickness or thicker. Solder joints of 4.0-lb/square foot lead sheets, 0.0625 inch thickness or thinner.
2. Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe flashing to be sleeve type, matching the pipe size, with a minimum length of 10 inches and with skirt or flange extending at least 8 inches around pipe.
2. Sleeve flashing to be flat sheet, with skirt or flange extending at least 8 inches around sleeve.
3. Embedded specialty flashing to be flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps and other drainage shapes.

3.04 Protection

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 15183

DUCT INSULATION

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of the following equipment to be furnished under this Contract:

1. Duct insulation.

1.02 Submittals

A. Submit product data in the form of manufacturers catalog literature for each product required.

B. Submit shop drawings containing the list of wording, symbols, letter size and color coding for mechanical identification.

C. Submit installation instructions and special procedures for installation.

D. Certify products meet or exceed specified requirements.

E. Record actual locations of tagged equipment; include tag numbers.

1.03 Quality Assurance

A. Meet ASME A13.1 and ANSI Z535.4 requirements for labeling and identification.

B. Maintain one (1) copy of each document on site.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ASME A13.1, Scheme for the Identification of Piping Systems.
2. ANSI Z 535.4, Product Safety Signs and Labels.
3. ASTM C 177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
4. ASTM C 411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
5. ASTM C 423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
6. ASTM C 518, Standard Test Method for Steady-States Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
7. ASTM C 553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
8. ASTM C 665, Standard Specification for Mineral-Fiber Blanket Thermal Insulation for Light Frame Construction and Manufactured Housing.

9. ASTM C 1071, Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material).
10. ASTM E 84, Standard Test Method for Surface Burning Characteristics of Building Materials.
11. ASTM F 25/F 25M, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Duct-Controlled Areas.
12. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
13. UL 723, Tests for Surface Burning Characteristics of Building Materials.

1.04 Qualifications

A. Company specializing in manufacturing products specified in this Section.

B. Company specializing in performing work of this Section.

PART 2 - PRODUCTS

2.01 Manufactures

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Ductwork insulation:
   a. Certaineed.
   b. Schuller (Manville).
   c. Owens Corning.
   d. Or Approved Equal.

2.02 Equipment Insulation

A. Insulation for Equipment:

1. Fire hazard classification:
   a. UL 723, ASTM E 84, NFPA 255.
   b. Flame spread not exceeding 25 and smoke developed not exceeding 100.
2. Provide minimum insulation thickness conforming to schedules or as shown on the Contract Drawings.

2.03 Ductwork Insulation

A. All ductwork insulation to be fiberglass.

B. Flexible Insulation:

1. Scheduled thickness to be Schuller (Manville) Microlite; Or Approved Equal.
2. Factory applied foil scrim vapor barrier facing.
3. Average thermal conductivity not to exceed 0.27 (Btu-IN)/(HR-FT2-°F) at a mean temperature of 75°F (installed).

4. Minimum density to be 0.75 LB/CF.
5. Fire hazard classification:
    a. UL 723, ASTM E 84, NFPA 255.
    b. Flame spread not exceeding 25 and smoke developed not exceeding 100.

C. Semi-Rigid Insulation for Indoor Installation:
1. Scheduled thickness to be Schuller (Manville) #814 SPIN-GLASS; Or Approved Equal.
2. Factory applied vapor barrier facing white scrim foil.
3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT2-°F) at a mean temperature of 75°F.
4. Minimum density to be 3.0 LB/CF.
5. Moisture adsorption:
    a. ASTM C 553.
    b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120° F and 96 percent relative humidity.

D. Semi-Rigid Insulation for Outdoor Installation:
1. Surface with scheduled thickness of Schuller (Manville) 800 Series SPIN-GLASS #815; Or Approved Equal.
2. Factory applied foil scrim vapor barrier facing.
3. Average thermal conductivity not to exceed 0.23 (Btu-IN)/(HR-FT2-°F) at mean temperature of 75°F.
4. Minimum density to be 3 LBS/CF.
5. Fungi and bacteria resistance:
    a. ASTM C 665.
    b. Does not breed or promote growth.

E. Provide minimum insulation thickness conforming to schedule or as shown on the Contract Drawings.

F. Duct Interior Lining Board:
1. Minimum noise reduction coefficients (NRC) is 0.45 when tested in accordance with ASTM C 423 on ASTM F 25/F 25M mounting.
2. Fire Hazard Classification:
    a. UL 723, ASTM E 84, NFPA 255.
    b. Flame spread not exceeding 25 and smoke developed not exceeding 100.
3. Service Temperature:
    a. ASTM C 411.
    b. Cooling and heating ducts up to 200°F.
4. Velocity Rating:
    a. ASTM C 1071.
    b. Maximum average air velocity is rated at 600 feet per minute.

5. Moisture Adsorption:
    a. ASTM C 553.
    b. Not greater than 0.5 percent moisture by volume when exposed to moisture laden air at 120°F and 96 percent relative humidity.
6. Fungi and Bacteria Resistance:
    a. ASTM C 665.
    b. Does not breed or promote growth.
7. Size and Performance:
    a. ASTM C 518 and ASTM C 177.
    b. 1 inch thickness, long textile glass type fibers firmly bonded by thermosetting resin.
    c. At 75°F mean temperature, the k value, expressed as (Btu-IN)/(HR-FT2-°F) does not exceed 0.27.

PART 3 - EXECUTION

3.01 Installation

A. Install products in accordance with the manufacturer's instructions.

B. General:
1. Consider ductwork, piping and equipment as exposed, except as otherwise indicated.
2. Consider ductwork, piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
    a. Consider ductwork, piping and equipment above ceilings as concealed.
3. Provide release for insulation application after installation and testing is complete.
    a. Apply insulation on clean, dry surfaces after inspection.
4. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
5. Provide insulation with vapor barrier for piping, ductwork and equipment where surfaces may be cooler than surrounding air temperatures.
    a. Provide vapor barrier (0.17 perm-inch; ASTM C 553) continuous and unbroken.
    b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor sealed to prevent condensation.
6. Apply specified adhesive, mastics and coatings at the manufacturer's recommended coverage per unit volume.

C. Install equipment per the manufacturer's instructions.

D. Ductwork Insulation:
1. Flexible Insulation:
    a. Butt edges tightly.
        1) Secure insulation with Benjamin Foster 85-20 adhesive; Or Approved Equal; applied in 6 inch strips on 12 inch centers and/or pins, applied on not more than 18 inch centers so that the insulation conforms to the duct surfaces uniformly and firmly.

b. Seal joints with facing overlap or 4 inch wide strips of like facing material adhered and stapled in place.

c. Properly seal any penetration in vapor barrier facing with Benjamin Foster 85-20 adhesive; Or Approved Equal.

d. Cut insulation slightly longer than the perimeter of the duct to ensure full thickness at corners.

2. Semi-Rigid Insulation and Duct Interior Lining Board:

a. Impaling over pins.

1) Apply insulation with edges butted.

2) Apply insulation with mechanically welded fasteners to the duct and secured with speed clips.

3) Clip pins off close to clip.

4) Space pins as required to hold insulation firmly against duct surface but not less than one (1) pin per 1.5 square feet.

5) Seal joints and speed clips with 3 inch wide strip of facing adhered with Benjamin Foster 85-20 adhesive; Or Approved Equal.

b. If the welded pin method is impossible, secure insulation to the duct with Benjamin Foster 85-20 adhesive; Or Approved Equal.

1) Cover the entire surface of duct with adhesive.

2) Use corner metal angle to protect edge of insulation.

3) Protect edge of insulation.

4) Seal joints as above.

E. Install interior duct lining board as indicated above.

1. Overall length shall be as indicated on the Contract Drawings or a minimum of 10 linear feet past any type of air supply fan.

3.02 Repair

A. Whenever any factory applied insulation or job applied insulation is removed or damaged, replace with the same quality or material and workmanship.

3.03 Schedules

A. Ductwork:

1. Fiberglass.

Table 15183 – Fiberglass Ductwork Locations and Insulation Requirements

Duct Service	Insulation and Thickness
Outside air and supply air downstream of heat recovery units, outside building	2 inch semi-rigid for outdoor installation
Outside air ducts, inside building	1 1/2 inch semi-rigid with vapor barrier
Supply air ducts, inside building	1 inch flexible with vapor barrier
Exhaust air ducts upstream of heat recovery units, inside building	1 1/2 inch semi-rigid
Exhaust air ducts upstream of heat recovery units, outside building	1 1/2 inch semi-rigid for outdoor installation

END OF SECTION

SECTION 15184

REFRIGERANT PIPING

PART 1 - GENERAL

1.01 Description

A. This Section includes refrigerant piping used for air conditioning applications.

B. Line test pressure for refrigerant R-134a.

1. Suction lines for air conditioning applications to be 115 psig.
2. Suction lines for heat pump applications to be 225 psig.
3. Hot gas and liquid lines to be 225 psig.

C. Line test pressure for refrigerant R-410A.

1. Suction lines for air conditioning applications to be 300 psig.
2. Suction lines for heat pump applications to be 535 psig.
3. Hot gas and liquid lines to be 535 psig.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

B. Section 15060 - Hangers and Supports

C. Section 15075 - Mechanical Identification

D. Section 15120 - Sleeves and Sleeve Seals

1.03 Submittals

A. Submit product data for each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure regulating valves.

B. Submit shop drawings showing layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop drawing scale to be 1/4 inch equals 1 foot.

2. Refrigerant piping indicated on the Contract Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Submit welding certificates.

D. Submit field quality control test reports.

E. Submit operations and maintenance data for refrigerant valves and piping specialties to include in maintenance manuals.

1.04 Quality Assurance

A. Qualify welding procedures and personnel according to applicable ASME Boiler and Pressure Vessel Code.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ARI 760, Performance Rating of Solenoid Valves for Use with Volatile Refrigerants.
2. ASHRAE 15, Safety Standard for Refrigeration Systems.
3. ASHRAE 34, Designation and Safety Classification of Refrigerants.
4. ASME B16.22, Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings.
5. ASME B31.5, Refrigeration Piping and Heat Transfer Components.
6. ASTM B 32, Standard Specification for Solder Metal.
7. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
8. ASTM B 280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
9. ASTM B 828, Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.
10. AWS A5.8, Specification for Filler Metals for Brazing and Braze Welding.
11. AWS D10.12M/D10.12, Guide for Welding Mild Steel Pipe.
12. Copper Development Association (CDA).
13. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
14. UL 429, Electrically Operated Valves.

1.05 Product Storage and Handling

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.06 Coordination

A. Coordinate size and location of roof curbs, equipment supports and roof penetrations.

PART 2 - PRODUCTS

2.01 Copper Tube and Fittings

A. Copper tube to meet ASTM B 88, Type K or L ASTM B 280, Type ACR.

B. Wrought copper fittings to meet ASME B16.22.

C. Wrought copper unions to meet ASME B16.22.

D. Solder filler metals to meet ASTM B 32. Use 95-5 tin antimony or alloy HB solder to join copper socket fittings on copper pipe.

E. Brazing filler metals to meet AWS A5.8.

F. Flexible Connectors:

1. Body to be tin bronze bellows with woven, flexible, tinned bronze wire reinforced protective jacket.
2. End connections to be socket ends.
3. Offset performance to be capable of minimum 3/4 inch misalignment in minimum 7 inch long assembly.
4. Pressure rating to be factory tested at minimum 500 psig.
5. Maximum operating temperature to be 250°F.

2.02 Valves and Specialties

A. Service Valves:

1. Body to be forged brass with brass cap including key end to remove core.
2. Core to be removable ball type check valve with stainless steel spring.
3. Seat to be polytetrafluoroethylene.
4. End connections to be with copper spring.
5. Working pressure rating to be 500 psig.

B. Solenoid Valves:

1. Meet ARI 760 and UL 429; listed and labeled by an NRTL.
2. Body and bonnet to be plated steel.
3. Solenoid tube, plunger, closing spring and seat orifice to be stainless steel.
4. Seat to be polytetrafluoroethylene.
5. End connections to be threaded.
6. Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2 inch conduit adapter, 208 V AC coil.
7. Working pressure rating to be 400 psig.
8. Maximum operating temperature to be 240°F.
9. Manual operator.

C. Safety Relief Valves:

1. Meet ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Body and bonnet to be ductile iron and steel, with neoprene O-ring seal.
3. Piston, closing spring and seat insert to be stainless steel.
4. Seat disc to be polytetrafluoroethylene.
5. End connections to be threaded.
6. Working pressure rating to be 400 psig.
7. Maximum operating temperature to be 240°F.

2.03 Refrigerants

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.
5. Or Approved Equal.

B. Meet ASHRAE 34, R-134a Tetrafluoroethane.

C. Meet ASHRAE 34, R-410A Pentafluoroethane/Difluoromethane

PART 3 - EXECUTION

3.01 Piping Applications for Refrigerant R-134a

A. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR, annealed temper tubing and wrought copper fittings with brazed or soldered joints.

B. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with soldered joints.

C. Safety relief valve discharge piping to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with soldered joints.

D. Safety Relief Valve Discharge Piping:

1. NPS 1 1/2 and smaller to be copper, Type ACR, annealed temper tubing and wrought copper fittings with brazed or soldered joints.
2. NPS 1 1/2 and smaller to be copper, Type ACR L, drawn temper tubing and wrought copper fittings with brazed or soldered joints.

3.02 Piping Applications for Refrigerant R-410A

A. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR L, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

B. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

C. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.

D. Hot gas and liquid lines, and suction lines for heat pump applications to be copper, Type ACR K L, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.

E. Hot gas and liquid lines, and suction lines for heat pump applications:

1. NPS 5/8 and smaller to be copper, Type ACR K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

2. NPS 3/4 to NPS 1 to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

3. NPS 1 1/4 and smaller to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.

4. NPS 1 1/2 to NPS 2 to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.

F. Safety relief valve discharge piping to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

G. Safety Relief Valve Discharge Piping:

1. NPS 5/8 and smaller to be copper, Type ACR K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

2. NPS 3/4 to NPS 1 to be copper, Type K, annealed or drawn temper tubing and wrought copper fittings with brazed or soldered joints.

3. NPS 1 1/4 and smaller to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with 95-5 tin antimony soldered joints.

4. NPS 1 1/2 to NPS 2 to be copper, Type ACR K, drawn temper tubing and wrought copper fittings with Alloy HB soldered joints.

3.03 Valve and Specialty Applications

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gauge taps at inlet and outlet of hot gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety relief valve discharge line to outside according to ASHRAE 15.

F. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

G. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.
2. Thermostatic expansion valves.
3. Hot gas bypass valves.
4. Compressor.

H. Install receivers sized to accommodate pump down charge.

I. Install flexible connectors at compressors.

3.04 Piping Installation

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems; indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on shop drawings.

B. Install refrigerant piping according to ASHRAE 15.

C. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

H. Install fittings for changes in direction and branch connections.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install piping as short and direct as possible, with a minimum number of joints, elbows and fittings.

K. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels, if valves or equipment requiring maintenance is concealed behind finished surfaces.

L. Install refrigerant piping in protective conduit where installed belowground.

M. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

N. Slope refrigerant piping as follows:

1. Install horizontal hot gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

O. When brazing or soldering, remove solenoid valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion valve bulb.

P. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

Q. Identify refrigerant piping and valves according to Section 15075.

R. Install sleeves for piping penetrations of walls, ceilings and floors. Meet the requirements for sleeves specified in Section 15120.

S. Install sleeve seals for piping penetrations of concrete walls and slabs. Meet the requirements for sleeve seals specified in Section 15120.

T. Install escutcheons for piping penetrations of walls, ceilings and floors. Meet the requirements for escutcheons as per applicable codes.

3.05 Pipe Joint Construction

A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Construct soldered joints according to ASTM B 828 or CDA's "Copper Tube Handbook."

E. Construct brazed joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper phosphorus alloy for joining copper socket fittings with copper pipe.

3.06 Hangers and Supports

A. Hanger, support and anchor products are specified in Section 15060.

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet long.

2. Copper clad hangers and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 to have a maximum span, 60 inches; minimum rod size, 3/8 inch.
2. NPS 5/8 to have a maximum span, 60 inches; minimum rod size, 3/8 inch.
3. NPS 1 to have a maximum span, 72 inches; minimum rod size, 3/8 inch.
4. NPS 1 1/4 to have a maximum span, 96 inches; minimum rod size, 3/8 inch.
5. NPS 1 1/2 to have a maximum span, 96 inches; minimum rod size, 3/8 inch.
6. NPS 2 to have a maximum span, 96 inches; minimum rod size, 3/8 inch.
7. NPS 2 1/2 to have a maximum span, 108 inches; minimum rod size, 3/8 inch.
8. NPS 3 to have a maximum span, 10 feet; minimum rod size, 3/8 inch.
9. NPS 4 to have a maximum span, 12 feet; minimum rod size, 1/2 inch.

D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:

1. NPS 2 to have a maximum span, 10 feet; minimum rod size, 3/8 inch.
2. NPS 2 1/2 to have a maximum span, 11 feet; minimum rod size, 3/8 inch.
3. NPS 3 to have a maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 4 to have a maximum span, 14 feet; minimum rod size, 1/2 inch.

E. Support multi-floor vertical runs at least at each floor.

3.07 Field Quality Control

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Meet ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high and low pressure side piping of each system separately at not less than the pressures indicated in Article 1.01 in this Section.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gauge throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials and retest until satisfactory results are achieved.

3.08 System Charging

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.

2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers. If vacuum holds for twelve (12) hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig.
4. Charge system with a new filter dryer core in charging line.

3.09 Adjusting

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high and low pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set point temperature of air conditioning or chilled water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to the manufacturer's written instructions:

1. Verify that the compressor oil level is correct.
2. Open the compressor suction and discharge valves.
3. Open refrigerant valves except bypass valves that are used for other purposes.
4. Check open compressor motor alignment and verify lubrication for motors and bearings.

END OF SECTION

THIS PAGE NOT USED

SECTION 15400

PLUMBING FIXTURES AND EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section is for the plumbing fixtures and associated elements.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 15060 - Hangers and Supports

C. Section 15080 - Mechanical Insulation

D. Section 15140 - Domestic Water Piping

E. Section 15150 - Sanitary Waste and Vent Piping

1.03 Submittals

A. Submit the following product data:

1. Piping system specialties.
2. Specialty valves.
3. Traps, drains and cleanouts.
4. Plumbing fixtures.

B. Submit the following operations and maintenance data:

1. Manufacturers of plumbing fixtures, trim and fittings shall include complete instructions with their products giving directions for replacing renewable parts of their products as well as instructions for cleaning the finished surfaces of such products.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. American Society of Mechanical Engineers (ASME), Pressure Vessel Code and Interpretations shall govern the quality and performance of certain products as specified herein.
2. ASHRAE 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. ASSE 1010, Performance Requirements for Water Hammer Arresters.
4. ASSE 1011, Performance Requirements for Hose Connection Vacuum Breakers.
5. ASSE 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Principle Fire Protection Backflow Preventers.

6. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
7. International Plumbing Code (IPC).
8. National Electric Manufacturer's Association (NEMA).
9. National Fire Protection Association (NFPA).
10. PDI WH201, Water Hammer Arresters Standard.
11. Underwriters Laboratories, Inc. (UL).

1.05 Delivery, Storage and Handling

A. Protection:

1. Use non-marring tools when making up plated piping to prevent scarring or other surface damage.
2. Provide adequate protective covering on fixtures and trim to prevent damage or defacement.
3. Store fixtures and trim at the site and elsewhere, protected from the elements.
4. Protect motors and electrical apparatus from construction debris and water during plumbing work in the vicinity of such equipment. Such protection may be afforded by using impervious membrane material sheets or other impervious materials of the Contractor's choosing.

PART 2 - PRODUCTS

2.01 Materials

A. Piping system specifications as specified in Section 15140 and Section 15150.

B. Pipe line support materials as specified in Section 15060.

C. Pipe insulating materials as specified in Section 15080.

D. Special Valves:

1. Provide non-freeze design wall hydrant for standard 3/4 inch hose end outlet and of length suited to wall thickness.
   a. Hydrant of cast bronze construction with removable T handle operator, stainless steel operating stem, removable nylon seat, 3/4 inch sweat inlet, rough bronze finish, with vacuum breaker, ASSE 1011.
   b. Manufacturers:
      1) Woodford Model 65.
      2) Zurn Industries, Inc.
      3) Wade.
      4) Or Approved Equal.
2. Trap primer valve to be machined of brass. Valve is not to have any springs. Inlet opening 1/2 inch male NPT, outlet 1/2 inch female NPT. Working pressure range

of 35 psig to 75 psig. Built in vacuum breaker and check valve. Valve suitable for supplying up to four (4) traps using trap primer distribution unit.

a. Manufacturers:
   1) Precision Plumbing Products, Inc; Prime-Rite.
   2) Or Approved Equal.

3. Trap primer distribution unit valve to be connected to outlet of trap primer valve to feed multiple floor drain traps. The unit is to be capable of supplying two (2), three (3) or four (4) traps from a single primer valve as indicated on the Contract Drawings.
   a. Manufacturers:
      1) Precision Plumbing Products, Inc.:
         a) Two (2) traps to be Model DU-2.
         b) Three (3) traps to be Model DU-3.
         c) Four (4) traps to be Model DU-4.
      2) Or Approved Equal.

E. Traps, Drains and Cleanouts:

1. Manufacturers:
   a. Watts Drainage.
   b. Zurn Industries, Inc
   c. Jay R. Smith Co.
   d. Or Approved Equal.

2. Pipe Traps:
   a. Provide P-traps in piping systems, as required by local prevailing code, composed of materials and joint style to match particular system piping.
      1) Floor drains connected to the Sanitary Drain System (SAN) are to have a deep seal trap with a 4 inch seal depth. This requirement does not apply to plumbing fixtures where the trap is specified in the plumbing fixture description.

3. Floor Drains:
   a. Drain outlets suited to the joint style of piping to which they are connected; provide side outlet drains where required.
   b. Floor Drain (FD-1) to be on-grade epoxy coated cast iron floor drain with anchor flange, weep-holes, adjustable round nickel bronze strainer and outlet compatible with drainage piping.
      1) Options:
         a) Strainer to be 5 inches.
         b) Discharge pipe size to be 4 inches.
         c) Trap primer connection.
      2) Manufacturers:
         a) Watts Drainage Model FD-200.
         b) Or Approved Equal.
   c. Floor Drain (FD-2) to be on-grade epoxy coated cast iron floor drain with anchor flange, weep-holes, adjustable round nickel bronze strainer and outlet compatible with drainage piping.

1) Options:
   a) Strainer to be 5 inches.
   b) Discharge pipe size to be 4 inches.
   c) Trap primer connection.
   d) 6 inch round nickel bronze funnel.
2) Manufacturers:
   a) Watts Drainage Model FD-200.
   b) Or Approved Equal.

d. Floor Drain (FD-3) to be on-grade epoxy coated cast iron floor drain with anchor flange, weep-holes, adjustable round nickel bronze strainer and outlet compatible with drainage piping.
   1) Options:
      a) Strainer to be 8 inches.
      b) Discharge pipe size to be 4 inches.
      c) Trap primer connection.
   2) Manufacturers:
      a) Watts Drainage Model FD-200.
      b) Or Approved Equal.

e. Floor Drain (FD-4) to be epoxy coated cast iron area drain with anchor flange, membrane clamp with weep-holes, 12 1/2 inch diameter adjustable top, loose set ductile iron grate supported by bucket and no hub connection (standard).
   1) Options:
      a) Vandal Proof.
      b) Sediment bucket.
      c) Backwater valve.
      d) Discharge pipe size to be 4 inches.
   2) Manufacturers:
      a) Watts Drainage Model FD-340.
      b) Or Approved Equal.

F. Cleanouts, Cover Plates and Caps:

1. Cast iron body with epoxy coating and ABS plastic plug with gasket.
   a. Floor cleanout (concrete) to be heavy duty ductile iron top suitable for Extra Heavy Duty (XHD) load class with vandal proof screws. Provide floor cleanout from one (1) of the following manufacturers:
      1) Watts Drainage C0-260.
      2) Or Approved Equal.
   b. Cleanout Ferrule:
      1) Manufacturers:
         a) Watts Drainage C0-380.
         b) Or Approved Equal.

c. Cleanout Tee:
   1) Manufacturers:
      a) Watts Drainage C0-460.
      b) Or Approved Equal.

G. Plumbing Fixtures:

1. Provide glazed finish fixtures free from discoloration, chips, flaws, craze and absorbency. Vitreous ware shall be fired first quality china, thoroughly fused and homogenous in color, close grained and free from pores.

2. Fittings and Trim:
   a. Provide fixture fittings and trim of chrome plated brass, and unless specified otherwise, of the same manufacturer as the fixtures, including P-traps, supply pipes, supply stops, union connections and escutcheons.
   b. Use fixture trim of such design that working threads, seats and discs are easily renewed without taking the body of the fitting apparatus from the fixture or supply lines.

3. Provide fixture supports and carriers designed to accommodate the fixture types as specified and as suited to the particular installation requirements of such fixtures.
   a. Manufacturers:
      1) Josam Manufacturing Co.
      2) Zurn Industries, Inc.
      3) Wade Division-Tyler Pipe.
      4) Jay R. Smith Manufacturing Co.
      5) Ancon, Inc.
      6) Or Approved Equal.

4. Fixture color to be white except where indicated otherwise in the Fixture Schedule.

5. Manufacturers:
   a. Fixtures:
      1) American Standard.
      2) Kohler.
      3) Eljer.
      4) Or Approved Equal.
   b. Seats:
      1) Church.
      2) Kohler.
      3) Olsonite.
      4) Or Approved Equal.
   c. Flush Valves:
      1) Sloan Valve Company.
      2) Zurn Industries, Inc.
      3) Delany.
      4) Or Approved Equal.

d. Faucets:
   1) American Standard.
   2) Kohler.
   3) Eljer.
   4) Or Approved Equal.
e. Sensor Faucets:
   1) Sloane Valve Company.
   2) Zurn Industries, Inc.
   3) Or Approved Equal.
f. Trim (Supply and Drain):
   1) McGuire Manufacturing.
   2) Zurn Industries, Inc.
   3) Or Approved Equal.
g. Piping Safety Covers:
   1) Tru-Bro.
   2) Pro-Wrap.
   3) Or Approved Equal.
h. Fixture Carriers:
   1) Zurn Industries.
   2) Josam Manufacturing Co.
   3) Jay R. Smith Co.
   4) Or Approved Equal.
i. Mop Service Basins:
   1) Fiat Products, Inc.
   2) Mustee.
   3) Stern Williams.
   4) Or Approved Equal.

6. Water Closets:
   a. Bowl to be 1.6 GPF water saver, floor mounted, elongated, vitreous china, siphon jet action, 17 inch high bowl, 10 inch rough in, 1 1/2 inch top spud. Provide water closet bowl from one (1) of the following manufacturers:
      1) Model 3043.102 Madera.
      2) Or Approved Equal.
   b. Seat to be white hydraulically compressed plastic, elongated open front less cover, self-sustaining, with stainless steel hinge posts and concealed check. Provide water closet seat from one (1) of the following manufacturers:
      1) Model 9500-SSC.
      2) Or Approved Equal.
   c. Flush valves to be chrome plated, metal oscillating non-hold open handle, 1 inch IPS screwdriver angle stop, with protective cap, adjustable tailpiece, vacuum breaker flush connection and spud coupling for 1 1/2 inch top spud, wall and spud flanges. Flushes on 1.6 gallons. Provide water closet flush valves from one (1) of the following manufacturers:
      1) Model Royal 111.

2) Or Approved Equal.

7. Lavatories:
   a. Bowl to be wall hung design of vitreous china with front overflow, D-shaped bowl, faucet holes on 8 inch centers, and splash shields (20 inches by 18 inches). Provide lavatory bowls from one (1) of the following manufacturers:
      1) Model 0355.015 Lucerne.
      2) Or Approved Equal.
   b. Faucet to be a combination lavatory faucet, ceramic disc valve cartridges with one (1) piece body on 8 inch centers, 1/2 inch male threaded inlets, coupling nuts, 4 inch spout, pop-up drain with 1 1/4 inch tailpiece, aerator, wrist blade handles, chrome finish. Provide lavatory faucets from one (1) of the following manufacturers:
      1) Model 6802.372H Heritage.
      2) Or Approved Equal.
   c. Supply piping to be 3/8 inch angle valve, wheel handle, 3/8 inch male threaded inlet, escutcheon, flexible tube riser, chrome finish. Provide lavatory supply piping from one (1) of the following manufacturers:
      1) Model 165LK.
      2) Or Approved Equal.
   d. Drain to be an adjustable cast brass P-trap, swivel-ell, 1 1/4 inch inlet, 1 1/4 inch outlet, cleanout plug, chrome finish. Provide lavatory drains from one (1) of the following manufacturers:
      1) Model 8088.
      2) Or Approved Equal.
   e. Drain and trim insulation kit to be molded closed cell insulation meeting ASTM D 635. Kit shall insulate drain, p-trap, valves and supplies. Stop valves accessible without insulation disassembly; flush nylon fasteners.

8. Mop Service Basins
   a. Floor mounted molded stone and resin one (1) piece homogeneous unit, 24 inches by 24 inches by 10 inches, with cadmium plated brass drain body and combination dome strainer of type 302 stainless steel. Provide mop service basins from one (1) of the following manufacturers:
      1) Model MSB-2424.
      2) Or Approved Equal.
   b. Service faucet to be chrome plated with vacuum breaker, integral stops, wall brace, pail hook and 3/4 inch hose thread on spout, four arm handles, body inlets, 8 inch centers. Provide mop service basin faucets from one (1) of the following manufacturers:
      1) Model 830-AA.
      2) Or Approved Equal.
   c. Trim to be vinyl bumper guard, 30 inch of 5/8 inch diameter rubber hose, hose clamp, mop hanger. Provide mop service basin trim from one (1) of the following manufacturers:
      1) Model E-77-AA, No. 832-AA, No. 889-CC.
      2) Or Approved Equal.

H. Lavatory Carriers:
   1. Carrier to be concealed arm design, coated rectangular steel uprights with welded feet, cast iron adjustable headers, concealed arms, steel sleeves, alignment truss and

mounting fasteners. Provide lavatory carriers from one (1) of the following manufacturers:

a. Model Z-1231.

b. Or Approved Equal.

I. Backflow Preventers:

1. Reduced Pressure Backflow Preventers:

a. Meet ASSE 1013 requirements.

b. Bronze body, with bronze internal parts and stainless steel springs.

c. Two (2) independently operating, spring loaded check valves; diaphragm type differential pressure relief valve located between check valves; third check valve opening under back pressure in case of diaphragm failure; non-threaded vent outlet; assembled with two (2) gate valves, strainer and four (4) test cocks.

d. Manufacturers:

1) Watts Regulator Series 909.

2) Or Approved Equal.

J. Mixing Valve Stations:

1. Manufacturers:

a. Leonard.

b. Armstrong.

c. Or Approved Equal.

2. Domestic water mixing valve station having a minimum flow rate of 1 gallon per minute with a 15 psi maximum pressure drop at 13 gallons per minute.

a. Adjustable mixed water temperature.

b. Suitable for wall mounting.

c. Suitable to mixing 140°F and 40°F degree water to provide 110°F leaving tempered water temperature for use in domestic hot water applications.

d. Manufacturers:

1) Model TM-28-E.

2) Or Approved Equal.

K. Water heater to be electric, vertical storage tank, UL listed, 150 psi working pressure.

1. Steel tank with glass lining of an alkaline borosilicate composition that has been fused by firing at a temperature up to 1600°F, fittings for inlet and outlet piping, ASME temperature/pressure relief valves, electrical connection, drain and brass valve, extruded magnesium rod for cathodic protection.

2. Steel jacket with baked enamel finish, foam insulation of thickness to meet ASHRAE 90.1.

3. Elements to be heavy duty, screw in type, incoloy sheaths and ceramic terminal blocks, medium watt density.

4. Adjustable immersion thermostat, 120 V control transformer, magnetic contactors, power circuit fusing, manual reset high temperature cut off, thermostat sequence controls.

5. Manufacturers:
    a. Model DVE 120.
    b. Or Approved Equal.

L. Water hammer arresters to be threaded type of corrosion resistant construction and pneumatic displacement, elastomer bellows design. Provide at all fixtures or equipment with fast opening or closing valves.

1. Water hammer arresters tested, certified and sized per PDI WH201.

2. Manufacturers:
    a. Josam Manufacturer 75001-S to 75006-S.
    b. Watts.
    c. Wade.
    d. Or Approved Equal.

PART 3 - EXECUTION

3.01 Installation

A. Install those products, as specified under Part 2 in this Section and not specifically covered for installation under Part 3 in this Section, in strict accordance with the manufacturer's installation instructions and at locations indicated on the Contract Drawings.

1. Equipment support and anchoring as specified in Section 15060.

B. Piping:

1. Fabrication and installation as specified in Section 15140 and Section 15150.

2. Pipe insulation as specified in Section 15080.

3. Supply Piping Installation Requirements:
    a. Do not install piping in a manner which can create a direct cross connection or an inter-connection between potable water and polluted water, or in a manner whereby a backflow of polluted water into the potable water system could occur.
    b. In the case where fixture fittings are equipped with screw drive stops, and supply pipes are equipped with stops, such stops shall serve as the shut off valve.
    c. Hose Bibb Installation:
        1) 30 inches above finished floor for interior locations.
        2) Non-freeze, 30 inches above grade for exterior locations.

C. Plumbing Fixtures:

1. Securely anchor surface mounted fixture hangers and supports into the structure using anchors and fasteners as specified in Section 15060.
    a. Install fixture carriers according to the manufacturer's installation instructions using fasteners as previously referenced.
    b. Provide chrome plated nuts, cap nuts, screw heads and washers where such are required in an exposed installation.

2. Fixture Installation:
    a. Install wall hung fixtures plumb and square with respect to the visible structure lines.

b. Set floor mounted fixtures securely anchored in position symmetrical with the floor plan.
c. Install water closets with sponge rubber closet flange gaskets; substitutes not permitted.
d. Install bead of sealant between fixture and floor and wall.

3.02 Field Quality Control

A. Finished Plumbing Test:

1. After fixtures are set and their traps filled with water perform final test on plumbing system for gas and water tightness.
2. Backflow preventer to be tested by a Certified Backflow Preventer Tester in accordance with the Plumbing Code requirements.
3. After filling all traps with water introduce a pungent, thick smoke into system until smoke exits roof vents, then plug vents and pressurize system equivalent to a 1 inch water column and maintain pressure until system inspection is completed.
4. Where smoke test is not allowed a peppermint test may be substituted. After filling all traps place 2 ounces of oil of peppermint into roof vents followed immediately by 10 quarts of hot (160°F) water and seal roof vents. Exclude persons having come in contact with peppermint from test area. A positive test (leakage) is detection of peppermint odor at any point in the system.
5. Where code prohibits above test method, test system for gas and water tightness by plugging roof vents and building drain, filling traps with water and introducing air pressure into the system equivalent to 1 inch water column. Maintain pressure without introduction of additional air until system inspection is completed.
6. Inspect rough-ins and determine exact fixture location with respect to the Contract Drawings.
7. Do not proceed until fixture positions are verified, or any adjustments in fixture locations are approved.

END OF SECTION

SECTION 15412

EMERGENCY PLUMBING FIXTURES

PART 1 - GENERAL

1.01 Description

A. Section includes:

1. Eyewash equipment.

1.02 Related Sections

A. The Contract Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 15075 – Mechanical Identification

1.03 Submittals

A. Submit product data for each type of product indicated. Include flow rates and capacities, furnished specialties and accessories.

B. Submit shop drawings including diagram power, signal and control wiring.

C. Submit product certificates of performance testing specified in Article 2.02 in this Section.

D. Submit field quality control test reports.

E. Submit operations and maintenance data for emergency plumbing fixtures to include in operations and maintenance manuals.

F. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Provide a separate lot of flushing fluid solution equal to at least 200 percent of amount of solution installed for each self-contained unit.

1.04 Quality Assurance

A. Electrical components, devices and accessories to be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI Z358.1, Emergency Eyewash and Shower Equipment.

2. NSF 61 Annex G, Drinking Water System Components - Health Effects.

3. ICC A117.1, Standard for Accessible and Usable Buildings and Facilities.

4. NFPA 70, National Electrical Code (NEC).

5. Public Law 90-480, Architectural Barriers Act.

6. Public Law 101-336, Americans with Disabilities Act.

1.05 Definitions

A. Accessible Fixture is an emergency plumbing fixture that can be approached, entered and used by people with disabilities.

B. Self-Contained Emergency Plumbing Fixture is a fixture with flushing fluid solution supply.

1.06 Maintenance Material Submittals

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Flushing fluid solution to be separate lot and equal to at least 200 percent of amount of solution installed for each self-contained unit.

PART 2 - PRODUCTS

2.01 Eyewash Equipment

A. Standard, Self-Contained Eyewash Units:

1. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:
   a. Fend-all.
   b. Or Approved Equal.
2. Capacity to be not less than 0.4 gallons per minute for at least fifteen (15) minutes.
3. Gravity tank to be 7 gallon, plastic and suitable for shelf mounting.
4. Flushing fluid to be medically acceptable solution manufactured and labeled according to applicable regulations.
5. Actuator to be pull down front panel.
6. Spray heads to be protected, two (2) mounted on tank.

2.02 Source Quality Control

A. Certify performance of emergency plumbing fixtures by an independent testing organization acceptable to authorities having jurisdiction.

PART 3 - EXECUTION

3.01 Examination

A. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Identification

A. Install equipment nameplates or equipment markers on emergency plumbing fixtures and equipment and equipment signs on water tempering equipment. Meet the requirements for identification materials specified in Section 15075.

3.03 Field Quality Control

A. After plumbing connections have been made, test for compliance with requirements for mechanical component testing. Verify ability to achieve indicated capacities.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection.
2. After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
3. After electrical circuitry has been energized, start units to confirm proper unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Emergency plumbing fixtures will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.04 Adjusting

A. Adjust or replace fixture flow regulators for proper flow.

B. Adjust equipment temperature settings.

END OF SECTION

THIS PAGE NOT USED

SECTION 15700

HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of heating, ventilating and air conditioning equipment and associated elements.

B. Air conditioning, heating and ventilation systems for switchgear area and battery room shall have the capacity to operate under the following conditions:

1. Outside Temperature:
   a. Summer dry bulb to be 104°F and wet bulb to be 78°F.
   b. Winter dry bulb to be minus 10°F.
2. Inside Temperature:
   a. Switchgear Area:
      1) Summer dry bulb to be 80°F.
      2) Winter dry bulb to be 68°F.
   b. Battery Room:
      1) Summer dry bulb to be 80°F.
      2) Winter dry bulb to be 68°F.
   c. Communications Room:
      1) Summer dry bulb to be 80°F.
      2) Winter dry bulb to be 68°F.

1.02 Related Sections

A. Section 01810 – Commissioning of Systems

1.03 Submittals

A. Submit product data for the following equipment:

1. Split system air conditioning units.
2. Exhaust fans.
3. Propeller unit heaters.
4. Energy recovery ventilators.

1.04 Quality Assurance

A. Electrical components, devices and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

B. Meet the applicable provisions of the most recent issues of the following references:

1. AHRI 1060, Performance Rating of Air-to-Air Heat Exchangers for Energy Recovery Ventilation Heat Equipment (I-P).
2. AMCA 204, Balance Quality and Vibration Levels for Fans.
3. AMCA 300, Reverberant Room Method for Sound Testing of Fans.
4. AMCA 301, Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
5. ARI 210/240, Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
6. ASHRAE 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size (ANSI Approved).
7. ASHRAE 62.1, Ventilation for Acceptable Indoor Air Quality (ANSI Approved).
8. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
9. ASTM A 653/A 653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
10. ASTM B 88, Standard Specification for Seamless Copper Water Tube.
11. ASTM B 117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
12. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
13. ISO 9001, Quality Management Systems - Requirements.
14. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
15. NEMA MG 1, Motors and Generators.
16. NFPA 70, National Electrical Code (NEC).
17. NFPA 90A, Installation of Air Conditioning and Ventilating Systems.
18. NFPA 90B, Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
19. NFPA 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
20. SMACNA HVAC Duct Construction Standards, Metal and Flexible.
21. SMACNA Thermoplastic Duct (PVC) Construction Manual.
22. SMACNA HVAC Systems - Testing, Adjusting and Balancing.
23. UL 181, Factory-Made Air Ducts and Connectors.
24. UL 555, Fire Dampers.
25. UL 555S, Smoke Dampers.
26. UL 705, Power Ventilators.
27. UL 823, Electric Heaters for Use in Hazardous (Classified) Locations.
28. UL 2021, Fixed and Location-Dedicated Electric Room Heaters.

1.05 Operations and Maintenance Data

A. The manufacturers of the products specified herein shall include complete instructions with their products giving directions for replacing renewable parts of their products as well as instructions for cleaning the finished surfaces of such products.

PART 2 - PRODUCTS

2.01 Indoor Units

A. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:

1. Friedrich.
2. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.
3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.
4. Or Approved Equal.

B. Wall Mounted, Evaporator Fan Components:

1. Cabinet to be enameled steel with removable panels on front and ends in color selected by SEPTA and discharge drain pans with drain connection.
2. Refrigerant coil to be copper tube, with mechanically bonded aluminum fins and thermal expansion valve to meet ARI 210/240.
3. Electric coil to be helical nickel chrome, resistance wire heating elements; with refractory ceramic support bushings, automatic reset thermal cutout, built-in magnetic contactors, manual reset thermal cutout, airflow proving device and one (1) time fuses in thermal box for overcurrent protection.
4. Fans to be direct drive, centrifugal.
5. Fan Motors:
    a. Meet NEMA designation, temperature rating, service factor, enclosure type and efficiency requirements specified in Division 15 Sections.
    b. Multi-tapped, multi-speed with internal thermal protection and permanent lubrication.
    c. Enclosure type to be total enclosed, fan cooled.
    d. NEMA Premium ™ efficient motors as defined in NEMA MG 1.
    e. Controllers, electrical devices, and wiring to meet the requirements for electrical devices and connections specified in Division 16 Sections.
    f. Mount unit mounted disconnect switches on exterior of units.
6. Surfaces in contact with the airstream to meet the requirements in ASHRAE 62.1.
7. Condensate Drain Pans:
    a. Fabricated with 1 percent slope in at least two (2) planes to collect condensate from cooling coils (including coil piping connections, coil headers and return bends) and humidifiers, and to direct water toward drain connection.
        1) Extend drain pan downstream from leaving face to meet ASHRAE 62.1.
    b. Single wall, stainless steel sheet.

c. Drain connection to be located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.

d. Pan top surface coating to be asphaltic waterproofing compound.

8. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Meet NFPA 90A.

2) Minimum resistance and MERV to meet ASHRAE 52.2.

3) Filter holding frames to be arranged for flat orientation, with access on both sides of unit. Filters shall be removable from one (1) side or lifted out.

9. Disposable Panel Filters:

1) Factory fabricated, viscous coated, flat panel type.

2) Thickness to be 1 inch.

3) MERV 5 according to ASHRAE 52.2.

4) Media to be interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.

5) Frame to be flame resistant cardboard.

2.02 Outdoor Units

A. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:

1. Friedrich.

2. Carrier Corporation; Home Comfort and HVAC Building & Industrial Systems.

3. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.

4. Or Approved Equal.

B. Air Cooled, Compressor Condenser Components:

1. Casing to be steel, finished with baked enamel in color selected by SEPTA, with removable panels for access to controls, weep holes for water drainage and mounting holes in base. Provide brass service valves, fittings and gauge ports on exterior of casing.

2. Compressor to be hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal and current sensitive overload devices, start capacitor, relay and contactor.

a. Compressor to be scroll type.

b. Two (2) speed compressor motor with manual reset high pressure switch and automatic reset low pressure switch.

c. Refrigerant charge to be R-407C or R-410A.

d. Refrigerant coil to be copper tube, with mechanically bonded aluminum fins and liquid sub-cooler to meet ARI 210/240.

3. Heat pumps to have reversing valve and low temperature air cutoff thermostat.

4. Fans to be aluminum propeller type, directly connected to motor.

5. Motor to be permanently lubricated, with integral thermal overload protection.

6. The low ambient kit permits cooling operation down to 15°F.

2.03 Accessories

A. Thermostat to be wireless infrared functioning to remotely control compressor and evaporator fan, with the following features:

1. Compressor time delay.
2. Twenty-four (24) hour time control of system stop and start.
3. Liquid crystal display indicating temperature, set point temperature, time setting, operating mode and fan speed.
4. Fan speed selection including auto setting.

B. Automatic reset timer to prevent rapid cycling of compressor.

C. Refrigerant line kits to be soft annealed copper suction and liquid lines factory cleaned, dried, pressurized and sealed; factory insulated suction line with flared fittings at both ends.

D. Provide drain hose for condensate.

E. Wiremold 4000 to enclose refrigerant and condensate piping where exposed to view in normally occupied spaces

2.04 Louvered Exhaust Fan

A. Description:

1. Fan shall be wall mounted, belt or direct driven, propeller exhaust fan.

B. Certifications:

1. Fan shall be listed by UL 705.

C. Construction:

1. The fan shall be of bolted construction utilizing corrosion resistant fasteners.
2. The motor, bearings and drives shall be mounted on a welded tubular steel power assembly.
3. The power assembly shall be rigidly secured to the fan housing.
4. The fan housing shall include a minimum 14 gauge base with integral spun venture and continuously welded curb cap corners.
5. Unit shall bear an engraved aluminum nameplate.
6. Nameplate shall indicate design CFM, static pressure and maximum fan RPM.

D. Coating:

1. All un-galvanized steel fan components shall have an electrostatically applied, baked polyester powder coating.
2. Paint must exceed one thousand (1,000) hour salt spray under ASTM B 117 test method.

E. Propeller:

1. Propeller shall be extruded aluminum airfoil design with cast aluminum hub.

2. The blade pitch shall be factory set and locked using set screws and roll pin.
3. The hub shall be keyed and securely attached to the shaft utilizing two (2) set screws or a taper lock bushing.
4. Propeller shall be balanced in accordance with AMCA 204.

F. Motor:

1. Motor shall be heavy duty type with permanently lubricated sealed ball bearing and furnished at the specified voltage, phase and enclosure.

G. Bearings:

1. Bearings shall be designed and individually tested specifically for use in air handling applications.
2. Construction shall be heavy duty regreasable ball type in a cast iron housing selected for a minimum L50 life in excess of two hundred thousand (200,000) hours at maximum cataloged operating speed.

H. Belts and Drives:

1. Belts shall be oil and heat resistant, non-static type.
2. Drives shall be precision machined cast iron type, keyed and securely attached to the wheel and motor shafts.
3. Drives shall be sized for 150 percent of the installed motor horsepower.
4. The variable pitch motor must be factory set to the specified RPM.

I. Capacity:

1. As scheduled.

2.05 Centrifugal Exhaust Fan:

A. Description:

1. Fan shall be designed to discharge air in a 360 degree pattern, away from the building, of capacity, motor characteristics and drive type as indicated on the Contract Drawings.

B. Fan construction as follows:

1. Housing to be of mill finish spun aluminum, incorporating rubber grommeted internal wiring passage, weather proof ventilated motor compartment and bird screen network of polyvinyl chloride coated steel or expanded aluminum mesh. Fan inlet to have a spun venture throat and an integral attachment collar or angle ring to receive through the wall sleeve.
2. Motor to be UL listed and of open drip proof type and resiliently mounted and sealed from the air stream. Motor to be provided with thermal overload protection and a factory mounted and wired UL approved non-fused disconnect switch within the motor compartment.
3. Fan wheel to overlap fan housing venture throat and be backwardly curved centrifugal wheel on a spun cone. Fan wheel shafts to be on bearing driven fans mounted in heavy duty permanently lubricated pillow block ball bearings. Drive pulleys to be of cast iron

type keyed to motor shafts. Fan wheel statically and dynamically balanced and shall bear the AMCA seal of air performance. Fan and drive to be mounted on vibration isolation mounts designed to prevent vibration transmission to the structure.

4. Fan wheel to be of spark proof construction and operation.
5. Where indicated on the Contract Drawings, provide the following fan manufacturer's accessories:
    a. Factory mounted and wired solid state speed controller to control capacity from 0 to 100 percent.
    b. Explosion proof motors to meet the requirements of Class I, Division I, Group D Hazardous Locations.
    c. Corrosion resistant polyester reinforced fiberglass, fire retardant coating on fan wheels/blades, housing, brackets and all other non-rotating parts factory applied to 30 mils thickness.
    d. Two (2) speed, 1800/900 RPM, one (1) winding motor to provide 100/50 percent capacity.
    e. Two (2) speed, 1800/1200 RPM, one (1) winding motor to provide 100/67 percent capacity.
6. Manufacturers:
    a. Penn Barry - Fumex.
    b. Cook.
    c. Greenheck.
    d. Or Approved Equal.

2.06 Fan forced Wall Heaters

A. Meet UL 823 and UL 2021.

B. Subject to compliance with the requirements, provide products by one (1) of the following manufacturers:
    1. Omark.
    2. Airtherm, A Mestek Company.
    3. McQuay International.
    4. Or Approved Equal.

C. Description:
    1. Assembly including casting, coil, fan and motor in vertical and horizontal discharge configuration with adjustable discharge louver.

D. Housing:
    1. Finish shall be baked enamel.
    2. Airstream surface in contact with the airstream shall meet the requirements in ASHRAE 62.1.
    3. Louver shall be adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

E. Electrical Resistance Heating Coil:

1. Nickel chromium heating wire, free from expansion noise and 60 Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion resistant metallic sheath with fins no closer than 0.16 inch.

2. Element end shall be enclosed in terminal box.

3. Fin surface temperature shall not exceed 550°F at any point during normal operation.

F. Fan and Motor:

1. Fan to be propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

2. Motor to be permanently lubricated, multi-speed.

G. Controls:

1. Wall mounted thermostat.

H. Size and capacity as scheduled on the Contract Drawings.

2.07 Energy Recovery Ventilators

A. Subject to compliance with requirements, provide products by one (1) of the following manufacturers:

1. Greenheck, Inc.

2. Mistsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.

3. Vemar CES Inc.

4. Or Approved Equal.

B. Surfaces in contact with the airstream to meet requirements in ASHRAE 62.1.

C. Housing to be the manufacturer's standard construction with corrosion protection coating and exterior finish, hinged access door or removable panels, with neoprene gaskets or inspection and access to internal parts, minimum 1 inch thick thermal insulation, knockouts for electrical and piping connections, exterior drain connection and lifting lugs.

D. Enthalpy wheel certified to AHRI 1060.

E. Provide unit meeting minimum energy recover effectiveness indicated in the Energy Recovery Ventilator Schedule shown on the Contract Drawings.

F. Supply and exhaust fans to be forward curved, centrifugal.

1. Motor and drive to be direct driven or belt driven with adjustable sheaves, motor mounted on adjustable base.

2. Motor sizes to be as indicated. If not indicted, large enough so driven load will not require motor to operate in service factor range above 1.0.

G. Disposable Panel Filters:

1. Meet NFPA 90A.

2. Filter holding frames to be arranged for flat or any orientation, with access doors on both sides of unit. Filters shall be removable from one (1) side or lift out from access plenum.
3. Factory fabricated, viscous coated, flat panel type.
4. Thickness to be 1 inch.
5. Minimum resistance to be 80, according to ASHRE 52.2.
6. Minimum MERV 5, according to ASHRA 52.2.
7. Media to be interlaced glass fibers sprayed with nonflammable adhesive.

H. Fabricated units to have space within housing for piping and electrical conduits. Wire motors and controls are only external connections are required during installation.

1. Indoor enclosure to be NEMA 250, Type 12 enclosure contains relays, starters and terminal strip.
2. Include non-fused disconnect switches.

I. Accessories:

1. Isolation dampers to be opposed blade, galvanized steel, aluminum or extruded aluminum dampers with cadmium plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized steel, aluminum or extruded aluminum frame with operating rods connected with a common linkage and electric damper operator factory wired. Blades shall have gaskets and edge seals, and shall be mechanically fastened to operating rod.
2. Duct flanges.
3. Rubber-in-shear isolator for ceiling mounted units.

J. Provide warranty on the manufacturer's standard form in which manufacturer agrees to repair or replace components of air-to-air energy recovery equipment that fail in materials or workmanship within specific warranty period.

PART 3 - EXECUTION

3.01 Examination

A. Examine areas and conditions, with the installer present, for compliance with requirements for installation tolerance and other conditions affecting performance of the work.

B. Examine casting insulation materials and filter media before air-to-air energy recovery equipment installation. Reject insulation materials and filter media that are wet, moisture damaged or mold damaged.

C. Examine roughing-in for electrical services to verify actual locations of connection before installation.

D. Proceed with installation only after unsatisfactory conditions has been corrected.

3.02 Installation

A. Install unit level and plumb.

B. Install evaporator fan components using the manufacturer's standard mounting devices securely fastened to building structure.

C. Install compressor condenser components on equipment supports. Anchor unit to supports with removable, cadmium plated fasteners.

D. Install and connect pre-charged refrigerant tubing to component's quick connect fittings. Install tubing to allow access to unit.

E. Suspend units from structural steel support frame using threaded steel rods and spring hangers.

F. Install units with clearances for service and maintenance.

G. Install new filters at completion of equipment installation and before testing, adjusting and balancing.

H. Pipe drains from drain pans to the nearest floor drain using ASTM B 88, Type L, drawing temper copper water tubing with soldered joints, same size as condensate drain connections.

3.03 Connections

A. Where piping is installed adjacent to unit, allow space for service and maintenance of units.

3.04 Field Quality Control

A. Engaged a factory authorized service representative to inspect, test and adjust components, assemblies and equipment installations, including connections.

B. Perform Tests and Inspections:

1. Engage a factory authorized service representative to inspect components, assemblies and equipment installations, including connections, and to assist in testing.

C. Tests and Inspections:

1. After installation, charge system and test for leaks. Repair leaks and retest units until no leaks exist.

2. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

F. Connect piping to units mounted on vibration isolators with flexible connectors.

G. Connect cooling condensate drain pans with air seal trap at connection to drain pan and install cleanouts at changes in pipe direction.

3.05 Equipment Start-Up

A. Engage a factory authorized service representative to perform startup service.

1. Complete installation and startup checks according to the manufacturer's written instructions.

B. The Contractor shall provide factory supervision for his start-up of equipment. Factory supervision shall include inspection of the equipment and refrigeration system prior to the start-up.

C. The Contractor shall perform equipment start-up and insure its proper operation prior to acceptance of work.

3.06 Demonstration

A. Engage a factory authorized service representative to train SEPTA maintenance personnel to adjust, operate and maintain units.

END OF SECTION

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SECTION 15794

ELECTRIC UNIT HEATERS

PART 1 - GENERAL

1.01 Related Documents

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 Summary

A. Section includes wall and ceiling heaters with propeller fans and electric-resistance heating coils.

1.03 Action Submittals

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings:

1. Include plans, elevations, sections, and details.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include details of anchorages and attachments to structure and to supported equipment.
4. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
5. Wiring Diagrams: Power, signal, and control wiring.

C. Samples: For each exposed product and for each color and texture specified.

1.04 Closeout Submittals

A. Operation and Maintenance Data: For wall and ceiling unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Modine.
2. Markel; TPI Corporation.

3. QMark; Marley Engineered Products.
4. Trane Inc.

2.02 Description

A. Assembly including chassis, electric heating coil, fan, motor, and controls. Comply with UL 2021.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.03 Cabinet

A. Front Panel: Extruded-aluminum bar grille, with removable panels fastened with tamperproof fasteners.

B. Finish: Baked enamel over baked-on primer with manufacturer's standard color selected by Architect, applied to factory-assembled and -tested wall and ceiling heaters before shipping.

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

D. Surface-Mounted Cabinet Enclosure: Steel with finish to match cabinet.

2.04 Coil

A. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in corrosion-resistant metallic sheath. Terminate elements in stainless-steel, machine-staked terminals secured with stainless-steel hardware, and limit controls for high-temperature protection Provide integral circuit breaker for overcurrent protection.

2.05 Fan And Motor

A. Fan: Aluminum propeller directly connected to motor.

B. Motor: Permanently lubricated.

2.06 Controls

A. Controls: Wall mounted thermostat and Low-voltage relay with transformer kit as required to integrate with the BAS/ATC system or the BAS/ATC sub contractor shall provide thermostat/sensor able to unit controls.

B. Electrical Connection: Factory wire motors and controls for a single field connection with disconnect switch.

2.07 Capacities and Characteristics

A. Refer to drawings

PART 3 - EXECUTION

3.01 Examination

A. Examine areas to receive wall and ceiling unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for electrical connections to verify actual locations before unit-heater installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Installation

A. Install wall and ceiling unit heaters to comply with NFPA 90A.

B. Install wall and ceiling unit heaters level and plumb.

C. Install wall-mounted thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

D. Ground equipment according to Section 16060 "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Section 16120 "Low-Voltage Electrical Power Conductors and Cables."

3.03 Demonstration

A. Engage factory-authorized service representative to train SEPTA maintenance personnel to adjust, operate, and maintain cabinet unit heaters. Refer to Section 01820 "Demonstration and Training."

END OF SECTION

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SECTION 15841

INDOOR, CUSTOM AIR-HANDLING UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section includes Custom Knock Down Units for field reassembly, components shipped in crates or skid mounted to the jobsite, to be installed as indoor air-handling units with factory supervision of reassembly of all components, to be assembled in the field by the installing contractor to factory specifications to maintain the factory warranty, including the following components and accessories:

1. Minimum 3” Double Wall foam injected casing panels.
2. Fan array as shown on schedule including, motors, and variable frequency drives for each fan/motor.
3. Air filtration.
4. Access Sections.
5. Dampers.

1.03 ACTION SUBMITTALS

A. Product Data: For each air-handling unit.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
3. Include unit dimensions and weight.
4. Include cabinet material, metal thickness, finishes, insulation, and accessories.
5. Fans:
   a. Include certified fan-performance curves with system operating conditions indicated.
   b. Include certified fan-sound power ratings.
   c. Include fan construction and accessories.
   d. Include motor ratings, electrical characteristics, and motor accessories.
6. Include certified coil-performance ratings with system operating conditions indicated.
7. Include filters with performance characteristics.
8. Include dampers, including housings, linkages, and operators.

B. Delegated Design Submittal: For vibration isolation, supports, indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, or BIM model, drawn to scale, showing the items described in this Section, and coordinated with all building trades.

B. Source quality-control reports.

C. Startup service reports.

D. Field quality-control reports.

E. Sample Warranty: For manufacturer's warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For air-handling units to include in emergency, operation, and maintenance manuals.

1.06 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Filters: One set(s) for each air-handling unit.
2. Gaskets: One set(s) for each access door.
3. Fan Belts: One set(s) for each air-handling unit fan.

1.07 WARRANTY

A. Warranty: Manufacturer agrees to repair or replace components of indoor, basic, air-handling units that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Manufacturer's standard, but not less than one year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. XETEX
2. Innovent
3. Air Enterpise

2.02 UNIT CASINGS

A. General Fabrication Requirements for Casings;

1. Forming: Form walls, roofs, and floors with at least two breaks at each joint.
2. Joints: Sheet metal screws or pop rivets.
3. Sealing: Seal all joints with water-resistant sealant. Hermetically seal at each corner and around entire perimeter.
4. Base Rail:
    a. Material: Structural Steel.
    b. Height: 6inches.

B. Double-Wall Construction:

1. Outside Casing Wall: Minimum 3” thick, foam injected, Galvanized steel, minimum 18 gauge thickness, with manufacturer's standard paint finish.
2. Inside Casing Wall: Aluminum, solid, minimum 20gauge thickness.
3. Floor Plate: Minimum 1/8” thick Aluminum treadplate floor, with foam insulation and 20gauge thickness aluminum panel to cover the entire underneath of the unit.
4. Casing Insulation:
    a. Materials: Minimum 3” thick foam insulation.
    b. Casing Panel R-Value: 18 Minimum.
    c. Insulation Thickness: 3inch.
    d. Thermal Break: Provide continuity of insulation with no through-casing metal in casing walls, floors, or roofs of air-handling unit.

C. Airstream Surfaces: Surfaces in contact with airstream shall comply with requirements in ASHRAE 62.1.

D. Static-Pressure Classifications:

1. For Unit Sections Upstream of Fans: Minus 2-inch wg.
2. For Unit Sections Downstream and Including Fans: 2-inch wg.

E. Panels and Doors:

1. Panels:
    a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
    b. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against airflow.
    c. Gasket: Neoprene, applied around entire perimeters of panel frames.
    d. Size: Large enough to allow unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 72 inches.
2. Doors:
    a. Fabrication: Formed and reinforced with same materials and insulation thickness as casing.
    b. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be

opened against airflow. Provide safety latch retainers on doors so that doors do not open uncontrollably.

c. Gasket: Neoprene, applied around entire perimeters of frame.

d. Size: Large enough to allow for unobstructed access for inspection and maintenance of air-handling unit's internal components. At least 24 inches wide by full height of unit casing up to a maximum height of 72.

3. Locations and Applications:

a. Fan Section: Doors.

b. Access Section: Doors.

c. Damper Section: Doors.

d. Filter Section: Doors large enough to allow periodic removal and installation of filters.

e. Mixing Section: Doors.

2.03 FAN, DRIVE, AND MOTOR SECTION

A. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.

B. Fans: Centrifugal, galvanized steel; mounted on solid-steel shaft.

1. Shafts: With field-adjustable alignment.

a. Turned, ground, and polished hot-rolled steel with keyway.

2. Shaft Bearings:

a. Heavy-duty, self-aligning, pillow-block type with an L-50 rated life of minimum 120,000 hours according to ABMA 9.

3. Housings: Formed- and reinforced-steel panels to form curved scroll housings with shaped cutoff and spun-metal inlet bell.

a. Bracing: Steel angle or channel supports for mounting and supporting fan scroll, wheel, motor, and accessories.

4. Housings, Plenum Fans: Steel frame and panel; fabricated without fan scroll and volute housing. Provide inlet screens for Type SWSI fans.

5. Airfoil, Centrifugal Fan Wheels (Plenum Fan Wheels): Smooth-curved inlet flange, backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; steel hub riveted to backplate and fastened to shaft with setscrews.

6. Mounting: For internal vibration isolation. Factory-mount fans with manufacturer's standard restrained vibration isolation mounting devices having a minimum static deflection of 1 inch.

7. Shaft Lubrication Lines: Extended to a location outside the casing.

8. Flexible Connector: Factory fabricated with a fabric strip minimum 3-1/2 inches wide, attached to two strips of minimum 2-3/4-inch-wide by 0.028-inch-thick, galvanized-steel sheet.

a. Flexible Connector Fabric: Glass fabric, double coated with neoprene. Fabrics, coatings, and adhesives shall comply with UL 181, Class 1.

C. Drive, Direct: Factory-mounted, direct drive.

D. Motors:

1. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors.
2. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
3. Enclosure Type: TEFC (totally enclosed fan cooled)

E. Comply with Section 16269 "Variable-Frequency Motor Controllers."

F. Variable-Frequency Motor Controller: Serving each fan individually in fan array.

1. Manufactured Units: Pulse-width modulated; constant torque and variable torque for inverter-duty motors.
2. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.
3. Unit Operating Requirements:
   a. Internal Adjustability:
      1) Minimum Speed: 5 to 25 percent of maximum rpm.
      2) Maximum Speed: 80 to 100 percent of maximum rpm.
      3) Acceleration: 0.1 to 999.9 seconds.
      4) Deceleration: 0.1 to 999.9 seconds.
      5) Current Limit: 30 to minimum of 150 percent of maximum rating.
   b. Self-Protection and Reliability Features:
   1) Surge suppression.
      2) Loss of input signal protection.
      3) Under- and overvoltage trips.
      4) Variable-frequency motor controller and motor-overload/overtemperature protection.
      5) Critical frequency rejection.
      6) Loss-of-phase protection.
      7) Reverse-phase protection.
      8) Motor-overtemperature fault.
   c. Bidirectional autospeed search.
   d. Torque boost.
   e. Motor temperature compensation at slow speeds.
      1) Panel-mounted operator station.
      2) Historical logging information and displays.
      3) Digital indicating devices.
   f. Control Signal Interface: Electric.
   g. Proportional Integral Directive (PID) control interface.
   h. DDC system for HVAC Protocols for Network Communications: ASHRAE 135.
4. Line Conditioning:
   a. Input line conditioning.

b. Output filtering.
c. EMI/RFI filtering.

2.04 AIR FILTRATION SECTION

A. Panel Filters:

1. Description: Flat, non-pleated factory-fabricated, self-supported disposable air filters with holding frames.
2. Filter Unit Class: UL 900.
3. Media: Interlaced glass, synthetic, or cotton fibers coated with nonflammable adhesive and antimicrobial coating.
4. Filter-Media Frame: High wet-strength beverage board with perforated metal retainer, or metal grid, on outlet side.

2.05 DAMPERS

A. Outdoor Air Dampers: Low-leakage, double-skin, airfoil-blade, galvanized-steel dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed-blade arrangement with zinc-plated steel operating rods rotating in sintered bronze or nylon bearings mounted in a single galvanized-steel frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 4 cfm/sq. ft. at 1-inch wg and 8 cfm/sq. ft. at 4-inch wg.

B. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
   a. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors.
   b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
   a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
   b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
   c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
   d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.

e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

7. Coupling: V-bolt and V-shaped, toothed cradle.

8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.

9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.

C. Mixing Section: Multiple-blade, air-mixer assembly located immediately downstream of mixing section.

D. Combination Filter and Mixing Section:

1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent or throw-away filters.

2.06 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.

2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.

2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to air-stream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

2.07 SOURCE QUALITY CONTROL

A. AHRI 430 Certification: Test, rate, and label air-handling units and their components in accordance with AHRI 430.

B. AHRI 260 or AMCA 311 Sound Performance Rating Certification: Test, rate, and label in accordance with AHRI 260 or AMCA 311.

C. Fan Aerodynamic Performance Rating: Factory test and rate fan performance for airflow, pressure, power, air density, rotation speed, and efficiency in accordance with AMCA 210.

D. Fan Energy Index (FEI): Test in accordance with AMCA 210 and rate in accordance with AMCA 99, AMCA 207, and AMCA 208.

E. Fan Operating Limits: Classify fans in accordance with AMCA 99, Section 14.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine casing insulation materials and filter media before air-handling unit installation. Replace with new insulation materials and filter media that are wet, moisture damaged, or mold damaged.

C. Examine roughing-in for steam, hydronic, and condensate drainage piping systems and electrical services to verify actual locations of connections before installation.

D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION, GENERAL

A. Equipment Mounting:

1. Comply with requirements for vibration isolation devices specified in Section 15068 "Vibration Controls for HVAC."

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing with new, clean filters.

D. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 15820 "Air Duct Accessories."

3.03 PIPING CONNECTIONS

A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to air-handling unit, allow for service and maintenance.

C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.

D. Connect condensate drain pans using NPS 1-1/4, ASTM B88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

E. union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

3.04 ELECTRICAL CONNECTIONS

A. Connect wiring according to Section16120 "Low-Voltage Electrical Power Conductors and Cables."

B. Ground equipment according to Section 16060 "Grounding and Bonding for Electrical Systems."

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

E. Unit wiring shall comply with UL standards. All electrical components shall be listed or recognized by a NRTL (ETL, UL, CSA, etc.). All wiring and electrical components provided with the unit shall be labeled according to the electrical diagram provided for easy identification. The unit shall be provided with a factory wired weatherproof control panel. Unit shall have a single point power terminal block for main power connection. A terminal strip shall be provided for low voltage control wiring. Supply fan motors shall have contactors and external overload protection. Space shall be provided for field wiring entrance.

F. A single non –fused disconnect switch shall be provided for disconnecting electrical power at the unit.

G. Unit shall be provided with factory mounted

1. Branch short circuit protection

2. 115 -volt control circuit transformer and fuse; 115-volt convenience outlet

3. LED Lights: Factory shall provide IP65, low profile LED lighting strips in locations noted in submittal drawings. Low voltage wiring shall be completed by factory and wired to switch easily accessed from exterior of unit.

4. Unit split electrical connections

5. Phase protection relay

3.05 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Section 16123 "Control-Voltage Electrical Power Cables."

C. Unit control equipment and sequence of operation shall be provided as per manufacturer standard sequence of operation. Controls shall be provided by unit manufacturer.

D. Provide a complete integrated microprocessor based Direct Digital Control (DDC) to all unit functions including monitoring, unit safety protections, and diagnostics. The controls system shall consist of all required items including but not limited to pressure sensors; keypad/display user interface.

E. Controls interface shall connect to terminal strip for BAS to interface with unit components; unit control board with BACnet MSTP connectivity.

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. Verify that shipping, blocking, and bracing are removed.
3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
7. Comb coil fins for parallel orientation.
8. Verify that proper thermal-overload protection is installed for electric coils.
9. Install new, clean filters.
10. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.07 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Comply with requirements in Section 15950 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

C. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.08 CLEANING

A. After completing system installation and testing, adjusting, and balancing of air-handling unit and air-distribution systems, and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.09 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Leak Test: After installation, fill water and steam coils with water, and test coils and connections for leaks.
2. Charge refrigerant coils with refrigerant and test for leaks.
3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Air-handling unit and components will be considered defective if unit or components do not pass tests and inspections.
5. Prepare test and inspection reports.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train SEPTA maintenance personnel to adjust, operate, and maintain air-handling units.

END OF SECTION

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SECTION 15850

DIFFUSERS, REGISTERS AND GRILLES

PART 1 - GENERAL

1.01 Description

A. Section includes:

1. Fixed face registers and grilles.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.03 Submittals

A. Submit product data for each type of product indicated, include the following:

1. Data sheets that indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static pressure drop and noise ratings.
2. Diffuser, register, and grille schedule that indicate drawing designation, room location, quantity, model number, size and accessories furnished.

B. Submit samples for initial selection for diffusers, registers, and grilles with factory applied color finishes.

C. Submit samples for verification for diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

D. Submit coordination drawings including reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from the installers of the items involved:

1. Ceiling suspension assembly members.
2. Method of attaching hangers to building structure.
3. Size and location of initial access modules for acoustical tile.
4. Ceiling mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels and special moldings.
5. Duct access panels.

E. Submit source quality control reports.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASHRAE 70, Method of Testing the Performance of Air Outlets and Air Inlets.

PART 2 - PRODUCTS

2.01 Registers and Grilles

A. Fixed Face Grille:

1. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following:
    a. A-J Manufacturing Co., Inc.
    b. Anemostat Products; a Mestek company.
    c. Carnes.
    d. Dayus Register & Grille Inc.
    e. Hart & Cooley Inc.
    f. Krueger.
    g. Nailor Industries Inc.
    h. Price Industries.
    i. Titus.
    j. Tuttle & Bailey.
    k. Or Approved Equal.
2. Material to be aluminum.
3. Finish to be baked enamel, white.
4. Face arrangement to be 1/2 inch by 1/2 inch by 1/2 inch grid core.
5. Core construction to be removable.
6. Frame to be 1 1/4 inches or 1 inch wide.
7. Mounting frame to include a filter.
8. Mounting to be via countersunk screw.
9. Accessory filter to be provided.

2.02 Source Quality Control

A. Rate diffusers, registers and grilles according to ASHRAE 70.

PART 3 - EXECUTION

3.01 Examination

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 Installation

A. Install diffusers, registers, and grilles level and plumb.

B. The Contract Drawings indicate general arrangement of ducts, fittings and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify SEPTA for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors and fire dampers.

3.03 Adjusting

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION

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SECTION 15857

HVAC GRAVITY VENTILATORS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY

A. Section Includes:

1. Hooded ventilators.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product

B. Shop Drawings: For gravity ventilators.

1. Include plans, elevations, sections, details, ventilator attachments to curbs, and curb attachments to roof structure.

2. Show weep paths, gaskets, flashing, sealant, and other means of preventing water intrusion.

C. Samples: For each exposed product and for each color and texture specified.

D. Samples for Initial Selection: For units with factory-applied color finishes.

E. Samples for Verification: For each type of louvered-penthouse ventilator indicated, in manufacturer's standard size.

F. Delegated Design Submittal: For shop-fabricated ventilators indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of shop-fabricated ventilators.

1.04 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Roof-framing plans and other details, drawn to scale, and coordinated with each other, based on input from installers of the items involved:

B. Welding certificates.

1.05 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum."

2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

1.06 COORDINATION

A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

PART 2 - PRODUCTS

2.01 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.02 HOODED VENTILATORS

A. Description: Hooded rectangular penthouse for intake and relief air.

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Greenheck Fan Corporation.
2. Loren Cook Company.
3. PennBarry; division of Air System Components.

C. Source Limitations: Obtain hooded ventilators from single manufacturer.

D. Construction:

1. Material, Galvanized Steel: Thickness required to comply with structural performance requirements, but not less than 0.064-inch-thick base and 0.040-inch-thick hood; suitably reinforced.
2. Material, Aluminum: Thickness required to comply with structural performance requirements, but not less than 0.063-inch-thick base and 0.050-inch-thick hood; suitably reinforced.
3. Insulation: Mineral-fiber insulation and vapor barrier.
4. Bird Screening: Aluminum, 1/2-inch-square mesh or flattened, expanded aluminum, 3/4-inch diamond mesh wire.

E. Galvanized-Steel Finish:

1. Surface Preparation: Clean surfaces of dirt, grease, and other contaminants. Clean welds, mechanical connections, and abraded areas, and repair galvanizing according

to ASTM A780/A780M. Apply a conversion coating suited to the organic coating to be applied over it.

2. Factory Priming for Field-Painted Finish: Where field painting after installation is indicated, apply an air-dried primer immediately after cleaning and pretreating.

3. Baked-Enamel Finish: Immediately after cleaning and pretreating, apply manufacturer's standard finish consisting of prime coat and thermosetting topcoat, with a minimum dry film thickness of 1 mil for topcoat and an overall minimum dry film thickness of 2 mils.

   a. Color and Gloss: As selected by Architect from manufacturer's full range.

F. Dampers:

1. Location: Curb damper tray.

2. Control: Motorized.

3. Tray: Provide damper tray or shelf with opening 3 inches less than interior curb dimensions indicated.

G. Roof Curbs: Galvanized-steel sheet; with mitered and welded corners; 1-1/2-inch-thick, rigid fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to fit roof opening and ventilator base.

1. Configuration: Self-flashing without a cant strip, with mounting flange.

2. Overall Height: 36 inches.

2.03 SOURCE QUALITY CONTROL

A. AMCA Certification for Hooded Ventilators: Test, rate, and label gravity ventilators in accordance with AMCA 511.

2.04 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 zinc coating, mill phosphatized.

D. Stainless Steel Sheet: ASTM A666, Type 304, with No. 4 finish.

E. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials.

1. Use types and sizes to suit unit installation conditions.

2. Use hex-head or Phillips pan-head screws for exposed fasteners unless otherwise indicated.

F. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the load imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488/E488M, conducted by a qualified independent testing agency.

G. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187/D1187M.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL

A. Install gravity ventilators level, plumb, and at indicated alignment with adjacent work.

B. Secure gravity ventilators to roof curbs with zinc-plated hardware, that comply with the wind and seismic fastening requirements. Use concealed anchorages where possible. Refer to Section 07720 "Roof Accessories."

C. Install gravity ventilators with clearances for service and maintenance.

D. Install perimeter reveals and openings of uniform width for sealants and joint fillers, as indicated.

E. Install concealed gaskets, flashings, joint fillers, and insulation as installation progresses. Comply with Section 07920 "Joint Sealants" for sealants applied during installation.

F. Label gravity ventilators according to requirements specified in Section 15077 "Identification for HVAC Piping and Equipment."

G. Protect galvanized and nonferrous-metal surfaces from corrosion or galvanic action by applying a heavy coating of bituminous paint on surfaces that will be in contact with concrete, masonry, or dissimilar metals.

H. Repair finishes damaged by cutting, welding, soldering, and grinding. Restore finishes, so no evidence remains of corrective work. Return items that cannot be refinished in the field to the factory, make required alterations, and refinish entire unit or provide new units.

I. Refer to Section 07720 "Roof Accessories" for flashing and counterflashing of roof curbs.

3.02 DUCT CONNECTIONS

A. Duct installation and connection requirements are specified in Section 15815 "Metal Ducts" and Section 15816 "Nonmetal Ducts." Drawings indicate general arrangement of ducts and duct accessories.

3.03 ADJUSTING

A. Adjust damper linkages for proper damper operation.

END OF SECTION

SECTION 15890

HVAC DUCTWORK

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements of the following equipment to be furnished under this Contract:

1. Ductwork and associated equipment.

1.02 Submittals

A. Submit product data in the form of manufacturers catalog literature for each product required.

B. Submit shop drawings containing the list of wording, symbols, letter size and color coding for equipment.

C. Submit installation instructions and special procedures for installation.

D. Certify products meet or exceed specified requirements.

1.03 Quality Assurance

A. Maintain one (1) copy of each document on site.

B. Meet the applicable provisions of the most recent issues of the following references:

1. American Society of Mechanical Engineers (ASME).
2. National Fire Protection Association (NFPA).
3. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.04 Qualifications

A. Company specializing in manufacturing products specified in this Section.

B. Company specializing in performing work of the Section.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Transverse Joints (Factory Fabricated Aluminum):
   a. Ductmate Industries, Inc.
   b. Or Approved Equal.
2. Fiberglass Ductwork:
   a. Peabody Spunstrand.

b. Ceilcote.
c. Or Approved Equal.

3. Flexible Ducts:
   a. Thermaflex.
   b. Condu-flex.
   c. Glass-flex.
   d. Or Approved Equal.
4. Turning Vanes:
   a. Barber-Colman.
   b. Titus.
   c. Tuttle and Bailey.
   d. Or Approved Equal.
5. Flexible Duct Connections:
   a. Vent Fabrics.
   b. American Warming.
   c. Or Approved Equal.
6. Flexible Connector Thrust Restraint:
   a. Mason WB.
   b. Or Approved Equal.
7. Access Doors in Ductwork:
   a. Vent Fabrics.
   b. American Warming.
   c. Or Approved Equal.
8. Ceiling Diffusers:
   a. Anemostat.
   b. Carnes.
   c. Titus.
   d. Or Approved Equal.
9. Grilles and Registers:
   a. Anemostat.
   b. Carnes.
   c. Titus.
   d. Or Approved Equal.
10. Air Filters:
    a. American Air Filter.
    b. Farr.
    c. Continental.
    d. Or Approved Equal.
11. Manual (Volume) Dampers:
    a. Air Balance.

b. Ruskin.
c. American Warming.
d. Or Approved Equal.

12. Duct Sealers:
    a. Chicago Mastic.
    b. 3M Co.
    c. Permatex.
    d. Benjamin Foster.
    e. Or Approved Equal.
13. Temperature Control and Automatic Dampers:
    a. Air Balance.
    b. Ruskin.
    c. American Warming.
    d. Or Approved Equal.
14. Louvers:
    a. Ruskin.
    b. Air Balance.
    c. American Warming.
    d. Or Approved Equal.

2.02 Components

A. Duct and Fittings (Metallic):
    1. Materials to be 3003 H-14 aluminum alloy.
    2. Fabrication:
        a. Minimum sheet material thickness:
            1) Ducts with largest side or diameter to 30 inches to be 0.05 inches thick.
            2) Ducts with largest side or diameter greater than 30 inches to be 0.08 inches thick.
        b. Utilize SMACNA HVAC Duct Construction Standards for minimum of 2 inch water gauge static pressure for the minimum sheet material thickness specified herein.
            1) Heavier gauge sheet material may be used with associated reinforcement as an alternate to minimum thickness specified.
            2) Lighter gauge sheet material with associated reinforcement shall not be used as an alternate to minimum thickness specified.
        c. Continuously weld seams on factory assembled units.
        d. Transverse Joints (Alternate A):
            1) SMACNA T-22 companion flange.
            2) Gasketed.
            3) Rigidity class:
                a) Ducts with largest side or diameter to 30 inches to be SMACNA Class H (2 1/2 inch by 2 1/2 inch by 3/16 inch angles).
        e. Transverse Joints (Alternate B):
            1) Materials and Fabrication:

a) Angles to be aluminum.
   i. Ductmate 35; Or Approved Equal.
b) Corners to be aluminum.
   i. Ductmate DC 35; Or Approved Equal.
c) Snap cleats to be aluminized or stainless steel.
d) Gaskets to be closed cell neoprene.
e) Bolts to be stainless steel.
f) Sheet metal screws to be self-drilling stainless steel with unthreaded section under head.

2) Fabrication:
   a) Rigidity class to be SMACNA Class H.
   b) 3/8 inch diameter by 1 inch bolts.

B. Supports and Hangers:

1. Materials:
   a. Support angles to be stainless steel.
   b. Hanger rods to be stainless steel.
   c. Anchors to be stainless steel wedge type.
2. Fabrication
   a. Trapeze type units.

C. Turning Vanes:

1. Materials to be same as duct.
2. Fabrication:
   a. Fabricate double vane units.
   b. Pressure drop through elbows to be a maximum 20 percent of velocity pressure.

D. Flexible Connections:

1. Hypalon, double coated closely woven glass fabric.
2. Fabrication to withstand 4.5 inch water column, positive and negative pressure.

E. Access Doors:

1. Materials:
   a. Inner panel, out panel and frame to be same as duct.
   b. Gaskets to be closed cell neoprene.
   c. Insulation to be 1 pound density fiberglass.
   d. Hinges to be stainless steel.
   e. Latches:
      1) Aluminum zinc alloy.
      2) Outside lever handle.
      3) Adjustable spacer.
      4) Beveled inside flange.
      5) Studs:
         a) Minimum 3/8 inch diameter stud for doors up to 24 inches wide by 48 inches high.

b) Minimum 1/2 inch diameter stud for doors larger than 24 inches by 48 inches.

2. Fabrication:
   a. Provide four (4) side continuous gaskets.
   b. Utilize continuous piano hinges.
   c. Latches required.
      1) One (1) 12 inches in any direction.
      2) Two (2) up to 18 inches by 18 inches.
      3) Two (2) with inside handles up to 24 inches by 48 inches.
      4) Three (3) with inside handles up to 24 inches by 72 inches.
      5) Minimum door size to be 12 inches by 12 inches.

F. Diffusers:
   1. Materials:
      a. Body to be extruded aluminum.
      b. Ceiling diffuser gaskets to be sponge rubber.
   2. Fabrication:
      a. Round or rectangular with removable core.
      b. Key operated opposed blade damper mounted in neck except where indicated on the Contract Drawings to be omitted.
      c. Finish:
         1) Aluminum.

G. Volume Dampers and Flow Equalizers for Round Neck Diffusers:
   1. Material to be aluminum.
   2. Fabrication:
      a. Design for neck velocity of 2500 feet per minute.
      b. Center rod operator accessible through diffuser without removing diffuser.
      c. Furnish with screws, duct collars, transitions and air pattern deflectors as required.

H. Air Grille and Register Assembly:
   1. Materials:
      a. Assembly to be extruded aluminum.
      b. Gaskets to be sponge rubber.
   2. Fabrication:
      a. Supply registers to be two (2) sets individually adjustable louvers.
      b. Exhaust and return registers to have 45 degrees deflection front blades.
      c. Dampers to be key operated opposed blade.
      d. Screw, duct collars and transitions as required.

I. Temperature Control, Automatic and Manually (Volume) Operated Dampers:
   1. Material:
      a. Body to be 6063 T5 aluminum.
      b. Seal blade edge to be extruded vinyl.

2. Fabrication:
    a. Frame thickness to be 0.125 inches minimum.
    b. Blades:
        1) Two (2) position damper to be parallel blade.
        2) Mixing and volume damper to be opposed blade.
        3) Airfoil shape.
        4) Maximum 6 inch width.
    c. Linkage to be concealed in the frame.
    d. Axles to be 1/2 inch plated steel hex.
    e. Bearings to be molded synthetic.
    f. Seals:
        1) Jamb to be flexible compression type.
    g. Control shaft to be removable, 1/2 inch diameter.
    h. Air leakage (4 square foot damper) at 4 inch water gauge pressure to be 99 CFM maximum.
    i. Provide outboard support for operator linkage where damper motor is to be installed outside of duct.
    j. Provide stainless steel locking quadrants for manual (volume) dampers.
    k. Provide fold out operator mounting bracket where damper motor is to be installed on face of damper or inside duct.
    l. Finish to be 215 R1 anodized.

PART 3 - EXECUTION

3.01 Installation

A. Metal Ductwork:

1. Install with longitudinal seams sealed for zero (0) leakage.
    a. Welded seams may be used upon acceptance of welded seam samples by SEPTA.
2. Install gaskets at each transverse joint and fasten sections together with bolts.
    a. Tighten for zero (0) leakage.
3. Install supports and hangers with anchors in accordance with SMACNA HVAC Duct Construction Standards.
4. Install turning vanes in square elbows:
    a. Unsupported vane length not to exceed 48 inches.
    b. Position vanes at proper angle to meet specified pressure drop.
5. Install flexible connections at fans:
    a. Locate as close as possible to fan.
    b. Allow 1 inch of slack to prevent vibration transmission.
    c. Install thrust restraints across connectors.
6. Install access doors where indicated on the Contract Drawings and at smoke and fire damper in accordance with NFPA requirements.

7. Volume extractors:
    a. Install at supply register, grilles, diffusers and supply branch connections from ducts.
    b. Provide branch duct extensions into main duct above and below extractor when branch duct is narrower than main duct.

B. Diffusers:

1. Install where shown on the Contract Drawings of size and capacities scheduled on the Contract Drawings.
2. Install anodized diffusers in exposed ductwork.

C. Air Grille and Register Assemblies:

1. Install where shown on the Contract Drawings of size and capacities scheduled on the Contract Drawings.
2. Install prime painted grilles and registers in areas where ductwork is concealed.
    a. Field paint to match adjacent surface finish.

END OF SECTION

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SECTION 15935

BUILDING SYSTEM CONTROLS

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements for the following items:

1. HVAC control panels.
2. Thermostats.
3. Gas detection.

B. Provide conduit and electrical wiring for complete system.

1.02 Related Sections

A. Section 01810 – Commissioning of Systems

1.03 Submittals

A. Submit shop drawings indicating operating data, system drawings, wiring diagrams and written detailed operational description of sequences.

B. Submit product description and engineering data for each control system component, including sizing. Submit data for each system component.

C. Record actual locations of controls including thermostats remotely located from equipment.

D. Submit operations and maintenance data and include the following:

1. Systems descriptions, set points, and controls settings and adjustments.
2. Inspection period, cleaning methods, recommended cleaning materials and calibration tolerances.
3. Interconnection wiring diagrams of completed field installed systems with identified and numbered system components and devices.

1.04 Quality Assurance

A. Products requiring electrical connection shall be listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

B. Meet the applicable provisions of the most recent issues of the following references:

1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA DC 3, Residential Controls - Electrical Wall-Mounted Room Thermostats.

1.05 Performance Requirements

A. Furnish the manufacturer's maintenance services on control system for one (1) year from date of Substantial Completion.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Manufacturers:

1. Honeywell Inc.
2. Johnson Control.
3. Siemens.
4. Specific Systems.
5. Or Approved Equal.

2.02 HVAC Control Panels

A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet. Provide as required for system operation, temperature indicators, pressure gauges, pilot lights, push buttons and switches flush on cabinet panel face.

B. NEMA 250 general purpose utility enclosures with enameled finished face panel.

C. Furnish common keying for every panel.

D. Systems requiring control panels include:

1. Ventilation Fans:
   a. Controls to include auto manual switches for each fan.
   b. Operating status indicating light.
   c. High/low speed indicating light.
   d. Power available indicating light.

2.03 Thermostats

A. Manufacturers:

1. Honeywell Inc.
2. Johnson Control.
3. Siemens.
4. Specific Systems.
5. Or Approved Equal.

B. Electric Line Voltage Room Thermostats:

1. Type to be NEMA DC 3, with setback/setup temperature control.
2. Covers to be locking with concealed set point.

2.04 Gas Detection

A. Gas Detection and Control System:

1. Manufacturers:
   a. MSA.

b. INTEC Controls.
c. Vulcan.
d. Sensidyne.
e. Or Approved Equal.

2. Gas detection control panel to be microprocessor based control panel with programmable relays.
   a. Control panel capable of receiving 0-20 mA analog signals.
   b. Programmable relays as required to achieve the control sequence.
   c. Panel capable of low, medium and alarm level control conditions.
   d. Liquid Crystal Display (LCD) with backlight.
   e. Provide alarm input into Supervisory Control and Data Acquisition (SCADA) system to indicate a high Hydrogen level in the battery room.
3. Hydrogen (H2):
   a. NEMA 4X sensor enclosure.
   b. Built in heater.

PART 3 - EXECUTION

3.01 Preparation

A. Verify power supply is available to panels.

B. Verify field end devices and wiring is installed prior to installation proceeding.

3.02 Installation and Design

A. The Contractor shall design, provide and install a Hydrogen gas detection system, within the battery room or within the room where the station batteries are located.

B. In addition to maintaining the specified temperature requirements for the battery rooms, the exhaust system/HVAC equipment shall provide ventilation when Hydrogen gas is detected. The exhaust system/HVAC equipment will activate when the gas sensor detects Hydrogen level at a concentration of 1.0 percent. Ventilation shall be provided as to prevent liberated Hydrogen gas from exceeding 1.0 percent concentration. If the Hydrogen gas concentration reaches 2.0 percent, the Hydrogen gas sensor shall continue to keep the ventilation fan running and send an alarm to the gas detection panels and send an alarm to the SCADA system via an output relay. The Contractor shall propose sensor locations per NFPA 70E requirements on the design drawings for SEPTA review and concurrence. The gas detection panel shall have both audible and visual alarms.

C. After completion of installation, test and adjust control equipment. Submit data showing set points and final adjustments of controls.

D. Install panels and other hardware in position on permanent walls not subject to excessive vibration.

E. Install thermostats and gas sensors and other exposed control sensors at locations as indicated on the Contract Drawings. Coordinate with room components before installation. Align mounting height with light switches.

F. Install guards on all wall mounted thermostats.

G. Install damper motors on outside of duct in warm areas. Do not install motors in locations at outdoor temperatures.

H. Install "hand/off/auto" selector switches to override automatic interlock controls when switch is in "hand" position.

I. All wiring shall be installed in conduit.

J. Refer to Division 16 specifications for wire and conduit material requirements.

END OF SECTION

SECTION 15940

SEQUENCE OF OPERATION

PART 1 - GENERAL

1.01 Description

A. This Section defines the manner and method by which controls function. Requirements for each type of control system operation and the intended sequence are specified in this Section. Equipment, devices and system components required for control systems are specified in other Sections.

B. Section includes sequence of operation for:

1. Electrical rooms ventilation cooling.
2. Electric duct heater.
3. Unit heaters.
4. Exhaust fans.

1.02 Related Sections

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 15935 - Building System Controls

C. Section 15950 - Testing, Adjusting and Balancing

D. Division 16 - Electrical

1.03 Submittals

A. Submit shop drawings indicating mechanical system controlled and control system components.

B. Label with settings, adjustable range of control and limits.

C. Submit written description of control sequence.

D. Submit flow diagrams for each control system, graphically depicting control logic.

E. Submit draft copies of graphic displays indicating mechanical system components, control system components, and controlled function status and value.

F. Submit Project record documents recording actual locations of components and set points of controls, including changes to sequences made after submission of shop drawings.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. NFPA 90A, Standard for the Installation of Air Conditioning and Ventilating Systems.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Application

A. Electrical Room Ventilation:

1. The ventilation system will operate from the control panel with an On-Auto-Off switch.
    a. On position – The fans will operate in the high-speed setting.
    b. Auto position – The fans will run on low speed continuously, on rise in space temperatures above an adjustable temperature set point (adjustable) initially set to 95°F; the fan will index to high speed for the supply and exhaust fan. On a drop-in temperature below the system set point, return the supply and exhaust fans to the low speed operating set point for normal electrical room ventilation.
    c. Off position – The fans will be de-energized.
2. Indicating lights will be provided to indicate the operating status and fan speed.

B. Electric Duct Heater:

1. An airflow switch will be provided to ensure adequate airflow prior to energizing the electric duct heater.
2. On a drop-in supply air temperature below the discharge air temperature sensor set point (adjustable); initially set to 55°F; the first stage of electric heat will energize to maintain leaving air temperature at 55°F. Upon a further drop in temperature additional stages of heat will energize as required to maintain discharge air temperature set point.
3. A three (3) hour (minimum) override timer will be provided with a second thermostat when the override timer is actuated the space temperature will be controlled by the local space thermostat to help raise the space temperature. When the timer is over the system will return to the controlling duct discharge temperature.

C. Electric Unit Heaters:

1. A unit mounted thermostat shall cycle the fan and electric heating element to maintain an adjustable space temperature set point (adjustable) of 55°F.

D. Exhaust Fans:

1. Battery Room:
    a. The battery room ventilation will be activated based on Hydrogen levels located within the space. The space Hydrogen sensor will monitor levels and energize the fan to maintain space Hydrogen levels below the set point (adjustable) initially set to 1.0 percent. Upon levels returning below the set point the fan will de-energize.
        1) Provide indicating lights at the room entrance to indicate the fan is energized with a manual on switch to energize the fan from outside the room prior to entering the battery room.
        2) Provide a signal to the Supervisory Control and Data Acquisition (SCADA) system to indicate operation of the fan and indication that the high-level alarm is activated.

2. General Ventilation for Toilet room and Support Facilities:
   a. The general ventilation system will operate continuously to ventilate the associated spaces.

END OF SECTION

THIS PAGE NOT USED

SECTION 15950

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements for testing, adjusting and balancing HVAC systems to produce design objectives, including the following:

1. Balancing airflow within distribution systems, including mains, branches and terminals to indicated quantities according to specified tolerances.
2. Adjusting total HVAC systems to provide indicated quantities.
3. Measuring electrical performance of HVAC equipment.
4. Setting quantitative performance of HVAC equipment.
5. Verifying that automatic control devices are functioning properly.
6. Measuring sound and vibration.
7. Reporting results of the activities and procedures specified in this Section.

1.02 Related Sections

A. Section 01810 – Commissioning of Systems

1.03 Submittals

A. Submit two (2) copies of the certified testing, adjusting and balancing reports prepared as specified in this Section on approved forms certified by the testing, adjusting and balancing agent.

1.04 Quality Assurance

A. Engage a testing, adjusting and balancing agent certified by either AABC or NEBB.

B. Certify the testing, adjusting and balancing field data reports. This certification includes the following:

1. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting and balancing reports.
2. Certify that the testing, adjusting and balancing team complied with the approved testing, adjusting and balancing plan and the procedures specified and referenced in this Section.

C. Use standard forms from AABC's "National Standards for Testing, Adjusting and Balancing."

D. Meet the applicable provisions of the most recent issues of the following references:

1. American Society of Heating, Refrigerating and Air Conditioning Engineers, Inc. (ASHRAE).
2. Associated Air Balance Council (AABC).

3. National Environmental Balancing Bureau (NEBB).
4. Sheet Metal and Air Conditioning Contractors National Association (SMACNA).

1.05 Performance Requirements

A. Coordinate the efforts of the factory authorized service representatives for systems and equipment, the HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist with testing, adjusting and balancing activities.

B. Provide seven (7) days advance notice for each test. Include scheduled test dates and times.

C. Perform testing, adjusting, and balancing after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

1.06 Warranty

A. Provide one (1) year warranty, from the date of final acceptance by SEPTA, under which period the Contractor will return to site and make adjustments as required by SEPTA.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation

A. Examine the Contract Documents to become familiar with Contract requirements and to discover conditions in the systems designs that may preclude proper testing, adjusting and balancing of systems and equipment.

1. The Contract Documents are defined in the General and Supplementary Conditions of the Contract.
2. Verify that balancing devices, such as test ports, gauge cocks, thermometer wells, flow-control devices, balancing valves and fittings and manual volume dampers are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting and commissioning specified in individual Specification Sections have been performed.

D. Examine system and equipment test reports.

E. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

F. Examine air handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight and equipment with functioning controls is ready for operation.

G. Examine equipment for installation and for properly operating safety interlocks and controls.

H. Examine automatic temperature system components to verify the following:

1. Dampers, valves, and other controlled devices operate by the intended controller.
2. Dampers and valves are in the position indicated by the controller.
3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions.
4. Thermostats are located to avoid adverse effects of sunlight, drafts and cold walls.
5. Sensors are located to sense only the intended conditions.
6. Sequence of operation for control modes is according to the Contract Documents.
7. Controller set points are set at design values. Observe and record system reactions to changes in conditions. Record default set points if different from design values.
8. Interlocked systems are operating.
9. Changeover from heating to cooling mode occurs automatically.

I. Report deficiencies discovered before and during performance of testing, adjusting and balancing procedures.

J. Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

K. Complete system readiness checks and prepare system readiness reports. Verify the following:

1. Permanent electrical power wiring is complete.
2. Automatic temperature control systems are operational.
3. Equipment and duct access doors are securely closed.
4. Dampers are open.
5. Ceilings are installed in critical areas where air pattern adjustments are required and access to balancing devices is provided.
6. Windows and doors can be closed so design conditions for system operations can be met.

3.02 Execution

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC or NEBB national standards and this Section.

B. Cut insulation, ducts, pipes and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Contract.

C. Fundamental Air System Balancing Procedures:

1. Prepare test reports for both fans and outlets. Obtain the manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
2. Prepare schematic diagrams of systems' "as-built" duct layouts.
3. Determine the best locations in main and branch ducts for accurate duct airflow measurements.
4. Check the airflow patterns from the outside air louvers and dampers and the return and exhaust air dampers, through the supply fan discharge and mixing dampers.
5. Locate start-stop and disconnect switches, electrical interlocks and motor starters.
6. Verify that motor starters are equipped with properly sized thermal protection.
7. Check dampers for proper position to achieve desired airflow path.
8. Check for airflow blockages.
9. Check condensate drains for proper connections and functioning.
10. Check for proper sealing of air handling unit components.

D. Constant Volume Air System Balancing:

1. The procedures in this Article apply to constant volume supply, return and exhaust air systems. Additional procedures are required for variable air volume, multi-zone, dual duct, induction unit supply air systems and process exhaust air systems. These additional procedures are specified in other Articles in this Specification.
2. Adjust fans to deliver total design airflows within the maximum allowable RPM listed by the fan manufacturer.
    a. Measure fan static pressures to determine actual static pressure as follows:
        1) Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
        2) Measure static pressure directly at the fan outlet or through the flexible connection.
        3) Measure inlet static pressure of single inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
    b. Measure static pressure across each air handling unit component.
        1) Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
    c. Measure static pressures entering and leaving other devices such as heating duct coils under final balanced conditions.
    d. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
    e. Adjust fan speed higher or lower than design with the approval of SEPTA. Make required adjustments to pulley sizes, motor sizes and electrical connections to accommodate fan speed changes.
    f. Do not make fan speed adjustments that result in motor overload. Consult the equipment manufacturers about fan speed safety factors. Modulate dampers and measure fan motor

amperage to ensure no overload will occur. Measure amperage under all normal operating modes of operation to determine the maximum required brake horsepower.

3. Adjust volume dampers for main duct, sub main ducts and major branch ducts to design airflows within specified tolerances.
   a. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
      1) Where sufficient space in sub mains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
   b. Re-measure each sub main and branch duct after all have been adjusted. Continue to adjust sub mains and branch ducts to design airflows within specified tolerances.
4. Measure terminal outlets and inlets without making adjustments.
   a. Measure terminal outlets using a direct reading hood or the outlet manufacturer's written instructions and calculating factors.
5. Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than the dampers at the air terminals.

E. Motors:

1. Test at final balanced conditions and record the following data for motors 1/2 horsepower and larger:
   a. Manufacturer, model, and serial numbers.
   b. Motor horsepower rating.
   c. Motor RPM.
   d. Efficiency rating if high efficiency motor.
   e. Nameplate and measured voltage, each phase.
   f. Nameplate and measured amperage, each phase.
   g. Starter thermal protection element rating.

F. Heat Transfer Coil:

1. Measure the following data for each electric heating coil:
   a. Nameplate data.
   b. Airflow.
   c. Entering and leaving air temperatures at full load.
   d. Voltage and amperage input of each phase at full load and at each incremental stage.
   e. Calculated kW at full load.
   f. Fuse or circuit breaker rating for overload protection.

G. Temperature Testing:

1. During testing, adjusting, and balancing, report need for adjustment in temperature regulation within the automatic temperature control system.
2. Measure indoor wet and dry bulb temperatures every other hour for a period of two (2) successive eight (8) hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

3. Measure outside air, wet and dry bulb temperatures.

H. Temperature Control Verification:

1. Verify that controllers are calibrated and commissioned.
2. Check transmitter and controller locations and note conditions that would adversely affect control functions.
3. Record controller settings and note variances between set points and actual measurements.
4. Verify operation of limiting controllers (i.e., high and low temperature controllers).
5. Verify free travel and proper operation of control devices such as damper and valve operators.
6. Verify sequence of operation of control devices. Note air pressures and device positions and correlate with airflow. Note the speed of response to input changes.
7. Confirm interaction of electrically operated switch transducers.
8. Confirm interaction of interlock and lockout systems.
9. Verify main control supply air pressure and observe compressor and dryer operations.
10. Record voltages of power supply and controller output; determine if the system operates on a grounded or ungrounded power supply.
11. Note operation of electric actuators using spring return for proper fail safe operations.

I. Reports:

1. Typewritten or computer printout in letter quality font, on standard bond paper, in three (3) ring binder, tabulated and divided into sections by tested and balanced systems.
2. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing Engineer.
    a. Include a list of the instruments used for procedures along with proof of calibration.
3. In addition to the certified field report data, include the following in the final report:
    a. Fan curves.
    b. The manufacturers' test data.
    c. Field test reports prepared by the system and equipment installers.
    d. Other information relative to equipment performance, but do not include approved shop drawings and product data.
4. In addition to the form titles and entries, include the following data in the final report, as applicable:
    a. Title page.
    b. Name and address of testing, adjusting and balancing agent.
    c. Project name.
    d. Project location.
    e. Contractor's name and address.
    f. Report date.

g. Signature of testing, adjusting and balancing agent who certifies the report.
h. Summary of contents, including the following:
   1) Design versus final performance.
   2) Notable characteristics of systems.
   3) Description of system operation sequence if it varies from the Contract Documents.
i. Nomenclature sheets for each item of equipment.
j. Notes to explain why certain final data in the body of reports vary from design values.
k. Test conditions for fans and pump performance forms, including the following:
   1) Settings for outside, return and exhaust air dampers.
   2) Conditions of filters.
   3) Cooling coil, wet and dry bulb conditions.
   4) Fan drive settings, including settings and percentage of maximum pitch diameter.
   5) Other system operating conditions that affect performance.

5. Apparatus coil test reports to include the following:
   a. Coil Data:
      1) System identification.
      2) Location.
      3) Coil type.
      4) Number of rows.
      5) Fin spacing in fins per inch.
      6) Make and model number.
      7) Face area in square feet.
      8) Tube and fin materials.
      9) Circuiting arrangement.
   b. Test Data:
      1) Airflow rate in CFM.
      2) Average face velocity in feet per minute.
      3) Air pressure drop in inches water gauge.
      4) Outside air, wet and dry bulb temperatures in °F.
      5) Entering air, wet and dry bulb temperatures in °F.
      6) Leaving air, wet and dry bulb temperatures in °F.
6. Fan test reports for the supply, return and exhaust fans, including the following:
   a. Fan Data:
      1) System identification.
      2) Location.
      3) Make and type.
      4) Model number and size.
      5) Manufacturer's serial number.
      6) Arrangement and class.
      7) Sheave make, size in inches, and bore.
      8) Sheave dimensions, center-to-center and amount of adjustments in inches.

b. Motor Data:
   1) Make and frame type and size.
   2) Horsepower and RPM.
   3) Volts, phase, and hertz.
   4) Full load amperage and service factor.
   5) Sheave make, size in inches, and bore.
   6) Sheave dimensions, center-to-center and amount of adjustments in inches.
   7) Number of belts, make and size.

c. Test Data:
   1) Total airflow rate in CFM.
   2) Total system static pressure in inches water gauge.
   3) Fan RPM.
   4) Discharge static pressure in inches water gauge.
   5) Suction static pressure in inches water gauge.

3.03 Tolerances

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, return and exhaust fans to be plus 10 to minus 10 percent.
   2. Air outlets and inlets to be plus 10 to minus 10 percent.

END OF SECTION

SECTION 16010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.01 Description

A. This Section addresses the parts of the power system electrical work that involve the following:

1. Interfaces and integration with other trades.
2. Submittals.
3. Quality assurance.
4. Manufacturer and equipment selection.
5. Reports.
6. Visit to site.

1.02 Related Sections

A. All requirements that are described in Division 1

B. Section 01010 – Summary of Work

C. Section 01300 – Submittals

D. Section 01400 – Quality Requirements

E. Section 01600 – Materials and Equipment

F. Section 01612 – Delivery, Storage and Handling – Traction Power Equipment

G. Section 16060 – Grounding and Bonding

H. Section 16075 – Electrical Identification

I. Section 16123 – Building Wire and Cable

J. Section 16130 – Raceways and Boxes

K. Section 16140 – Wiring Devices

L. Section 16240 – Battery Equipment

M. Section 16440 – Panelboards

N. Section 16500 – Lighting

O. Section 16772 – CCTV System

P. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit - Including HMI

Q. Section 16950 – Testing

R. Section 16953 – Electrical Testing - Traction Power Equipment (CTD)

1.03 Contract Documents

A. Design Modifications:

1. Perform design modifications only with prior written approval from SEPTA.

B. Intent of Contract Drawings:

1. The Contract Drawings do not indicate all fittings, hardware or appurtenances required for a complete operating installation.

2. Wiring diagrams are not intended to indicate the exact course of raceways or exact location of outlets. Raceway locations are subject to revision as may be necessary at the time of installation. Location of undimensioned features are subject to SEPTA's approval.

3. One-line diagrams, feeder diagrams and riser diagrams are schematic and do not show physical arrangement of equipment.

1.04 Delivery, Storage and Handling - Traction Power Equipment

A. Refer to Sections 01600 and 01612.

1.05 Protection during Storage

A. Provide protection of products against loss or damage.

B. Protect products from the effects of weather. Prior to installation, store items in clean, dry, indoor locations. Take all precautions as recommended by the manufacturer of the equipment. Store items subject to corrosion and items containing insulation, such as conductors, in a clean, dry, heated, indoor location.

C. Following installation, protect products from corrosion, dust, dirt, physical damage and the effects of moisture.

1.06 As-Built Drawings

A. Keep records of all site modifications to produce accurate as-built drawings for submission to SEPTA. Include information of the work by others.

1.07 Submittals

A. Submit manufacturer's descriptive literature, product specifications, published details, performance/capacity rating schedules or charts and installation instructions, as specified in Section 01300 and as augmented by each Section of Division 16.

B. Submit shop drawings:

1. Approve and submit shop drawings certified for construction by product manufacturers as follows:

a. The shop drawings applicable to items listed under submittals in each Section of Division 16; and such items as may be scheduled or noted on the Contract Drawings.

b. Include the associated Installation and Maintenance manuals (I & M) for the respective equipment with shop drawing submittals.

2. Include (as applicable) anchor bolt layouts; details indicating construction and materials of construction; dimensions; equipment, and weights of principal parts and the completely assembled item.

B. Review each submittal for completeness and for compliance with the Contract Requirements including the Contract Specifications and approved Contractor Detailed Design Drawings and Specifications. Failure to comply, even though the submittal is based on the manufacturer and specified equipment, will result in an immediate rejection of the submittal.

1.08 Quality Assurance

A. Provide the services of a Traction Power Integrator/Designer (TPI) and assume complete responsibility for the work that is performed by the TPI.

B. Meet the building and electrical code requirements of state, county, township or other political subdivisions, which exceed the requirements of national codes, standards and approving bodies. Modify the electrical work to be in conformity with such laws, ordinances, rules and regulations without additional expense to SEPTA.

C. Upon completion of work, and prior to final payment, furnish formal certification of final inspections to SEPTA from Authorities Having Jurisdiction (AHJs) and secure required permits or certificates from such authorities. Additionally, prepare detailed diagrams and drawings, which may be required by those AHJs.

C. Products as specified in these Specifications and as indicated on the Contract Drawings are those of companies having established reputations in the manufacture of the particular materials, equipment or apparatus specified. Provide products from the manufacturers that are either of their own make, or products of others, for which the manufacturer assumes full responsibility. Replacement parts shall be available for these products.

D. Provide UL Listed products whenever comparable, products of like design, function and appearance have been submitted to UL and have received the UL Label. Provide products labeled for the specific use intended and the location where it will be installed. Provide and include evidence or proof of UL listings by respective references on product data or shop drawing document submittals. Provide UL listing cards where such information is not otherwise evident or obvious on the submittal documents.

E. Have the work inspected by an authorized inspection agency for compliance with National Electrical Code (NEC) and obtain certificates of approval, acceptance and compliance with code regulations. Work shall not be deemed complete until such certificates have been delivered to SEPTA for review.

F. Meet the applicable provisions of the most recent issues of the following references:

1. International Building Code (IBC).

2. IEEE C2, National Electrical Safety Code (NESC).

3. NFPA 70, National Electrical Code (NEC).

4. National Electrical Installation Standards (NEIS) developed by the National Electrical Contractors' Association (NECA).

1.09 Interfaces and Integration with Other Trades

A. This Section provides supplemental requirements and responsibilities for performing the work as described herein and in the other Sections, in order to achieve the following goals:

1. The requirement of a single point of responsibility for the selection of equipment, materials, compatibility and interface with other elements of the integrated system.
2. System interfaces and integration.
3. Interface with Other Trades:
    a. Assume responsibility to identify all interface requirements with all the trades required for performing work under this Contract so that all aspects of the work are correctly sized and located. While not exhausting all the possible interfaces, the following are the kinds of interfaces to be considered:
        1) Locations of electrical equipment pads.
        2) New cable trenches.
        3) Existing underground objects.
        4) Water, drainage and sewer utility piping.
        5) Assume responsibility to coordinate the installation of all equipment with the existing ground grid and new ground bus, including grounding tail locations in equipment pads and/or floors.

B. Coordinate the communication system work with SEPTA's Signals and Communications group, through the SEPTA Project Manager. The coordination shall include the work of routing communication cables to/from the control room and interface cabinet.

1.10 Manufacturer and Equipment Selection

A. Traction Power materials, equipment and installation for this Contract shall meet or exceed the requirements for Seismic Design Category B as per IBC standards. The Contractor to provide seismic design details.

B. The names of the manufacturers who are known to have products similar to the products specified in these Specifications are listed in the Specification. It is the Contractor's responsibility to ensure that the product that is selected from these manufacturers meets the detailed requirements contained in these Specifications.

C. The decision of SEPTA regarding whether the product meets the Specification requirements is final and binding on the Contractor. If the Contractor decides to offer products from other than those named, it shall in such cases be accepted Approved-Equal if, to the best of SEPTA's knowledge, information and belief, the products are approximately equal in physical size, strength, arrangement, durability, usefulness, suitability, performance and convenience for the purpose intended.

D. SEPTA is the sole judge of the qualifications of such products and determine all questions regarding the conformation of any products with the specified products. If such products are acceptable to SEPTA but differ significantly from those in the Specifications, to the extent that their proper incorporation into the work requires changes to the structural, mechanical, electrical, instrumentation, or any other changes of whatsoever nature, the Contractor shall assume responsibility to accept the full cost for such changes. SEPTA shall judge the qualifications of such products and determine all questions regarding the conformation of any products with the specified products based on the Contractor’s submittals.

1.11 Reports

A. Certified Test Reports:

1. Where certified test reports are required by the Contract Documents, they will meet the following requirements:

a. Before delivery of materials for which certified test reports are required, submit certified copies of the reports of tests required in reference publications or specified within the Contract Documents for approval to SEPTA. Perform the testing in an approved independent laboratory. If testing was performed in the manufacturer's own testing laboratory, the credentials of its test lab and procedures must be submitted to SEPTA's Project Manager who may approve the testing lab as a certified alternate to an independent testing lab. Accompany test reports with a notarized certificate from the manufacturer or supplier certifying that the tested material meets the specified requirements and is the same design, type, quality, manufacturer and make as that proposed to be supplied.

b. At the option of the SEPTA Project Manager, or where specified, furnish, in lieu of the specified tests and other tests required in the various reference documents, a certificate of compliance from the manufacturer. The certificate must state that the manufacturer has performed the required tests; that products to be supplied meet the test requirements; that products tested were of the same design, type, quality, and manufacturer and make as those proposed to be supplied. The intent of this requirement is to permit, as approved by the SEPTA Project Manager, the manufacturer to provide certified test reports for non-production related tests that were performed on equipment having the same configuration, capacities and characteristics.

1.12 Visit to Site

A. Prior to submitting a bid, visit the proposed construction site and become familiar with the existing facilities and conditions.

B. Immediately inform SEPTA's Project Manager of anything found that is incorrectly represented or not represented on the Contract Drawings, or is not specified within the Specifications.

C. Failure to meet the above shall not be just cause for additional payment should conflicting or non-represented conditions be encountered during construction.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 General

A. Locate and install all equipment to be readily accessible for operation and maintenance. SEPTA reserves the right to require minor changes in location of raceways or equipment without incurring any additional costs or charges.

B. Install raceway stub-ups in accordance with field conditions and equipment shop drawings.

C. Locate wall switches, outlets and lighting to suit field conditions.

D. Install equipment using procedures defined in NECA Standard of Installation.

E. Energize any space heaters in equipment or provide temporary heat during storage and until such time the equipment is finally commissioned.

F. Cap raceway runs with seals manufactured by the raceway manufacturer.

G. Keep openings in boxes or equipment closed during construction.

3.02 Traction Power Integrator/Designer

A. Appoint a Traction Power Integrator/Designer (TPI) with significant prior experience in the complete power system, including equipment and system integration, traction power system equipment, its related control systems and protective relay selection, relay coordination studies and relay settings, integration with site/civil, fencing, lighting, painting and structural elements of the Contract up to and including testing, and the training of SEPTA personnel. Refer to Section 01010 for additional requirements.

B. The Traction Power Integrator/Designer shall review, prior to submission to SEPTA, the shop drawings to ensure that the selected equipment is fit for the intended application and does not conflict with the equipment of other Contractors.

C. The Traction Power Integrator/Designer shall be a registered Professional Engineer in the Commonwealth of Pennsylvania. The Contractor shall submit the Traction Power Integrator/Designer resume prior to award of the Contract.

D. The Traction Power Integrator/Designer shall be a member of the Contractor’s design firm that will bring the 50% level design to 100% and sign/seal the drawings. The design team shall have architects and design engineers, licensed in the Commonwealth of Pennsylvania, of all disciplines.

3.03 Interfaces with Other Contracts

A. Interferences:

1. Perform construction activities in a manner not to delay or interfere with other operations of work in the Contract.

2. Prior to performing electrical installations, coordinate the work with the other work either being performed or planned at the location, especially in congested areas.

3. In the event that interferences develop, the decision of the SEPTA Project Manager will be final and no additional compensation will be allowed for relocation of either existing electrical installation or the new installation.

B. Scheduling:

1. Schedule electrical work; unless otherwise indicated; in accordance with the requirements of Section 01400.

2. Provide coordination and agreement of work schedule. Start no work in an area without approval from SEPTA.

3. Coordinate the work in such manner as not to interfere or conflict with the performance of work by SEPTA's employees, or the obligations and duties of its maintenance personnel during the normal operating hours.

END OF SECTION

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SECTION 16050

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 - GENERAL

1.01 Description

A. Requirements for the basic materials and methods of installation of electrical systems, which include the following materials and systems:

1. Metal framing system (including metal framing material, fittings and related accessories) also known as strut system.
    a. Provide all metal framing material, fittings and related accessories to support the equipment, conduits and cables as shown on the Contract Drawings.
    b. Provide all labor, supervision, engineering and fabrication required for installation of the metal framing systems.
2. Cable tray systems.
3. Cable (vertical support) strain relief grips, bus drops and conduit risers when cable end is not available.
4. Cable fire proofing tape system.
5. Floor and wall sleeves.
6. Beam clamps.
7. Concrete inserts.
8. Anchors.
9. Duct watertight cable plugs.
10. Padlocks for various traction power and auxiliary power equipment.

1.02 Related Sections

A. All requirements that are described in Division 1

B. Section 07841 – Penetration Fire Stopping

C. Section 07842 – Joint Fire Stopping

D. Section 16120 – Conductors and Cables

E. Section 16130 – Raceways and Boxes

F. Section 16240 – Battery Equipment

G. Section 16440 – Panelboards

H. Section 16500 – Lighting

1.03 Submittals

A. Submit the proposed manufacturers with model or catalog numbers, identifying the materials and equipment proposed.

B. Submit brochures, catalog cuts, or shop drawings for materials and equipment as designated on the returned list of materials.

C. Submit samples of any materials for review by SEPTA's Project Manager. Samples shall be sent to the Project site and stored by the Contractor.

D. Submit certification from the manufacturers verifying that the equipment furnished conforms to the specified requirements.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
2. ASTM A 276/A 276M, Standard Specification for Stainless Steel Bars and Shapes.
3. ASTM A 480/A 480M, Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
4. ASTM A 370, Standard Test Methods and Definition for Mechanical Testing of Steel Products.
5. ASTM A 1011/A 1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, and High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
6. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
7. NEMA FG 1, Fiberglass Cable Tray Systems.
8. NFPA 70, National Electrical Code (NEC).

B. Inspection of Materials:

1. Inspection of the material will be made at the point of delivery. However, SEPTA's Project Manager reserves the right to make any tests or inspection that he may deem necessary at the Contractor's plant.
2. In the event inspection is made at the plant, grant SEPTA's Project Manager, and/or representative, free entry at all times while work under this Specification is being performed, to all parts of the plant that concern the manufacture of the pertinent material/equipment.
3. Render all assistance to satisfy SEPTA's Project Manager that the material/equipment is being furnished in accordance with this Specification.
4. Assume the responsibility to impose these conditions in Contracts with the equipment manufacturer.
5. In all cases, notify SEPTA's Project Manager when the finished material/equipment is ready for shipment in order that plant inspection of the material/equipment may be made if desired.

C. The construction code requirements of state, county, city, utility companies or other political subdivision, which exceed the requirements of the NEC, shall be met and complied

with. Modify the electrical work to be in conformity with such laws, ordinances, rules and regulations.

D. Use electrical materials, which are new, UL listed, meet UL requirements and bear the UL label. In lieu of the UL listing, or where standards have not been established by UL and label service or certification service is not available, material and equipment shall meet the requirements of a recognized national testing laboratory, such as one (1) of the following laboratories:

1. ETL Testing Laboratories, Inc.
2. MET Electrical Testing Company, Inc.
3. SGS U.S. Testing Company, Inc.
4. Applied Research Laboratories, Inc.

E. Perform work of this Section in accordance with requirements of the NEC applicable to basic electrical materials and as modified by this Specification.

F. Have the work inspected by an authorized electrical inspection agency for compliance with the NEC and obtain certificates of approval, acceptance and compliance with code regulations. Work shall not be deemed complete until such certificates have been delivered to SEPTA's Project Manager for review.

1.05 Operational and Maintenance Data

A. Furnish SEPTA's Project Manager with one (1) set of final drawings, in reproducible form and on CD-ROM disk in AutoCAD format, of the material and equipment supplied under this agreement, in their accepted, as-built form.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Metal Framing Systems:

1. The following metal framing system manufacturers are approved for use on this Contract:
   a. Unistrut Buffalo-P1000 Series.
   b. Versabar Corporation.
   c. Cooper B-Line.
   d. Or Approved Equal.
2. Material:
   a. All metal framing system components that are in unheated spaces, shall be fabricated from structural grade steel that is hot dipped galvanized, meeting ASTM A 1011/A 1011M and ASTM A 123/A 123M.
   b. All metal framing system components that are installed outdoors, shall be fabricated from structural grade stainless steel meeting ASTM A 480/A 480M and ASTM A 276/A 276M.
   c. Cables shall be supported using Unistrut, Porce-A-Clamp (thermoplastic elastomer insulator) with stainless steel clamps and hardware; Or Approved Equal.

B. Cable Trays:

1. Cable Trays for AC Circuits and/or Control Cables:
   a. Cable trays shall be steel, hot dip galvanized meeting ASTM A 123/A 123M after fabrication, with continuous ventilated punched bottom.
   b. Minimum cable tray widths shall be 18 inches. Cable tray depth shall be selected to limit the initial fill to 50 percent of the allowable fill, as defined in the NEC. Inside depth shall be 4 inches minimum.
   c. All connectors, accessories and supports shall be supplied to provide a complete system.
   d. Upper flanges shall be rolled out and downward.
   e. Minimum radius of elbows, crosses, tees, et al shall be as required for the minimum bending radius of the largest diameter cable installed.
   f. Cable tray connections shall be solid plates, with multiple bolts on each rail. Total resistance of a connection, when made in accordance with the manufacturer's requirements, shall not exceed the resistance of 2 feet of side rail.
   g. Cable trays shall be as manufactured by the companies listed below:
      1) Husky-Burndy.
      2) T.J. Cope.
      3) PW. Industries.
      4) Or Approved Equal.
   h. All wiring on cable trays shall be multi-conductor jacketed up through 500 kcmil and shall be of the same insulation level.
   i. Where cable tray is mounted from the ceiling, a metal framing system shall be used. A single rod mounted system will not be accepted.

C. Cable Strain Relief Grips:

1. Select appropriate type cable strain relief grips for the application and be fully aware of the breaking strength, safety and technical data regarding the product.
2. Provide support of AC cables in vertical conduit drops.
3. Cable strain relief grips shall be manufactured by the companies listed below:
   a. Hubbell Kellems.
   b. Daniel Woodhead.
   c. Ericson.
   d. Or Approved Equal.

D. Sleeves:

1. Sleeves shall be rigid galvanized steel tubing. Extend sleeves through floor or 2 inches above the finished floor and 2 inches below ceilings.
2. Seal conduits penetrating walls below grade with a waterproof, modular, mechanical expansion seal consisting of interlocking synthetic rubber links shaped to continuously fill the annular space between the conduit and wall opening. Assume responsibility for the sizing of links and wall sleeve. Seal conduits in fire rated walls with fire seals of the same rating as wall composition.
   a. Fire retardant sealant shall be asbestos free; UL classified, FM approved and meet ASTM E 814. Forming and backing material installed with the sealant shall be bulk ceramic fiber or

rigid fiberboard rated for 2300°F. Refer to Sections 07841 and 07842 for additional sealant information.

3. For slabs above grade, plastic core form block outs may be used to form sleeve opening where exposed in electrical closets and other areas not subject to flooding.

E. Anchors:

1. Bolts, Nuts Washers and Screws:
   a. Less than 3/8 inch trade size to be stainless steel.
   b. Over 3/8 inch trade size to be galvanized.
2. For Hollow Masonry:
   a. Toggle type bolts.
   b. Epoxy bolt or stud.
3. For Steel Work:
   a. Either machine screws, welded threaded studs or spring tensioned clamps.

F. Inserts:

1. Channel Inserts:
   a. Not lighter than 12 gauge carbon steel hot dip galvanized after fabrication.
   b. Not smaller than 1 1/2 inches by 1 1/2 inches, and have 13/32 inch by 3 inch slots on 4 inch centers.
   c. Pullout load rating shall be not less than 1,500 pounds per linear foot uniformly distributed.
   d. Inserts embedded in concrete shall have solid base plate with concrete anchors welded to base plate and coated with cold applied zinc rich paint.
2. Spot inserts:
   a. Rated 800 pounds.
   b. Carbon steel galvanized after fabrication.
   c. Safety factor of five (5).
   d. Covered to prevent concrete from filling insert.

G. Beam Clamps:

1. Shall be galvanized steel, with tapped holes in base and face for bolts or hanger rods.

H. Duct Water-Tight Cable Plugs:

1. Watertight cable seals shall be as manufactured by the companies listed below:
   a. Jack Moon, Inc.
   b. OZ Gedney.
   c. Or Approved Equal.

I. Padlocks (If required by SEPTA):

1. Padlocks shall have 2 inch wide solid brass body with 1 inch brass shackle clearance, 3/8 inch shackle diameter. Each padlock shall be keyed differently and each provided with two (2) keys.
2. Manufacturer:
   a. Wilson Bohannan Padlock Company (Model 92120-2-A).

b. Or Approved Equal.

3. Provide a durable key box, wall mounting type, with hinged doors to organize the keys. Provide as a minimum, one hundred (100) assignment key hangers.

PART 3 - EXECUTION

3.01 Preparation

A. Transmit submittals and deliverables required by this Section.

B. Furnish products as indicated on the Contract Drawings.

C. Ensure substrates are in suitable condition to receive the work of this Section.

D. Review the Contract Drawings and Specifications thoroughly in preparation for installation of the materials and equipment. Materials shall be procured and stored, and planned for use in a manner that minimizes waste and substitutions and maximizes installation efficiency and quality of the end product.

E. Determine the exact location of all equipment within the space assignments designated on the Contract Drawings. The right to make any reasonable change in location of equipment, before installation, is reserved by SEPTA's Project Manager.

F. Design and install all electrical equipment and apparatus that may require periodic maintenance and operation in a manner that provides accessibility and arrangement.

G. Examine all Contract and Reference Drawings, to verify and properly coordinate the placement of conduits and outlets; check all drawings including mechanical drawings, equipment drawings and shop drawings, for apparatus that must be connected.

3.02 Installation, Application and Execution

A. Cable Trays:

1. Cable trays shall be supported by metal framing systems.

2. Maximum distance between tray supports shall be 8 feet.

3. Supports for tray fittings shall be located as follows:

a. Horizontal straight sections shall be supported within 2 feet of splices.

b. Vertical straight sections shall be supported every 8 feet.

c. Horizontal elbows shall be supported at the midpoint of the arc.

d. Horizontal tees shall be supported within 2 feet of each opening.

e. Horizontal crosses shall be supported within 2 feet of each opening and diagonally under the cross for 2 feet and 3 feet radii fittings.

f. Vertical elbows shall be supported at each end.

g. Dropout at end of runs shall be supported under the fitting.

4. Cable trays shall be ruggedly clamped in place at every support. Sliding glide clamps may be used in horizontal runs, where provision for thermal expansion is required. Sloping and vertical cable trays shall be through bolted or positively anchored to the support by means other than friction, so as to support the specified design load. Make provisions to allow cable tray supports to accommodate thermal expansion of the cable tray system.

5. Wherever possible maintain a minimum vertical clearance of 4 feet from the top of all cable trays to the underside of beams, ceilings, ducts, piping and other obstructions, and 4 feet 3 inches from bottom of cable tray to switchgear and clearance of 12 inches shall be maintained from the top of the bottom cable tray to the bottom of the top cable tray.
6. All cable tray runs shall be marked with the cable tray numbers at both ends and every 25 feet. Marking shall be high black letters stenciled in a visible location on the outside of the cable tray side channel.
7. The following partial list is intended to serve as an example of the kinds of equipment that shall be supported using metal framing systems:
    a. Automatic transfer switches, disconnect switches, panel boards, battery chargers, bus ducts, light fixtures, conduits, pull boxes, splice boxes, cable strain relief grips and exposed cables run along the wall, or ceiling, interrupter switches and related operating mechanisms

B. Anchors:

1. Holes for anchors placed in pre-stressed and post-tensioned concrete shall be made so as not to weaken tendons or tensioning wires.

C. Beam Clamps:

1. Beam clamps may be used for support of raceways, enclosures, panelboards or equipment where attached to/from fixed steel supports or structures.
2. Beam clamps fastened to steel supports not horizontal or vertical shall be provided with a swing connector.
3. Beam clamps fastened to structures in a horizontal position (where bolt is horizontal) shall not be used for support of equipment exceeding 10 pounds.

END OF SECTION

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SECTION 16060

GROUNDING AND BONDING

PART 1 - GENERAL

1.01 Description

A. This Section covers requirements for the design, furnishing, installing and testing the grounding and bonding of indoor and outdoor electrical equipment, manholes, handholes, pull boxes, junction boxes, fences, metallic structures and enclosures.

B. Measure the soil resistivity at each Traction Power Substation (TPSS) and perform a ground grid design study. Design supplemental ground grid, if required, in accordance with IEEE 80. Calculate step and touch potentials and ground grid resistance to remote earth.

C. Install new supplemental ground grid, if required, which will include new ground rods, new grounding wires, new grounding pigtails, new ground busbars, new grounding lugs and fittings.

D. Ground all equipment and structures as specified and bond the new supplemental ground grid to the existing ground grid.

E. Provide additional clean low resistance backfill, as specified herein.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 02220 – Excavating, Backfill and Compaction

C. Section 05090 – Metal Fasteners, Joining and Welding

D. Section 16050 – Basic Electrical Materials and Methods

E. Section 16120 – Conductors and Cables

F. Section 16953 – Electrical Testing - Traction Power Equipment (CTD)

1.03 Submittals

A. Meet the submittal requirements of the general electrical work section and the general provisions.

B. Submit the following documents and samples for the SEPTA review and approval:

1. Ground grid calculations and grounding plan. Include the location of pigtails for connection to the equipment, steel structures, fence and existing ground grid.
2. Description of exothermic welding process.
3. Description of jointing process.
4. Test Procedures:
    a. Test procedure for measuring ground grid resistance.
    b. Test procedure for measuring electrical continuity of the grounding system.

5. Test Reports:
    a. Ground grid resistance.
    b. Results of electrical continuity measurements.
6. Product Data:
    a. Grounding conductors and pigtails.
    b. Ground rods.
    c. Ground busbars.
    d. Connectors, compression joints, lugs and fittings.
    e. Exothermic welding molds, weld metal and electronic ignitor.
    f. A test report demonstrating that the ignitor meets standard requirements for electromagnetic and electrostatic compatibility, including radiated emissions and electrostatic discharge.
7. Shop Drawings:
    a. Ground grid layout.
    b. Location plan of ground rods, connectors and pigtails. Assume responsibility for provision of all ground rods, connectors and pigtails.
8. Submit a sample of each type of mechanical and compression connectors proposed, along with a description of its intended use.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM B 3, Standard Specification for Soft or Annealed Copper Wire.
2. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
3. ASTM B 187/B 187M, Standard Specification for Copper, Bus Bar, Rod, and Shapes and General Purpose Rod, Bar, and Shapes.
4. IEEE C2, National Electric Safety Code (NESC).
5. IEEE 80, IEEE Guide for Safety in AC Substation Grounding.
6. IEEE 81, IEEE Guide for Measuring Earth Resistivity, Ground Impedance and Earth Surface Potentials of a Grounding System.
7. IEEE 142, IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book).
8. IEEE 837, IEEE Standard for Qualifying Permanent Connections Used in Substation Grounding.
9. IEC 61000 Series, Electromagnetic Compatibility.
10. NFPA 70, National Electric Code (NEC).
11. UL 44, Thermoset-Insulated Wires and Cables.
12. UL 83, Thermoplastic-Insulated Wires and Cables.
13. UL 467, Grounding and Bonding Equipment.

14. UL 486A/B, Wire Connectors.
15. UL 486C, Splicing Wire Connectors.
16. UL 486D, Sealed Wire Connector Systems.
17. UL 486E, Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
18. UL 506, Specialty Transformers.

1.05 System Requirements

A. Provide a complete grounding and bonding system including all grounding electrodes, electrode conductors, equipment grounding conductors, bonding jumpers, grounding bushings, connections and other materials that may be required.

B. All raceway, cable tray and non-current carrying metal equipment and enclosures shall be continuous and bonded to the grounding system.

C. The grounding and bonding system shall be as indicated on the Contract Documents and shall meet the requirements of NEC Article 250.

D. The grounding system shall provide a resistance to earth not exceeding the design value or five (5) ohms, whichever is less.

1.06 Existing Soil Testing

A. The Contractor shall employ a third party electrical ground resistance testing company to test the existing soil in no less than ten (10) evenly spaced locations throughout the existing TPSS site.

B. The Contractor shall submit all testing plans/procedures and an SSWP detailing the testing to be performed to satisfy Article 1.06/A in this Section for SEPTA approval per the terms in Section 01300 of this Contract.

C. The Contractor's Engineer of Record is required to submit the above test reports along with a summary report indicating whether or not the existing soil is suitable to be re-used for the new ground grid system.

D. If the existing soil is determined to be of suitable resistance per Article 1.06/C in this Section, then the existing soil shall be reused and supplemented with new clean low resistance soil if required at no additional cost to SEPTA.

E. If the existing soil, all or in part, is determined to NOT be of suitable resistance per Article 1.06/D in the Section then the Contractor shall provide additional new clean low resistance soil in the quantity required and dispose of the soil at a suitable facility at no additional cost to SEPTA.

PART 2 - PRODUCTS

2.01 Basic Grounding Materials

A. Grounding Conductors:

1. Use class B stranded, No. 4/0 AWG minimum, annealed copper conductors, meeting ASTM B 3 for the ground grid and for all non-flexible grounding connections.
2. Use braided copper conductors, No. 4/0 AWG minimum, for all pigtails and flexible grounding connections.
3. All connections shall be capable of carrying the rated short circuit current.
4. Aluminum conductors are prohibited.
5. Use of splices is allowed only with prior approval from SEPTA.

B. Insulated conductors shall meet the requirements for 600 V system grounding. Provide green insulation for conductors No. 2 AWG and smaller, and black insulation with green taped ends for conductors larger than No. 2 AWG.

C. Use steel ground rods copper clad by the molten weld casting process. Use 3/4 inch diameter, 10 foot or 20 foot long rods. Achieve this length by UL approved splicing or welding of two (2) 10 foot or four (4) 5 foot ground rods. The Contractor to determine ground rod length based on field conditions.

D. Busbars for grounding shall be minimum 2 inch by 1/4 inch meeting ASTM B 187/B 187M, 98 percent conductivity copper, minimum.

E. Provide polymer concrete ground grid access well with cover.

F. Accessories:

1. Lugs:
   a. Select suitable lugs for attaching grounding conductors to equipment or metallic surfaces.
   b. Use UL listed NEMA two (2) hole, compression type lugs manufactured of tin plated or silver plated copper. Exothermically weld or install the lugs with a hydraulic tool.
2. Use stainless steel or silicon bronze bolts and braided, flexible tin plated copper jumpers.

2.02 Exothermic Welding Materials

A. Molds:

1. Use synthetic graphite material molds capable of withstanding high temperatures generated during the welding process.
2. Use molds bearing permanent marking indicating the name of manufacturer, type and size of welding mixture compatible with the welding process, and the size of cable or bus connection.
3. Select molds furnished with safety information, connection preparation and welding procedure.

B. Weld Metal:

1. Use weld metal consisting of copper oxide.
2. Weld metal packages shall identify the type of weld metal and the metals to be connected.

C. Electronic Ignitor:

1. Provide rugged and water resistant ignitor meeting the requirements of UL 506, IEC 61000 series of standards.
2. Provide the ignitor with a high intensity LED indicator viewable in sunlight. Provide the unit with an overvoltage protection.
3. Provide field replaceable, No. 18 AWG, one hundred and forty-two (142) strand, individually insulated, copper leads.

2.03 Manufacturers

A. Manufacturers:

1. Harger.
2. Erico.
3. Thermoweld.
4. Burndy.
5. Thomas and Betts.
6. Ilsco.
7. Ideal Industries.
8. Or Approved Equal.

PART 3 - EXECUTION

3.01 Site Work

A. Excavation:

1. Clear the TPSS site. Excavate for the new supplemental ground grid and prepare subgrade by leveling and compacting soil. Should rock be encountered, over excavate.
2. Allow for equipment footings, foundations and slabs.

B. Supplemental Ground Grid Installation:

1. Construct the supplemental grounding grid per the approved design using copper conductors arranged to form a mesh.
2. Following installation of ground grid conductors, ground rods and pigtails, notify SEPTA prior to backfilling the supplemental ground grid. Place no backfill, concrete or asphalt until inspection by SEPTA is completed and the grounding installation is approved.

3. Install ground rods, grounding wires, grounding pigtails, grounding lugs and fittings. Weld exothermically all underground wire cross, tee, pigtail and ground rod connections.
4. Bond the new supplemental ground grid to the existing ground grid.

C. Backfilling:

1. Provide 12 inches minimum of clean low resistance compacted soil, free from debris and rocks, on top of the ground grid conductors.
2. The backfill shall be a mixture of surface soils and loam with limited amount of sand and gravel such that the resistivity does not exceed one hundred (100) ohm-meters. Compact the backfill.
3. Protect grounding conductors, ground rods, pigtails and fittings from damage at all times during installation and backfilling by isolation from other construction activities. Avoid driving of any kind of vehicle over grounding conductors, ground rods and pigtails.

D. Crushed Rock (Castor TPSS only):

1. Following installation of equipment foundations, equipment footings, provide 4 inch depth, minimum, layer of new crushed stone or pebbles within the TPSS areas not covered by concrete and asphalt.
2. Extend the layer of crushed stone or pebbles 6 feet, minimum, beyond the TPSS fence. The Contractor to determine final distance based on field conditions and site locations.

3.02 General Grounding Requirements

A. Provide all grounding as required by this Specification and shown on the Contract Drawings.

B. Weld all ground grid connections exothermically, including tees, crosses, pig tail connections and ground rod connections. Compression or mechanical connections underground are prohibited.

C. Prior to welding to exposed structural steel, remove epoxy coating from the steel at the location of grounding conductor connection. Following completion of the weld, reapply epoxy coating to exposed surfaces of the steel.

D. Compression type or mechanical connections may be used in dry, above grade locations with the approval of SEPTA. Attach lugs to items being grounded with stainless steel or silicon bronze bolting hardware.

E. Protect grounding conductors from physical and environmental damage. Wherever possible, enclose grounding and bonding conductors in non-metallic raceways. Where conductors are required to be exposed, support grounding conductors by corrosion resistant metallic hardware at 4 foot intervals or less.

F. Use bi-metallic strips and oxide inhibiting compound for all mechanical connections where copper to aluminum or copper to steel connections are made. Abrade all contact surfaces prior to application of the inhibiting compound and before attachment of the bolted connection. Apply the compound to all copper, aluminum and steel parts.

G. Make all grounding and bonding connections by continuous grounding conductors via shortest possible route and without splices, or unnecessary bends and kinks in the conductors.

3.03 Exothermic Welding

A. Clean and dry the surfaces to be welded. Wire brush or file the points of contact to clean bare metal surfaces.

B. Use suitable welding cartridges and molds for the type of weld performed. Perform welding in accordance with the manufacturer's recommendations. Discard worn or damaged molds.

C. Place powdered welding metal in the mold along with the conductors to be welded. Ignite the powder to produce molten copper to weld the conductors to each other or to a surface.

D. After welds have been completed and cooled, brush slag from the weld area and thoroughly clean the joint.

E. Where exothermic grounding connections made between copper wire and steel surfaces are direct buried, coat the connection with a Coal Tar Epoxy (CTE) coating before backfilling. Also, coat the entire area of the steel surface disturbed by the exothermic welding.

F. Where exothermic welds are made to a galvanized surface, remove the galvanizing and expose a clean surface by grinding wheel. After welding, touch up the steel surface with zinc rich primer.

G. Test all welds by striking with a two (2) pound steel hammer. Replace any defective welds.

3.04 Perimeter Fence Grounding Installation

A. Install one (1) No. 4/0 AWG bare copper grounding conductor along the entire perimeter of the fence, on the inside of the fence, at a depth of 2 1/2 feet below grade, except in the area where the fence crosses the ground grid as shown on the Contract Drawings.

B. Provide a ground on the top rail of the perimeter fence at every vertical post via No. 2 AWG stranded copper conductor. The conductor shall also be connected to the mesh.

3.05 Ground Rod Installation

A. Install ground rods as shown on the Contract Drawings. Install ground rods in line with top of the grid.

B. If extensive rock formation is encountered, inform SEPTA and obtain direction to relocate the ground rods or provide supplemental ground rods. Supplemental ground rods are those needed in addition to the grounding system as shown on the Contract Drawings to make the grounding system conform to the design calculations.

C. Connect ground rods to grid conductors using exothermic welding.

3.06 Ground Grid Access Well Installation

A. Install one (1) ground rod in the well to enable measurement of the ground grid resistivity.

B. Weld the ground rod to the ground grid.

3.07 Pigtail Installation

A. Provide flexible conductor pigtails required for the following connections:

1. Ground grid to indoor and outdoor electrical equipment.
2. Ground grid to ground busbars.
3. Grounding conductor or ground grid to fence posts and fence mesh.

B. Install “pigtails” as shown on the Contract Drawings. Protect all pigtail conductors with stubbed-up conduits.

C. Install pigtails of the following minimum lengths:

1. Roof mounted equipment pigtail to be 45 feet long measured from the foundation stubbed-up grounding conduit.
2. Perimeter fence pigtail to be 5 feet long measured from the grounding wire.
3. All other equipment pigtails to be 15 feet long measured from the foundation stubbed-up grounding conduit.

D. Coordinate pigtail stub up location to ensure that all equipment is grounded as specified.

E. Indoor and Outdoor Equipment:

1. Provide minimum of two (2) pigtails from ground grid to each grounding busbar.

F. Electrical Equipment Site Fence Pigtails:

1. Install pigtails from ground grid to enable the following:
   a. Grounding of each fence corner post.
   b. Grounding of each fence gate post.
   c. Grounding every fence third post.
   d. Grounding of the fence mesh between grounded posts.

G. Perimeter Fence Pigtails:

1. Location of fence within the area of ground grid:
   a. Install pigtails from ground grid to enable the following:
      1) Grounding of each fence gate post.
      2) Grounding every fence third post.
      3) Grounding of the fence mesh between grounded posts.
2. Location of fence outside of the area of ground grid:
   a. Install pigtails from grounding conductor to the inside and outside mesh every 8 feet.
   b. Install pigtails from the grounding conductor to enable the following:
      1) Grounding of each fence corner post.
      2) Grounding of each fence gate post.
      3) Grounding every fence third post.
      4) Grounding of the fence mesh between grounded posts.

3.08 Perimeter Fence Grounding Installation

A. At each end of the fence mesh, weld the grounding conductor and the inside and outside meshes to the ground grid.

B. Weld the inside and outside meshes to the pigtails welded to the grounding conductor.

C. Connect the pigtails from the grounding conductor to the fence poles and fence meshes as shown on the Contract Drawings.

D. Ground the corner posts, every third post, gate posts and the fence mesh to the pigtails connected to the ground grid or the ground wire.

E. Ground the fence gates to the fence posts with soft braided copper conductor as shown on the Contract Drawings.

F. Bond each entrance gate post located at street elevation to the corner fence post at the TPSS elevation.

G. Bond the barbed wire to every corner posts, every third post and gate posts.

3.09 TPSS Ground Bus

A. Provide TPSS ground busbar, as shown on the Contract Drawings, for connection of the following equipment:

1. Traction power rectifier-transformer neutrals.
2. Surge arresters.
3. Neutrals of auxiliary transformer and potential transformers.

3.10 Raceway Bonding and Grounding

A. Bond all metallic raceways together to provide a continuous metallic electrical path to ground. Bond metallic raceways to other raceway components using insulated grounding bushings. Connect grounding bushings to the grounding system using conductors sized in compliance with the NEC.

B. All metal conduits, raceways, pull boxes and cable shields shall be bonded and connected to the ground bus.

C. Install grounding conductors in non-metallic raceway systems in accordance with the NEC.

3.11 TPSS Yard Fence Grounding

A. Ground the corner posts, every third post, gate posts and the fence mesh to the pigtails connected to the ground grid.

B. Ground the fence gates to the fence posts with soft braided copper conductor as shown on the Contract Drawings.

3.12 Tests

A. Perform grounding tests of the completed ground system.

B. Measure the TPSS ground grid resistance before foundation installation. If the measured resistance is higher than the design value or five (5) ohms, install additional ground rods to bring the resistance down to the design value or lower.

END OF SECTION

SECTION 16070

HANGERS, ANCHORS AND SUPPORTS

PART 1 - GENERAL

1.01 Description

A. This Section covers hangers, anchors and supports as specified herein for use in Traction Power Substations (TPSSs).

B. Types of hangers, supports, anchors and seals in this Section include the following:

1. Hanger rod attachments.
2. Building attachments.
3. Miscellaneous materials.
4. Anchors.

C. Supports, anchors and seals furnished as a part of factory fabricated equipment are specified as part of the equipment assembly in other Sections of this Specification.

1.02 Related Sections

A. Section 01300 – Submittals

1.03 Submittals

A. Shop drawings and manufacturer's literature shall be submitted in accordance with Section 01300.

B. Submit catalog cuts, specifications, installation instructions and dimensioned drawings for each type of support, anchor and seal.

C. Submit as-built drawings of building supports.

1.04 Quality Assurance

A. Products shall be provided which are Underwriter Laboratories listed and Factory Mutual approved.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 36/A 36M, Standard Specification for Carbon Structural Steel.
2. MFMA-4, Metal Framing Standards Publication.
3. MSS SP-58, Pipe Hangers and Supports, Materials, Design, Manufacture, Selection, Application, and Installation.

PART 2 - PRODUCTS

2.01 Hanger Rod Attachments

A. Except as otherwise indicated, factory fabricated hanger rod attachments shall be provided in compliance with MSS SP-58. Only one (1) type by one (1) manufacturer shall be used for each service. Size of hanger rod attachments shall be selected to suit hanger rods.

B. Steel turnbuckles to be MSS Type 13.

C. Steel clevises to be MSS Type 14.

D. Swivel turnbuckles to be MSS Type 15.

E. Malleable iron sockets to be MSS Type 16.

F. Steel weld-less eye nuts to be MSS Type 17.

2.02 Building Attachments

A. Building attachments shall be coordinated with the existing building design.

B. Steel strut shall be galvanized steel type channel, 1 5/8 inch or larger on a side, complete with spring nuts, clips, conduit clamps, bolts and accessory fittings.

2.03 Manufacturers of Hangers and Supports

A. Subject to compliance with requirements, hangers and supports shall be provided from one (1) of the following manufacturers:

1. C&S Mfg. Corp.
2. Carpenter and Patterson, Inc.
3. Elcen Metal Products Co.
4. F&S Central Mfg. Corp.
5. Fee & Mason Mfg. Co., Div. of A-T-O Inc.
6. ITT Grinnell Corp.
7. Or Approved Equal.

2.04 Miscellaneous Materials

A. Metal framing products shall meet MFMA-4.

B. Steel plates, shapes and bars shall meet ASTM A 36/A 36M.

PART 3 - EXECUTION

3.01 Preparation

A. Installation of hangers, supports and anchors shall proceed only after required building structural work has been completed in areas where the work is to be installed. All inadequacies shall be corrected at no additional cost to SEPTA.

B. Prior to installation of hangers, supports, anchors and associated work, the Contractor shall meet at Project site with the installer of each component of associated work, inspection and testing agency representatives and the installers of other work requiring coordination with work of this Section and SEPTA for the purpose of reviewing material selections and procedures to be followed in performing the work in compliance with requirements specified.

3.02 Installation of Building Attachments

A. Building attachments shall be installed at required locations on structural steel for proper equipment support. Additional building attachments shall be installed where support is required for additional concentrated loads.

B. Note variation on as-built drawings.

3.03 Installation of Hangers and Supports

A. Hangers and supports shall be installed complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated, hangers and supports shall be installed of same type and style as installed for adjacent similar equipment.

B. Adjust supports to allow adequate clearances between equipment.

END OF SECTION

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SECTION 16075

ELECTRICAL IDENTIFICATION

PART 1 - GENERAL

1.01 Description

A. Provide electrical equipment identifications consisting of the following:

1. Nameplates.
2. Labels.
3. Identification signs.
4. Warning signs.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control - Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling - Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials - Traction Power Equipment

E. Section 01822 – Demonstration and Training - Traction Power Equipment

F. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment

G. Section 05090 – Metal Fasteners, Joining and Welding

H. Section 09910 – Paints and Coatings

I. Section 16050 – Basic Electrical Materials and Methods

J. Section 16060 – Grounding and Bonding

K. Section 16240 – Battery Equipment

L. Section 16290 – Protective Devices and Instrument Transformers

M. Section 16335 – Surge Protection

N. Section 16440 – Panelboards

O. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit - Including HMI

P. Section 16953 – Electrical Testing - Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following documents to the SEPTA Project Manager for review and approval:

1. Tabulation of all equipment that require nameplates.
2. Drawings of all nameplates.
3. Text of all labels and signs.

4. System for numbering control wires and cables.
5. System for numbering of terminal blocks.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Nameplates:

1. Provide all major items of equipment, such as auxiliary transformers, rectifier transformers, 15 kV switchgear, DC switchgear, power panels, and relay and control panels with permanent nameplates identifying the equipment, relevant parameters, manufacturer and other appropriate information such as serial numbers.
2. Design the nameplates in accordance with applicable IEEE, ANSI and NEMA standards.

B. Labels:

1. Provide equipment cubicles and wall mounted equipment with black lamicoid labels. Provide primary equipment description using white lettering 2 inches high and secondary description using lettering 3/4 inch high.
2. Identify all external and internal devices mounted on enclosure doors and panels, such as protective relays, auxiliary relays, control switches, instruments, transducers, indicating lights, test blocks, terminal blocks and fuse blocks with engraved labels. Securely attach labels in the vicinity of the device.
3. Provide control wires and cables with identification numbers.
4. Provide terminal blocks with identification numbers.

C. Identification Signs:

1. Provide the following equipment identification signs, as appropriate:
   a. Switchgear cubicles.
   b. Panelboards.
   c. Transformers.
   d. Remote control panels.
   e. Remote Terminal Unit (RTU) and interface cabinet.
   f. Disconnect switches.
   g. Battery equipment.
   h. Communication equipment.
   i. Cables.
   j. Control wires.

D. Warning Signs:

1. Provide graffiti resistant, stain resistant and airborne pollutant resistant signs. Select easily cleanable signs with high resistance to abrasion, bleach cleaning agents and fading due to UV radiation present in sunlight.
2. Provide "Danger - High Voltage & Arc Flash Hazard" warning signs of size not less than 12 inches by 12 inches, at following locations as a minimum:

a. Outdoor rectifier transformers.
b. Traction Power Substation (TPSS) fence and TPSS exterior door.
c. Protective mesh on building roof, if applicable.
d. Around the entire perimeter of each TPSS.

3. Provide a sample of each warning sign for review and approval by SEPTA.

PART 3 - EXECUTION

3.01 Preparation

A. Clean all surfaces in preparation for attaching the nameplate.

B. After drilling tap holes, clean off all metal filings and oil residue.

3.02 Installation, Application and Execution

A. Attach all nameplates, labels and signs with non-corrosive screws.

B. Color code 600 V and below power conductors as indicated in Table 16075-1.

Table 16075-1 Power Conductor Color Coding

Phase	208/120 V
A	Black
B	Red
C	Blue
N	White
EGC	Green

C. Color code communications cables as indicated by industry standards.

END OF SECTION

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SECTION 16120

CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of material and labor for furnishing, installing, connecting, energizing, testing, cleaning and protecting communications cable and accessories, none of which can be replaced by smaller or lesser current carrying capacity product than that which is being removed.

1.02 Related Sections

A. Section 01600 – Materials and Equipment

B. Section 16060 – Grounding and Bonding

C. Section 16075 – Electrical Identification

D. Section 16950 – Testing

1.03 Submittals

A. Submit with all product data evidence of testing agency/quality verification, listing and labeling either by printed mark on the data or by a separate listing card. If not available, provide from the product manufacturer a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

B. Submit product data for the following products; indicate clearly the Contract specific usage of each product:

1. Conductors and cables, along with installation details and the detailed conduit and cable schedules.
2. Termination and splices.
3. Tools for terminations.

C. Tensions Calculations:

1. Submit cable pulling calculations for all underground runs. Calculations shall include both pull load and tensions, along with safety factors, for all cables.
2. Design conduit runs so as not to exceed tension limits of the manufacturer.

D. Record actual installed lengths and locations, both concealed and exposed work, on the record drawings.

E. Submit record drawings, product data, and installation and maintenance instructions for Project closeout.

1.04 Quality Assurance

A. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are listed and labeled by Underwriters Laboratory (UL), or certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory (ETL).

B. All work to meet the regulatory requirements of all state and local codes and requirements.

C. Install work under the supervision of skilled licensed electricians.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI/TIA 568C: Commercial Building Telecommunications Cabling Standards.
2. ANSI/TIA 568 C.3 Fiber Cabling Component Standard.
3. ASQC C1, Specification of General Requirements for a Quality Program.
4. ASTM B 3, Standard Specification for Soft or Annealed Copper Wire.
5. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
6. ASTM B 33, Standard Specification for Tin-Coated Soft or Annealed Copper Wire for Electrical Purposes.
7. ASTM B 189, Standard Specification for Lead-Coated and Lead-Alloy-Coated Soft Copper Wire for Electrical Purposes.
8. ASTM D 1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
9. ICEA S-105-692, Standard for 600V Single Layer Thermoset Insulated Utility Underground Distribution Cables.
10. ICEA/NEMA S-95-658/WC 70, Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
11. ICEA T-33-655, Low-Smoke Halogen Free (LSHF) Polymeric Cable Jackets.
12. IEEE 1202, IEEE Standard for Flame-Propagation Testing of Wire & Cable.
13. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 V.
14. NEMA WC 26, Binational Wire and Cable Packaging Standard.
15. NFPA 70, National Electrical Code (NEC).
16. RUS PE-39, Specification for Filled Telephone Cables.
17. Telecordia GR-20: Generic Requirements for Optical Fiber and Optical Fiber Cable.
18. UL 13 - Power-Limited Circuit Cables.
19. UL 83, Thermoplastic-Insulated Wires and Cables.
20. UL 1685, Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

1.05 Delivery, Storage and Handling

A. Deliver, store and handle materials and products in strict compliance with manufacturer's instructions and industry standards.

B. Protect items from damage during delivery, storage and handling in accordance with Section 01600.

C. Test and inspect cable upon receipt to ensure cables are not damaged during delivery.

D. Packaging of wire and cable shall meet NEMA WC 26.

1.06 Qualifications

A. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

1.07 Field Samples

A. Provide one (1) 36 inch long sample of each type of wire to be used.

PART 2 - PRODUCTS

2.01 General Requirements for Single-Conductor and Multi-conductor Communication cable

A. Rated voltage to be 600 V.

B. Conductors:

1. ASTM B3 or B8 annealed copper.
2. Size No. 10 AWG and smaller to be solid or Class B or Class C stranded.
3. Size No. 8 AWG and larger to be Class B stranded.

C. Insulation shall be cross-linked polyethylene (XLPE) Low Smoke Zero Halogen (LSZH) insulated cable meeting UL 1685 and ICEA T-33-635.

D. Cable to be UL Listed as follows:

1. Non-metallic-sheathed cable to be Type TC, suitable for wet and dry locations.
2. Metallic sheathed cable to be Type MC, suitable for wet and dry locations.

E. Provide twenty-five (25) pair No. 19 AWG and fifty (50) pair No. 22 AWG communication cable suitable for outside plant cable in duct banks and through manholes.

F. Provide two (2) and twenty-five (25) pair No. 22 AWG communication cable for indoor/outdoor cable in the existing Traction Power Substation (TPSS) building. Use sun resistance, flame-retardant, dual-rated, insulation labeled as Gasoline and Oil Resistant II.

G. Provide four (4) pair UTP cable per Article 2.02 in this Section.

H. Provide outside plant cable with gel flooded core for protection outside element blocking compound, filling the air space between the insulated conductors.

I. Outside and inside plant cable shall be provided with an overall 0.005 inch thick corrugated solid copper tape shield applied longitudinally with overlap to provide 100 percent electrical shielding coverage.

J. Each outside plant cable shall be provided with an outer jacket of black UV resistance, low density, high molecular weight virgin polyethylene, compounded to withstand sunlight, temperature variations and other environmental conditions, as well as installation handling without damage. Jacketed cable shall be rated for a combination of aerial, lashed, in conduit or underground duct or direct burial applications.

K. Each inside plant cable shall be provided with a light grey jacket of the standard type produced by the manufacturer for telephone applications, except UTP Ethernet cable.

L. Imprint the jacket with the date of manufacture, wire type and the manufacturer's name.

M. Wire and cable manufactured more than twelve (12) months before delivery to the job site shall not be used.

N. Manufacturers:

1. Clifford of Vermont, Inc.
2. Okonite.
3. Or Approved Equal.

2.02 Unshielded Twisted Pair (UTP) Data Cable

A. Provide inside plant cable which meets the following:

1. Cable fabricated using solid No. 24 AWG un-coated copper conductors with polyethylene insulation, color coded conductor insulation and overall Low Smoke Zero Halogen (LSZH) jacket.
2. Unshielded cable with controlled dielectric properties for Ethernet category 5E or better.
3. UL listed with a blue jacket.
4. Dry (Not flooded).
5. Manufacturers:
   a. Belden Corporation.
   b. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Inspect conduits, junction boxes and manholes for cleanliness, lack of burrs, alignment and completeness. Correct deficiencies before proceeding.

B. Ensure that grounding fittings are installed at places called for in Section 16060.

C. Swab conduits with a nylon bush and steel mandrel.

D. Ascertain that pulling calculations have been made and are available for long runs and pulls indicated in this Section. Ascertain that a means of controlling pulling tension is installed on mechanical assist devices for pulling cable.

E. Pre-lubricate conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

3.02 Installation

A. General:

1. Install all wiring outside of equipment in conduit.

2. Do not perform wiring work until other work that might cause damage to the wires, cables or conduits has been completed. Take the necessary precautions to prevent the accumulation of water, dirt or other foreign material in the conduits during the execution of the work.

B. Cable Pulling:

1. Meet the manufacturer's recommendations for the inspection, handling, storage temperature conditioning prior to installation, bending and training limits, pulling limits and calculation parameters for installation of all cable. Use quadrant blocks located properly along the cable run. Remove from the job site and replace all cables that were subjected to excessive bending and tension and all cables that are cracked or have damaged or nicked outer jackets.

2. Pull cables down grade with the feed-in point at the manhole, handholes or buildings of the highest elevation. Flexible cable feeds shall be used to convey cables through the manhole opening and into the duct runs. Lubricate all cables during pulling with lubricants specifically recommended by the cable manufacturer.

3. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer. Use dynamometer to measure pulling tensions on all runs pulled with mechanical assistance and for all runs where calculations are required to be submitted. If pulling tension is exceeded during pulling, cables shall be removed and marked as defective and not reused.

4. Install cables in manholes along those walls providing the longest route to the maximum spare cable lengths. Form cables to closely parallel walls so as not to interfere with duct entrances. Support cable on brackets and insulators at a maximum of 2 feet apart. Lubricants must be used and must be approved by the cable manufacturer.

C. Wiring Identification:

1. Color code wires and cables as specified in Section 16075.

2. Identify all control wiring and wire numbers corresponding to record drawings.

D. Wire and Cable Splices:

1. Splices between termination points are prohibited without prior written authorization of the SEPTA Project Manager. The intent of this Section is to prohibit intermediate splices unless they are explicitly shown on the Contract Drawings.

3.03 Field Quality Control

A. Conduct verification field tests prior to energizing cables or utilizing fibers prior to final tests specified in Section 16950.

END OF SECTION

SECTION 16121

MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.01 Description

A. This Section specifies furnishing, installing, testing and terminating of 15 kV, No. 4/0 AWG triplexed, 133% 220 mil insulation level, copper tape shield, with a No. 1/0 AWG insulated ground wire for use on:

1. 13.2 kV AC, 3 phase, 60 Hz grounded or ungrounded systems.
2. 4.8 kV AC, 3 phase, 60 Hz ungrounded systems.

B. Cable shall be suitable for a forty (40) year design life, installed either in underground ducts or aerially on a messenger. Material and construction shall be as specified herein, and where an ANSI, ICEA, AEIC, ASTM, UL or NEMA specification number is given, the latest revision thereof shall apply.

C. The cable shall be designed and constructed so that it will operate at normal operating temperatures of at least 90°C maximum, emergency operating temperatures of at least 130°C, and short circuit operating temperatures of at least 250°C. The cable shall be suitable for a minimum installation temperature of minus 40°C.

D. Cable supplied to replace PECO feeders shall minimally match the size and type of the existing feeders and any other PECO requirements. Do not match existing PECO cable type if the existing PECO cables are paper insulated, lead covered (PILC) cable.

1.02 Related Sections

A. Section 01300 – Submittals

1.03 Submittals

A. The Contractor shall submit the following calculations, certifications, test reports, shop drawings and data for the SEPTA Project Manager's review in accordance with Section 01300:

1. Submit shop drawings, catalog cuts and other forms of descriptive data delineating the construction of the cables specified herein.
2. Submit certified dimensioned cable cross section diagram, maximum recommended pulling tension and cable weight.
3. Submit installation and test instructions.
4. Submit special storage instructions, if applicable.
5. Submit recommended pulling lubricants.
6. Submit pulling calculations for all cables whose total run exceed 300 feet or have exceeded 270 degrees in total pulling angle.
7. Submit recommended termination materials and procedures.

8. The Contractor shall submit for approval five (5) certified copies of test reports of all the tests conducted at the factory and in the field. Test reports shall be submitted within two (2) weeks after completion of tests. In case of "Factory Tests", test reports shall include original data, detailed calculation of test data to arrive at the results and interpretation of results. Test reports shall contain the characteristics, curves, etc. where required for interpretation of results. Authorization to ship will not in any way relieve the Contractor of this responsibility under this Contract.
9. Submit certificate certifying that the cables meet the requirements specified herein, meet the standards designated herein and that the cables have been tested as specified herein.
10. Following Contract award, submit for approval the following technical data for each cable specified in this Section. The characteristics of the cable shall be fully explained by providing the following information:
    a. Conductor stranding.
    b. Conductor material.
    c. Conductor coating.
    d. Insulation material.
    e. Minimum and nominal insulation thickness in mils.
    f. Shielding Thickness:
        1) Conductor shielding in mils.
        2) Insulation (non-metallic) in mils.
        3) Insulation (metallic) in mils.
    g. Maximum Copper Temperature with Time Constants:
        1) Continuous in °C.
        2) Emergency in °C.
        3) Short circuit in °C.
    h. Minimum installation temperature in °C.
    i. Jacket material temperature rating in °C.
    j. Jacket thickness (nominal) in mils.
    k. Physical Requirements:
        1) Tensile strength of the insulation and jacket in psi.
        2) Elongation at rupture (set) of the insulation and jacket in percent.
    l. Aging Requirements:
        1) After air oven (indicate condition) of the insulation and jacket:
            a) Tensile strength, change in unaged value, of the insulation and jacket in percent.
            b) Elongation at rupture, change in unaged value, of the insulation and jacket in percent.
        2) After oil immersion test (indicate conditions) of the jacket only:
            a) Tensile strength of unaged value in percent.
            b) Elongation at rupture of unaged value only in percent.
    m. Accelerated Water Absorption:
        1) Electrical method increase in capacitance:
            a) One (1) to fourteen (14) days in percent.

b) Seven (7) to fourteen (14) days in percent.

2) Gravimetric method water absorption in mg/in.

n. Electrical Requirements (Insulation):

1) AC voltage test in kV/min.

2) DC voltage test in kV/min.

3) Insulation resistance (minimum) in mega-ohms.

o. Cable outside diameter (nominal) in inches.

p. Allowable minimum bending radius in inches.

q. Allowable pulling tension in pounds.

r. Allowable side wall pressure in psi.

s. Reel Data:

1) Diameter in inches.

2) Width in inches.

3) Drum diameter in inches.

4) Tare weight in pounds.

5) Arbor diameter in inches.

t. Ampacities:

1) Cable in ducts, one (1) or two (2) cables per duct per the duct bank drawing sections, earth temperature 20°C, RHO = 90, conductor temperature 90°C:

a) Three (3) cables per duct bank:

i. 100 percent load factor in amperes.

ii. 50 percent load factor in amperes.

iii. 30 percent load factor in amperes.

b) Six (6) cables per duct bank:

i. 100 percent load factor in amperes.

ii. 50 percent load factor in amperes.

iii. 30 percent load factor in amperes.

u. Electrical Characteristics (Indicate Conditions):

1) Resistance in ohms/1000 feet.

2) Reactance (inductive) in ohms/1000 feet.

3) Impedance in ohms/1000 feet.

v. Cable weight in pounds/1000 feet.

B. Submit with the bid proposal the value of the cable proof tests referred to in Article 3.02/G in this Section.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. AEIC CS8, Specification for Extruded Dielectric, Shielded Power Cables Rated 5 through 46 kV.

2. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft

3. CSA C68.5, Shielded and Concentric Neutral Power Cable for Distribution Utilities.

4. ICEA S-93-639/NEMA WC74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electrical Energy.
5. ICEA T-25-425, Guide for Establishing Stability of Volume Resistivity for Conducting Polymeric Components of Power Cables.
6. IEEE C2, National Electrical Safety Code (NESC).
7. IEEE 404, IEEE Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV.
8. NFPA 70, National Electrical Code (NEC).
9. UL 1072, Medium-Voltage Power Cables.

B. The manufacturer shall have a minimum of fifteen (15) years of experience in the manufacture of medium-voltage power cables.

C. Tests:

1. All tests and measurements of finished cable and material used in the manufacture of the cable shall be made as prescribed in the referenced ICEA/NEMA specifications.
2. The manufacturer shall perform a partial discharge test per AEIC CS8; the maximum allowable discharge shall be five (5) pico-Coulombs at four (4) times rated voltage to ground. The results of this test shall be included with the certified test report.

D. Tolerances:

1. All dimensional, physical, and chemical tolerances not specifically stated herein for various materials and finished cable shall be in accordance with the referenced specifications noted herein covering materials and finished cable.

E. Inspection:

1. Inspection of the cable will be made at the point of delivery or at the manufacturer's plant. The manufacturer shall grant the inspector free entry at all times while work under this Section is being performed, to all parts of the plant that concern the manufacturer of the wire. The manufacturer shall supply, free of cost, all reasonable facilities to satisfy the inspector that wire is being furnished in accordance with this Section. A number of such visits may be required to ascertain conformance of the wire with the requirements of this Section.
2. The manufacturer shall notify SEPTA at least seven (7) working days before the finished cable is ready for shipment, in order that the plant inspection of the cable may be made if desired.

F. Rejection:

1. Any reel of cable that fails to meet the requirements of this Section will be rejected.
2. SEPTA reserves the right to reject any cable received upon reels which are damaged or in imperfect condition or reels on which cable has not been properly protected from damage.

3. All rejected material shall be promptly removed from SEPTA's property and replaced, free of cost, with material meeting all requirements of this Section.

G. Patented Material:

1. In the event that any cable delivered to SEPTA under this Section shall be protected by any patent (or copyright), the Contractor agrees to and shall defend, indemnify, and save harmless SEPTA from any and all suits, claims, judgments and costs arid causes of action at law or in equity arising out of or related to the sale, purchase, or use of any such article, which sale, purchase, or use is alleged to be in violation of any rights under a patent (or copyright).

H. Guarantee:

1. The Contractor shall guarantee that the cable furnished under this Section is of first class material and professional workmanship throughout, and that it has been tested in accordance with this Section so as to meet all of the standards set by this Section, and the Contractor agrees that it shall replace any of the following unsatisfactory material:
   a. Any lengths of cable found defective in material or workmanship during the installation of the cable; or
   b. Any lengths of cable which fail during normal use within one (1) year of the date on which that cable was placed in service, or which shows evidence of defective material or workmanship. SEPTA shall give reasonable notice of any defects to the Contractor and shall afford the Contractor reasonable opportunity to inspect any defective material. The date of placing in service is to be interpreted as the date on which operating voltage was first applied, but in no case shall it be later than six (6) months after the date of receipt from the factory.
2. All replacements by the Contractor under the provisions of this Section shall be made free of charge, to the delivery point called for in the original order.
3. Except as otherwise agreed, lengths of cable which have been replaced under the provisions of this Section shall become the property of the Contractor and shall be returned to the Contractor by SEPTA, unless special conditions of removal or transportation costs made these procedures uneconomical. In which case, SEPTA shall credit the Contractor with the scrap value of the cable.

I. Certification:

1. The Contractor shall furnish certified copies of the results of all tests and measurements made to determine the quality and serviceability of the cable manufactured in accordance with this Section. Such results shall show compliance with all the requirements of this Section. Final approval shall be contingent upon receipt and approval by SEPTA of these certified test results.
2. Regardless of the point at which inspection is made, the Contractor shall make all tests specified herein and shall forward to SEPTA certificates showing that the tests have been made and including the results of the tests.
3. In addition to the results of the tests, the certificates shall state the Purchase Order numbers and reel numbers of the reels covered. In order to avoid delay in identification and acceptance of the material, these certificates must be received by SEPTA before the arrival of the material.

1.05 Delivery, Storage and Handling

A. Ship cable in reels, suitably covered to protect the cable from injury during shipment. Ship only one (1) length of cable on a reel. Seal, secure and protect cable ends from injury. Make both cable ends available for testing, unless cable size or reel construction precludes that possibility.

B. Store cables to protect them from injury.

1.06 Qualifications

A. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

1.07 Field Samples

A. Provide one (1) 36 inch long sample of each type of wire to be used.

PART 2 - PRODUCTS

2.01 Description

A. Conductor:

1. Conductors shall be annealed, uncoated copper of the size stated in the Bid Request and Purchase Order.

2. Conductors shall be Class B stranded in accordance with ASTM B 8 and compressed 3 percent maximum.

B. Conductor Shield:

1. A Conductor Shield is an extruded layer of semiconducting, thermosetting compound that is compatible with the conductor and insulation, shall be applied with a thickness in accordance with Table 1 below:

TABLE 16120-1 CONDUCTOR SHIELD THICKNESS

Conductor Size Range (AWG/kcmil)	Average Conductor (mm)	Shield Thickness (mils)
8 - 4/0	0.381	15
250 - 500	0.508	20
600 - 1000	0.635	25
1500 - 2000	0.762	30

2. The shield material shall strip cleanly from the conductor.

3. The contact surface between the conductor shielding and the insulation shall be cylindrical and free from protrusions and irregularities that extend more than five (5) mils into the insulation and seven (7) mils into the conductor shielding. The conductor shield layer shall be free of any voids larger than three (3) mils at the insulation interface.

4. The shielding material shall meet the physical requirements and not exceed the maximum volume resistivity values per the ANSI standards.
5. The DC volume resistivity of the extruded conductor shield shall not exceed 50 meter-ohms at 90°C when tested.
6. The conductor screen compound shall have a minimum elongation of 100 percent after an air oven test at 121°C for one hundred and sixty-eight (168) hours.
7. The conductor screen compound shall have a brittleness temperature not warmer than minus 40°C.

C. Insulation:

1. The insulation shall be an ethylene-propylene rubber, contrasting in color from the extruded conductor screen and insulation screen.
2. Insulation shall be for use in wet or dry locations, at conductor temperatures of at least 90°C for continuous operation.
3. The insulation thickness shall be that required to obtain 100% or 133% cable insulation level for a rated circuit voltage of 15 kV, phase-to-phase, as stated in the Contract Documents.
4. The insulation shall be triple-tandem extruded with the conductor and insulation screens.

D. Insulation Shield:

1. The insulation shield shall be an extruded semi-conducting EPR compound, completely compatible with the insulation.
2. The insulation shield shall meet the physical requirements of the cable standards.
3. The minimum and maximum thickness of the insulation shielding shall be in accordance with the cable standards.
4. Protrusions and irregularities shall not exceed five (5) mils into the insulation and shall not exceed seven (7) mils into the insulation shielding. The insulation-shielding layer shall be free of any voids larger than five (5) mils at the insulation interface.
5. The DC volume resistivity of the extruded insulation shield shall not exceed 75 meter-ohms at 90°C when tested in accordance with ICEA T-25-425.
6. The insulation shielding shall strip freely and cleanly from the underlying insulation using standard stripping tools. Any conductive material left after stripping shall be easily removable by wiping the insulation.
7. The outer surface of the insulation shield shall be printed with the words ”SEMICONDUCTING REMOVE BEFORE SPLICING AND TERMINATING." Indent printing is not permitted.

E. Copper Tape Shield:

1. The outer screen/insulated core shall be covered with an uncoated copper tape.
2. The copper tape shall have a nominal thickness of at least five (5) mils.
3. The copper tape shall be applied helically with at least a nominal 25 percent overlap.

F. Jacket:

1. Single and multiple conductor cables shall have a heavy duty black jacket made of low-smoke/zero halogen polyolefin meeting the requirements of the cable standards.
2. Multiple conductor cables shall also have a heavy duty black low-smoke/zero halogen polyolefin compound jacket over each individual insulated and shielded conductor.
3. The nominal thickness of the jacket shall be 80 mils and shall not be less than 80 percent of this value at any place on the cable.
4. The jacket shall be free stripping and suitable for exposure to sunlight.

G. Markings:

1. The following information shall appear on the cable jacket at least once per 3 feet of cable length:
   a. Manufacturer's name.
   b. Conductor size.
   c. Conductor material.
   d. Voltage rating.
   e. Insulation designation.
2. A permanent marking containing the phrase "Property of SEPTA," manufacturer, year of manufacture, and sequential footage number, repeated every foot of cable length, shall be inserted under the shielding tape of single conductor cables, and under the core binder tape of multiple conductor cables.

H. Reels:

1. Unless otherwise specified, each reel shall contain 1000 feet (minus 0 percent, plus 2 percent) of cable. SEPTA may accept any wire length beyond the base, untoleranced length as stated on the Purchase Order, but will not accept any charge, cost, or fee associated with any such excess.
2. The cable shall be delivered tightly coiled and absolutely without kinks or crosses so that it can be run off without fouling or injury.
3. The reels shall be of heavy construction with steel or iron hubs. The arbor hole shall be not less than 3 inches in diameter and the transverse dimension shall not be less than 3 feet for reels having a gross mass of 4,500 pounds or over, and in no case shall this dimension be less than 1 foot. The minimum flange diameter shall be 60 inches. Ends of bolts used to reinforce the reels shall be hammered over to prevent easy removal of the nuts. The diameter of the drum shall not be less than 14 times the diameter of the cable. Cable shall be wound on the reel in such a manner that it is suitably protected from damage during shipment and so that the inner end is readily accessible for testing. Each end of the cable shall be firmly and properly secured to the reel. The inner, or drum end, of the cable, when allowed to project through the flange of the reel, shall be protected from damage by a suitable covering of galvanized or painted sheet of iron or steel having ends and sides rounded or shaped so as to ward off vehicles or other reels.
4. Reels shall be shipped upright on their flanges.

5. Both ends of the cable shall be hermetically sealed prior to shipment. When specifically requested by SEPTA, pulling eyes shall be attached to the cable. Seals and pulling eyes shall be attached in such a manner that they will not have any sharp or rough edges which will damage the grip or rope used in pulling the cable.
6. Each reel shall be legibly and indelibly marked with the manufacturer's name or trademark, size, kind and length of wire, reel number, gross, tare and net weights, purchase order number, and SEPTA Standard Specification and Class & Lot Numbers. A label shall be securely attached to each head of the reel that shall plainly state SEPTA's Purchase Order number, length ordered, length shipped, number and size of conductor, voltage rating, SEPTA Specification number and reel number.
7. Each reel shall be marked with an arrow and suitable accompanying wording stenciled on the end of the reel, indicating the direction in which the reel should be rolled.

2.02 Fireproofing

A. The Contractor shall furnish and install a form of arc and fire protection tape for all cables to be manufactured by the following:

1. 3M Scotch 77 Fire and Arc Proofing Tape with an overwrap of Scotch 69 Glass Cloth Electrical Tape.
2. Or Approved Equal.

2.03 Cable Duct Lubricant

A. Furnish high performance cable pulling lubricant specifically developed for compatibility with low-smoke/zero halogen jacketed cables. The lubricant properties shall include slow drying, thin slippery film residue that remains for two (2) or more months after use, not flame sustaining, stringy gel that clings to cables and temperature stable with no flash point.

B. Cable lubricant shall be capable of being hand or pump applied and cleaned away with water.

C. Provide cable lubricant as manufactured by the following:

1. American Polywater types LZ or WLZ.
2. Or Approved Equal.

2.04 Manufacturers

A. Medium Voltage Cable Assemblies:

1. Select a cable manufacturer who is regularly engaged in the production of similar wire and cable. Provide products from one (1) of the following manufacturers:
   a. The Okonite Company.
   b. Kerite Cable.
   c. BICC.
   d. Or Approved Equal.

B. Terminations for Medium Voltage Cable:

1. Terminations of 15 kV rated cable shall be as manufactured by one (1) of the following:
   a. Tyco Raychem (HVT-Z series).
   b. 3M.
   c. Or Approved Equal.

PART 3 - EXECUTION

3.01 Installation

A. General:

1. Cable shall not be pulled until conduits have been cleaned and swabbed, and are free from obstructions.
2. Pull, install and protect cables as follows:
   a. Use factory installed compression type pulling eyes for all pulls except as otherwise specified.
   b. Seal all cable ends before pulling into ducts. The ends of a cable when cut shall not be left with the insulation exposed to moisture unless splice is to be done immediately.
   c. Strip reels of all nails in outside edges of reel heads before pulling of cable. Conveniently locate reels for feeding cable into the duct or conduit without excessive binding or possible injury to cable by abrasion. Reels shall be jacked to clear ground level by at least 6 inches before pulling of cable.
   d. Attached pulling ropes to cables with ball bearing swivels to prevent twisting of cable during pulling.
   e. Pull cable into ducts and conduits under moderate tension. The manufacturer's recommended maximum pulling tensions shall not be exceeded. Any lubricant used shall not have a deleterious effect on the conductor insulation.
   f. Station sufficient personnel between the reel and the duct entrance during pulling operations to inspect, control and direct the passage of cable. Equip duct mouth with a form of bell end to prevent chafing of the cable while being inserted.
   g. Minimum bending radii as measured to inside surface of the cables shall not be less than those recommended by the manufacturer.
   h. Lubricate cables with the cable manufacturer approved material which shall be placed into the duct prior to the installation of the pulling rope.
   i. Do not allow cable to chafe on the ground, pull boxes or any sharp surfaces during pulling. Provide timbers and flexible cable pulling tubes to guide and protect the cable, where necessary.
   j. All cables installed shall be continuous from terminal to terminal.
   k. Mark all cables with printed numbers on cable tags at all terminal points. Refer to the approved shop drawings for numbering of cables.
   l. Install cables as shown on the approved shop drawings. Provide supports, conduit and other hardware as required. All ferrous hardware shall be hot dip galvanized.
3. Handle cable reels carefully to avoid injury to persons or cables. Control movement of reels on loading skids or sloping grades by use of a snub line or wedge. Always block reels after positioning.

4. When a cable is cut, seal the ends properly. Cut back cable ends which have been exposed to the weather, a minimum of 1 foot and properly seal. If this seal is broken, repair it immediately. One (1) of the two (2) following methods shall be used for sealing rubber or thermoplastic cable ends. In both cases, clean the cable jacket and buff so that all cable wax, pulling compounds and contaminations are removed from the surface.
    a. For the first method the end shall then be sealed with epoxy resin using a procedure which shall be approved by SEPTA.
    b. For the second method a combination of rubber and vinyl tape may be used to provide a seal. The end shall first be sealed with high voltage electrical tape and then overwrapped with vinyl electrical tape.

B. Terminations:

1. Make cable terminations in strict accordance with the manufacturer's instructions unless otherwise directed by the SEPTA Project Manager.
2. Terminations of power cables shall be made at the equipment as shown. It is of the utmost importance that perfect electrical contact be secured at the points of connection of each cable. All connections shall have a conductivity and insulation resistance at least equal to that of the cable.
3. Splicers shall have a minimum of five (5) years of experience in splicing and terminating medium voltage power cables of the type and size(s) involved under similar conditions. Prior to making of a termination, the Contractor shall submit to the SEPTA Project Manager, for approval, the name of each individual who will perform this type of work including the background of each such individual on similar previous Projects.
4. Each supplier shall be certified by the SEPTA Project Manager. SEPTA may request the splicer to make a test termination in the presence of the SEPTA Project Manager before the approval is granted.

C. Fire Proofing:

1. Apply arc and fire protection tapes to conductors for cables passing through manholes, handholes, pull boxes and termination cabinets.

3.02 Tests

A. General:

1. The Contractor shall provide all instruments, materials and labor required for tests specified herein.
2. The Contractor shall formulate overall test program of the equipment and installation which shall include but not be limited to the tests specified in this Section to ensure equipment and material are in compliance with the relevant standards, this Section, and satisfactory and reliable performance in actual intended operation.
3. Tests at the factory shall include but not be limited to:
    a. Tests listed in this Section.
    b. The manufacturer's standard tests.
    c. Tests as per relevant NEMA, IEEE and ANSI standards not included in the manufacturer's standard tests.

d. Any other tests to ensure satisfactory performance of the product.

4. Tests and checkouts in the field shall include but not be limited to the following:
   a. Tests as listed in this Section.
   b. Tests as per relevant NEMA, IEEE and ANSI standards not included in this Section.
   c. Any other tests to ensure satisfactory performance of cable and installation.

B. Conditions of Tests:

1. Prior to testing of any cable and the installation, the following conditions shall be fulfilled by the Contractor:
   a. The Contractor shall have in his possession approved shop drawings.
   b. The Contractor shall have submitted testing procedure for SEPTA's Project Manager approval at least forty-five (45) days in advance of the testing.
   c. For factory tests, a minimum of four (4) weeks advance notification shall be given to the SEPTA Project Manager on the schedule date of tests to enable him to witness the tests. Field tests shall be scheduled in consultation with the SEPTA Project Manager.

C. Witnessing Tests:

1. The SEPTA Project Manager will (at his option) witness complete or partial testing on all the cable and installation unless a wavier is granted for witnessing factory tests, in which case test reports of the product for which the waiver was granted shall be submitted for review to obtain clearance for packing and shipping. Waiver of witnessing factory tests on any cable shall not be construed as a waiver for all future supplies either of the same type or different cable.

D. Responsibility:

1. The Contractor shall assume full responsibility during the factory and field testing of all cable and installation provided by him. Should there be any loss or damage to such cable or installation as a result of these tests, the Contractor shall be fully responsible for replacing the damaged cable. Replacement of damaged cable shall include all costs, including, but not limited to, removal of damaged cable, furnishing of, transportation of, and installation of replacement cable.

E. Rejection and Retesting:

1. Failure of cable or termination to withstand tests or to meet ratings shall be sufficient grounds for rejection of the item tested.
2. If it is not possible to rectify rejected cable, new cable shall be installed/terminated between existing terminations/splices by the Contractor at his expense. The replacement cable must meet all requirements of this section.

F. Factory Tests:

1. Ethylene Propylene Insulated Cable:
   a. The manufacturer shall conduct all applicable factory tests specified in the referenced standards.
   b. The manufacturer shall furnish test certificates for each reel of cable for approval.

G. Field Tests:

1. General:

a. All tests shall be successfully completed to show that the installation meets the Specification requirements before final acceptance. The Contractor shall perform the specified tests on all cable installed under this Contract.

b. Tests and checkouts shall be conducted in accordance with the approved test procedure specified in this Section, the NEC and applicable standards and specifications of ANSI, NEMA, IEEE, AEIC, etc.

c. Field tests are required for all cable.

d. The Contractor shall provide properly qualified personnel who shall be responsible for supervising, coordinating, and performing all electrical field testing and checking work, and who will maintain a written record of all tests conducted.

e. Testing and checkouts shall be performed in the presence of SEPTA.

f. The Contractor shall furnish all test results to SEPTA. Result sheets shall include date of test, personnel involved, items tested, type of tests and test data. Test certificate shall show the type and ratings of test instruments used and details of their calibration including dates of their first calibration.

g. Any equipment or cable damaged due to improper test procedure or test apparatus handling shall be replaced or restored to original condition by the Contractor at his expense.

h. Safety devices including but not limited to rubber gloves and blankets, screens and barriers, danger signs, padlocks, etc., shall be provided by the Contractor and used to protect and warn all personnel in the vicinity of the tests.

2. Power Cable Field Tests:

a. Procedure:

1) All single conductor cables shall be tested as specified herein. The object of these tests is to ascertain the following:

a) Dielectric strength of the cable insulation has not been impaired during installation.

b) Cable splices and terminations are made properly.

c) Integrity of the cable system prior to energization.

2) The tests shall include, but not be limited to, the following:

a) Continuity tests.

b) Insulation resistance tests.

c) High potential direct current test.

3) The test or tests shall be carried out under the supervision of a competent, qualified and trained technician in the presence of the SEPTA Project Manager. All the technicians involved in the testing shall be fully aware of the detailed test procedures and hazards involved in the high potential direct current testing.

4) For high potential tests, the area around the ends of the cable under test shall be roped off and warning signs posted. A guard shall be posted at each end for the duration of the tests to prevent unauthorized people entering the test area.

5) Prior to testing, the Contractor shall submit for approval a detailed step by step testing procedure, the list of personnel involved and the make and model number and details of the instruments he intends to use. Written approval of the procedure, personnel and instruments must be obtained before commencement of testing of any cable. Approval of the procedure does not in any way relieve the Contractor from his responsibility with regard to safety of personnel, equipment and property.

b. Installation Tests/Acceptance Tests:

1) After installation of the entire length of cable run and completing all terminations, the Contractor shall perform the below listed tests on each cable circuit.

2) To preclude damage to equipment and devices, all equipment normally connected to the power circuit shall be disconnected from the cable to be tested.
   a) Continuity test shall be performed to prove the continuity of the conductor. Immediately after the test, both ends of the cable shall be tagged with cable identification number.
   b) Phasing test shall be performed to establish the phase identification of the cable for the purpose of phasing. This test shall be done at both ends of a length of installed cable.
   c) Insulation resistance test shall be performed to determine the cable insulation resistance to ground and between the conductors in the case of the two phase cables. A total of three (3) measurements are required for each circuit; one (1) from conductor-to-conductor and two (2) from conductor-to-sheath.
3) Test shall be conducted with a 2,500 V, motor operated megger. Each measurement shall be held until each reading reaches a constant value for five (5) minutes. Megger test values of insulation resistance obtained shall not be less than 15 Megaohms. The Contractor shall bring to the attention of the SEPTA Project Manager similar readings those are unequal with the variations of 25 percent or more.
4) The Contractor shall also record the temperature, humidity, duration of test and voltage for each test.
5) High potential test shall be performed only after the insulation resistance test has been successfully completed.
   a) Before conducting the high potential direct current test, the Contractor shall make sure that the following requirements are complied with:
      i. Equipment and the shields, ground wire of nearby insulated conductors not under test and the ground stick are all securely tied to the manhole or Traction Power Substation (TPSS) grounding system.
      ii. The insulated conductor under test must have a safe clearance from adjacent grounded conductors, insulation shield and surrounding metal objects. A 1/4 inch clearance for every 1000 V of DC test voltage is regarded as a safe distance.
      iii. High voltage test gloves are worn by each participant.
      iv. The test voltages meet the recommendations of the cable manufacturer and the splice kits and termination manufacturers.
      v. Danger signs and sentries are posted at all critical points along the entire cable route under test.
      vi. The operator's manual for particular test set being used has been read and understood.
      vii. All safety precautions have been observed at the testing end and at the far end of the cable.
   b) Each insulated conductor in a conduit shall be tested separately while grounding test equipment and all conductors not under test, with metallic shield or ground wires to the manhole or TPSS ground. The test equipment shall be supplied from a stable, constant voltage source having a maximum variation of the voltage of plus/minus 5 percent. Preferably, a motor driven alternator shall be used for the supply. The output voltage of the test set must be filtered, regulated and spike free. The following test procedure shall be followed:
      i. Ground each conductor to be tested with ground stick before test. Connect test lead to conductor that is to be tested. Then, remove ground stick from conductor to be tested; conduct test. Upon completion of testing that conductor, allow voltage to decay to approximately 5 kV before re-applying ground. Follow above procedure for each conductor being tested.

ii. Apply the direct current test voltage between the conductor and the grounded sheath slowly in equal steps (in steps of 5 to 7 percent of full test voltage) until the designated voltage is reached. The rate of voltage acceleration shall be consistent under each step.

iii. Allow sufficient time after each step for the leakage current to stabilize.

iv. Record total leakage current in micro-amperes after each step. The same length of time shall be allowed after each step for the total current to stabilize before taking readings.

v. The equivalent DC test voltage shall be 80 percent of the AC factory test voltage. Maintain the test voltage for fifteen (15) minutes after it has reached the specified value.

vi. Record total current values in micro-amperes at one (1) minute intervals for the duration of the test.

vii. Set the test voltage control to zero (0) at the end of the test period. Allow the residual voltage on the circuit to decay to approximately 5 kV before applying manual grounds.

viii. The tested conductors should remain grounded for at least thirty (30) minutes after completion of the test.

c) Failure of the initial leakage current to decrease, or any increase in the leakage current at any time during the test shall be presumed to be indicative of a cable defect.

c. Proof Tests:

1) The SEPTA Project Manager reserves the right to have the Contractor proof test the cable installed under this Contract any time during the warranty period of the Contract work or at any time during the performance of this Contract.

2) The proof test shall consist of a high potential direct current test as described above with the test voltage specified to the Contractor at the time of the test; the test voltage is to be applied and maintained for a period of five (5) minutes.

3) The Contractor shall include in his bid proposal the cost of performing a total of two (2) proof tests (per cable type tested). The cost of performing the tests shall include all labor for isolation of cable to be tested and for performing the work according to the instructions and direct supervision of the SEPTA Project Manager. The SEPTA Project Manager will arrange for isolation of the cable from the switchgear inside the TPSS.

4) Any defects found as a result of the high potential proof test shall be corrected by the Contractor at no expense to SEPTA.

5) After successful completion of the proof test, the Contractor shall provide all material, labor and equipment to reestablish the integrity of the installed cable to its original status which prevailed before the cable was isolated for testing.

d. Any cables found defective during the testing shall be replaced with new cables by the Contractor. Rectification of defects of any cable shall be done only with specific approval of the SEPTA Project Manager.

END OF SECTION

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SECTION 16122

DC TRACTION POWER CABLE

PART 1 - GENERAL

1.01 Description

A. This Section specifies furnishing, installing, testing, and terminating of 2 kV, low smoke zero halogen, suitable for continuous exposure to sunlight DC traction power cable.

B. Conductors covered by this Section are intended for use in DC traction service operated at nominal 700 V subjected to additional voltage stresses resulting from the operations of regenerative braking of vehicles. Cables shall be suitable for installation in dry or wet locations, in exposed or underground conduits, cable trays, cable racks, directly buried or run exposed.

1.02 Related Sections

A. Section 01300 – Submittals

1.03 Submittals

A. The Contractor shall submit the following shop drawings and data for the SEPTA Project Manager's review in accordance with Section 01300:

1. Shop drawings, catalog cuts and other forms of descriptive data delineating the construction of the cables specified herein.
2. Certified dimensioned cable cross section diagram, maximum recommended pulling tension and cable weight.
3. Installation and test instructions.
4. Special storage instructions, if applicable.
5. Recommended pulling lubricants, compatible with the jacket and semiconducting shield materials.
6. Pulling calculations for all cables whose total run exceed 300 feet, or have exceeded 270 degrees in total pulling angle, for review by SEPTA's Project Manager.
7. Recommended termination materials and procedures.
8. Five (5) certified copies of test reports of all the tests conducted at the factory and in the field for the SEPTA Project Manager's approval. Test reports shall be submitted to SEPTA within two (2) weeks after completion of tests. In case of "Factory Tests", test reports shall include original data, detailed calculation of test data to arrive at the results and interpretation of results. Test reports shall contain the characteristics, curves, etc. where required for interpretation of results. Authorization to ship will not in any way relieve the Contractor of this responsibility under this Contract.
9. Certificate certifying that the cables meet the requirements specified herein, meet the standards designated herein and that the cables have been tested as specified herein.

10. Submit the following technical data for each cable specified in this Section for approval of the SEPTA Project Manager. The characteristics of the cable shall be fully explained by providing the following information:
    a. Conductor stranding.
    b. Conductor material.
    c. Conductor coating.
    d. Insulation material.
    e. Insulation thickness in mils.
    f. Maximum Copper Temperature:
        1) Continuous in °C.
        2) Emergency in °C.
        3) Short circuit in °C.
    g. Minimum installation temperature in °C.
    h. Jacket material in °C.
    i. Jacket thickness (nominal) in mils.
    j. Physical Requirements:
        1) Tensile strength of the insulation and jacket in psi.
        2) Elongation at rupture (set) of the insulation and jacket in percent.
    k. Aging Requirements:
        1) After air oven (indicate condition) of the insulation and jacket:
            a) Tensile strength, change in unaged value, of the insulation and jacket in percent.
            b) Elongation at rupture, change in unaged value, of the insulation and jacket in percent.
        2) After oil immersion test (indicate conditions) of the jacket only:
            a) Tensile strength of unaged value of the jacket only in percent.
            b) Elongation at rupture of unaged value on the jacket only in percent.
    l. Accelerated Water Absorption:
        1) Electrical method increase in capacitance:
            a) One (1) to fourteen (14) days in percent.
            b) Seven (7) to fourteen (14) days in percent.
        2) Gravimetric method water absorption in mg/in.
    m. Electrical Requirements (Insulation):
        1) AC voltage test in kV/min.
        2) DC voltage test in kV/min.
        3) Insulation resistance (minimum) in megaohms.
    n. Cable outside diameter (nominal) in inches.
    o. Allowable minimum bending radius in inches.
    p. Allowable pulling tension in pounds.
    q. Allowable side wall pressure in psi.
    r. Reel Data:
        1) Diameter in inches.
        2) Width in inches.
        3) Drum diameter in inches.

4) Tare weight in pounds.
5) Arbor diameter in inches.

s. Ampacities:
1) Cable in ducts, one (1) or two (2) cables per duct per the duct bank drawing sections, earth temperature 20°C, RHO = 90, conductor temperature 90°C.

t. Electrical Characteristics (Indicate Conditions):
1) Resistance in ohms/1000 feet.
2) Reactance (inductive) in ohms/1000 feet.
3) Impedance in ohms/1000 feet.

u. Cable weight in pounds/1000 feet.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM B 3, Standard Specification for Soft or Annealed Copper Wire.
2. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
3. ASTM B 33, Standard Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes.
4. ASTM B 172, Standard Specification for Rope-Lay-Stranded Copper Conductors having Bunch-Stranded Members, for Electrical Conductors.
5. ASTM B 496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
6. ASTM D 257, Standard Test Methods for DC Resistance or Conductance of Insulating Materials.
7. ASTM D 412, Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers-Tension.
8. ASTM D 470, Standard Test Methods for Crosslinked Insulations and Jackets for Wire and Cable.
9. ASTM D 471, Standard Test Method for Rubber Property-Effect of Liquids.
10. ASTM D 573, Standard Test Method for Rubber-Deterioration in an Air Oven.
11. ASTM D 624, Standard Test Method for Tear Strength of Conventional Vulcanized Rubber and Thermoplastic Elastomers.
12. ASTM E 662, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
13. ICEA S-95-658/NEMA WC 70, Power Cables Rates 2000 V or Less for the Distribution of Electrical Energy.
14. ICEA/NEMA T-27-581/WC 53, Standard Test Methods for Extruded Dielectric Power, Control, Instrumentation, and Portable Cables for Test.
15. IEEE C2, National Electrical Safety Code (NESC).

16. IEEE 532, IEEE Guide for Selecting and Testing Jackets for Power, Instrumentation, and Control Cables.
17. NFPA 70, National Electrical Code (NEC).
18. NFPA 258, Recommended Practice for Determining Smoke Generation of Solid Materials.
19. UL 44, Thermoset-Insulated Wires and Cables.
20. UL 1072, Medium-Voltage Power Cables.
21. UL 1581, Electrical Wires, Cables, and Flexible Cords.

B. Furnish and install DC traction power cables having a performance record demonstrating a minimum of twenty (20) years successful operating experience in transit applications.

C. Cable splicers to be certified by SEPTA's Project Manager and experienced in making or breaking splices and terminations of similar cables for similar application with a minimum of five (5) years of proven experience.

1.05 Delivery, Storage and Handling

A. Ship cable in reels, suitably covered to protect the cable from injury during shipment. Ship only one (1) length of cable on a reel. Seal, secure and protect cable ends from injury. Make both cable ends available for testing unless cable size or reel construction precludes that possibility.

B. Deliver scrap pieces of cable to SEPTA per Article 3.01/B/2 in this Section.

C. Store cables to protect them from injury.

PART 2 - PRODUCTS

2.01 General

A. All insulators, connectors and support hardware for installation of new traction power feeder and negative return cable shall be new, having the physical dimensions, electrical ratings and mechanical strength required for the intended service as shown on the Contract Drawings and as specified herein.

B. DC traction power positive and negative cables that are suitable for use in wet and dry locations in conduit, underground duct system and aerial installation.

1. Cables furnished shall be constructed in accordance with the following requirements:
    a. 500,000 circular mils ethylene propylene rubber (EPR) insulated cross-linked polyolefin (XLPO) jacketed cable for 2 kV DC.
    b. 1,000,000 circular mils ethylene propylene rubber (EPR) insulated cross-linked polyolefin (XLPO) jacketed cable for 2 kV DC.
    c. 1,500,000 circular mils ethylene propylene rubber (EPR) insulated cross-linked polyolefin (XLPO) jacketed cable for 2 kV DC.
    d. 2,000,000 circular mils ethylene propylene rubber (EPR) insulated cross-linked polyolefin (XLPO) jacketed cable for 2 kV DC.
2. Provide all accessories and terminations.

2.02 General Cable Requirements

A. Cables shall be manufactured to the following requirements:

1. Furnish cable that is single conductor and UL listed.
2. All cables shall be installed without splices, termination to termination, unless shown on the Contract Drawings.
3. The cable shall be suitable for use for power distribution feeders, indoors or outdoors, in wet or dry locations, as opens runs of cable, in cable tray, in conduit, ducts or aerial cable. The cable shall be sunlight resistant.
4. The insulation shall be triple tandem extruded with the conductor and insulation screens.
5. The cable shall be insulated with an ozone resistant and discharge resistant, flexible, thermoset Ethylene Propylene Rubber (EPR) dielectric and meet or exceed the references listed in this Section.
6. The cable construction shall be certified as low smoke and zero halogen.

B. Markings:

1. The following information shall appear on the cable jacket at least once per 3 feet of cable length:
   a. Manufacturer’s name.
   b. Conductor size.
   c. Conductor material.
   d. Voltage rating.
   e. Insulation designation.
2. A permanent marking containing the phrase "Property of SEPTA," manufacturer, year of manufacture, and sequential footage number, repeated every foot of cable length, shall be inserted under the shielding tape of single conductor cables, and under the core binder tape of multiple conductor cables.

2.03 Cable Connectors, Clamps and Hardware

A. Connectors for connections to switchgear and bus bar shall be mechanical, high conductivity copper alloy. The connector opening shall be sized to accommodate the size cables being connected and as noted on the Contract Drawings. All connectors shall be new.

B. Temporary connectors for splicing supplementary cable shall be full tension compression type as recommended by the cable manufacturer.

C. Beam clamps and cable supports shall be furnished in accordance with details on the Contract Drawings.

D. Cable riser clamps shall be of two (2) piece grade 1130 fiberglass blocks for supporting riser cables or tap cables and shall be furnished either separately or as part of an assembly as shown on the Contract Drawings and conforming to the Contract Drawings.

E. All feeder cables shall be located and installed in accordance with the details on the Contract Drawings.

F. All splices shall be installed using equipment from the manufacturer of the splice.

2.04 Fire Proofing

A. If necessary, the Contractor shall furnish and install a form of arc and fire protection tape for all cables to be manufactured by the following:

1. 3M Scotch 77 Fire and Arc Proofing Tape with an overwrap of Scotch 69 Glass Cloth Electrical Tape.
2. Or Approved Equal.

2.05 Cable Duct Lubricant

A. Furnish high performance cable pulling lubricant specifically developed for compatibility with low smoke/zero halogen jacketed cables. The lubricant properties shall include slow drying, thin, slippery film residue that remains for two (2) or more months after use, not flame sustaining, stringy gel that clings to cables and temperature stable with no flash point.

B. Cable lubricant shall be capable of being hand or pump applied and cleaned away with water.

C. Provide cable lubricant as manufactured by the following:

1. American Polywater types LZ or WLZ.
2. Or Approved Equal.

2.06 Cable Splices

A. Splice connectors for DC cables will only be permitted in manholes and pull boxes if necessary.

B. Insulation over the connector shall be 2 kV rated heat-shrinkable heavy wall tubing, flame retardant, low smoke zero halogen, conforming to the electrical requirements of ICEA S-95-658 for 0-2 kV rating.

C. Finished assembled splice shall be positively insulated and made waterproof, suitable for underground installation.

D. Provide heat-shrinkable heavy wall tubing as manufactured by the following: Raychem, Type FCSM or approved equal.

2.07 Manufacturers

A. DC Traction Power Cable Assemblies:

1. Select a manufacturer who is regularly engaged in the production of similar wire and cable and accessories.

PART 3 - EXECUTION

3.01 Installation

A. General:

1. The Contractor shall inform the SEPTA Project Manager about any field conditions encountered which are not covered or are substantially different from those shown on the Contract Drawings or specified in this Section and perform the work in question in accordance with the SEPTA Project Manager's instructions.
2. The Contractor shall conform to safety features and requirements specified.
3. Cables shall be continuous and without splices unless otherwise directed.

B. Feeder Cable:

1. Cables shall be handled with care. Cables shall not be run over by vehicles or any other object that could damage the insulation or conductors. Each reel shall be examined for cuts, kinks, or other damage. Damaged portions shall be removed and replaced or repaired as directed by the SEPTA Project Manager.
2. Scrap materials shall be gathered up and disposed of in a manner satisfactory to the SEPTA Project Manager. The scrap cable pieces shall be salvaged and returned to the SEPTA Project Manager.
3. The cable shall be inspected continuously as it leaves the reel. If damage is detected, the cable pulling operation shall be stopped and the cable being installed is to be removed and replaced at no additional cost to SEPTA.
4. All equipment such as sheaves, clamps, come-alongs, and cable pulling equipment shall be in good condition. Any such equipment that, in the opinion of the SEPTA Project Manager, could result in damage to the cables shall be removed from the work site.
5. Cable shall not be pulled until conduits have been cleaned and swabbed and are free from obstructions.
6. Pull, install and protect cables as follows:
    a. Use factory installed compression type pulling eyes for all pulls except as otherwise specified.
    b. Seal all cable ends before pulling into ducts. The ends of a cable when cut shall not be left with the insulation exposed to moisture unless splice is to done immediately.
    c. Strip reels of all nails in outside edges of reel heads before pulling of cable. Conveniently locate reels for feeding cable into the duct or conduit without excessive binding or possible injury to cable by abrasion. Reels shall be jacked to clear ground level by at least 6 inches before pulling of cable.
    d. Attach pulling ropes to cables with ball bearing swivels to prevent twisting of cable during pulling.
    e. Pull cable into ducts and conduits under moderate tension. The manufacturer’s recommended maximum pulling tensions shall not be exceeded. Any lubricant used shall not have a deleterious effect on the conductor insulation.
    f. Station sufficient personnel between the reel and the duct entrance during pulling operations to inspect, control and direct the passage of cable. Equip duct mouth with a form of bell end to prevent chafing of the cable while being inserted.
    g. Minimum bending radii as measured to inside surface of the cables shall not be less than those recommended by the manufacturers.
    h. Lubricate cables with the cable manufacturer approved material which shall be placed into the duct prior to the installation of the pulling rope.

i. Do not allow cable to chafe on the ground, pull boxes or any sharp surfaces during pulling. Provide timbers and flexible cable pulling tubes to guide and protect the cable, where necessary.

j. All cables installed shall be continuous from terminal to terminal.

k. Mark all cables with printed numbers on cable tags at all terminal points and at 25' intervals in cable trays. Refer to the Contract Drawings for numbering of cables.

l. Install cables as shown on the Contract Drawings. Provide supports, conduit and other hardware as required. All ferrous hardware shall be hot dip galvanized.

7. After pulling, cable exposed in manholes and pull boxes shall be thoroughly cleaned to remove all pulling lubricant.

8. Splices in the DC traction power cables shall be made only where approved by the SEPTA Project Manager. All splices shall have a conductivity and insulation resistance equal or greater than that of the cable.

9. Splices shall be installed in accordance with the cable splice manufacturer's recommendations.

10. Splices not furnished with an integral or proprietary insulation shall be insulated by sufficient wraps of approved tape or heat shrink tubing to yield an insulation level at least 100 percent above the conductor insulation.

11. Handle cable reels carefully to avoid injury to persons or cables. Control movement of reels on loading skids or sloping grades by use of a snub line or wedge. Always block reels after positioning.

12. When a cable is cut, seal the ends properly. Cut bank cable ends which have been exposed to the weather, a minimum of 1 foot and properly seal. If this seal is broken, repair it immediately. One (1) of the two (2) following methods shall be used for sealing rubber or thermoplastic cable ends. In both cases, clean the cable jacket and buff so that all cable wax, pulling compounds and contaminations are removed from the surface.

    a. For the first method the end shall then be sealed with epoxy resin using a procedure which shall be approved by SEPTA.

    b. For the second method a combination of rubber and vinyl tape may be used to provide a seal. The end shall first be sealed with high voltage electrical tape and then overwrapped with vinyl electrical tape.

C. Current Carrying Connectors:

1. Wire surfaces, which are in contact with conducting surfaces of the connector, shall be thoroughly wire brushed and shall have an inhibitor applied. Where connectors are not factory loaded, the same inhibitor shall be applied in the field to the connector.

2. Corrosion inhibitors shall be stable over a wide temperature range, able to adhere to cold metal surfaces, water repellent, weather resistant, and inert to copper, aluminum, zinc, tin, cadmium, steel, and neoprene rubber. Grit bearing inhibitors shall be used except for flat lugs, sliding surfaces or where omission is recommended by the connector manufacturer. Grit shall be compatible with the connector and wire metal.

3. Bolts in bolt-type connectors shall be lubricated as recommended by the manufacturer and torqued to the manufacturer's recommendation using a calibrated torque wrench.

D. Control of Scrap:

1. Scrap components including retired cable shall be collected, removed daily from the job site and the Contractor shall salvage and return any new cable to the SEPTA Project Manager to a location directed by the SEPTA Project Manager.

E. Fire Proofing:

1. Apply arc and fire protection tapes to cables passing through manholes, manholes, handholes, pull boxes, termination cabinets, cable tray, and at any location where the cable is exposed and not in conduit.

3.02 Tests

A. General:

1. The Contractor shall provide all instruments, materials and labor required for tests specified herein.
2. Cable shall be tested per the standard manufacturers' tests and in accordance with the following standards:
   a. IEEE 532.
   b. UL 1072.
3. The Contractor shall formulate overall test program of the equipment and installation which shall include but not be limited to the tests specified in this Section to ensure equipment and material are in compliance with the relevant standards, this Section, and satisfactory and reliable performance in actual intended operation.
4. Tests at the factory shall include but not be limited to:
   a. Tests listed in this Section.
   b. The manufacturer’s standard tests.
   c. Tests as per relevant NEMA, IEEE and ANSI standards not included in the manufacturer’s standard tests.
   d. Any other tests to ensure satisfactory performance of the product.
5. Tests and checkouts in the field shall include but not be limited to the following:
   a. Tests as listed in this Section.
   b. Tests as per relevant NEMA, IEEE and ANSI standards not included in this Section.
   c. Any other tests to ensure satisfactory performance of cable and installation.

B. Conditions of Tests:

1. Prior to testing of any cable and the installation, the following conditions shall be fulfilled by the Contractor:
   a. The Contractor shall have in his possession approved shop drawings.
   b. The Contractor shall have submitted testing procedure for SEPTA’s Project Manager approval at least forty-five (45) days in advance of the testing.
   c. For factory tests, a minimum of four (4) weeks advance notification shall be given to the SEPTA Project Manager on the schedule date of tests to enable him to witness the tests. Field tests shall be scheduled in consultation with the SEPTA Project Manager.

C. Witnessing Tests:

1. The SEPTA Project Manager will (at his option) witness complete or partial testing on all the cable and installation unless a wavier is granted for witnessing factory tests, in which case test reports of the product for which the waiver was granted shall be submitted for review to obtain clearance for packing and shipping. Waiver of witnessing factory tests on any cable shall not be construed as a waiver for all future supplies either of the same type or different cable.

D. Responsibility:

1. The Contractor shall assume full responsibility during the factory and field testing of all cable and installation provided by him. Should there be any loss or damage to such cable or installation as a result of these tests, the Contractor shall be fully responsible for replacing the damaged cable. Replacement of damaged cable shall include all costs, including, but not limited to, removal of damaged cable, furnishing of, transportation of, and installation of replacement cable.

E. Rejection and Retesting:

1. Failure of cable or termination to withstand tests or to meet ratings shall be sufficient grounds for rejection of the item tested.

2. If it is not possible to rectify rejected cable, new cable shall be installed/terminated between existing terminations/splices by the Contractor at his expense. The replacement cable must meet all requirements of this section.

F. Factory Tests:

1. Ethylene Propylene Rubber Insulated Cable:

a. The manufacturer shall conduct all applicable factory tests specified in the referenced standards.

b. The manufacturer shall furnish test certificates for each reel of cable for approval.

G. Field Tests:

1. General:

a. All tests shall be successfully completed to show that the installation meets the Specification requirements before final acceptance. The Contractor shall perform the specified tests on all cable installed under this Contract.

b. Tests and checkouts shall be conducted in accordance with the approved test procedure specified in this Section, the NEC and applicable standards and specifications of ANSI, NEMA, IEEE, AEIC, etc.

c. Field tests are required for all cable.

d. The Contractor shall provide properly qualified personnel who shall be responsible for supervising, coordinating, and performing all electrical field testing and checking work, and who will maintain a written record of all tests conducted.

e. Testing and checkouts shall be performed in the presence of SEPTA.

f. The Contractor shall furnish four (4) copies of all test results to SEPTA. Result sheets shall include date of test, personnel involved, items tested, type of tests and test data. Test certificate shall show the type and ratings of test instruments used and details of their calibration including dates of their first calibration.

g. Any equipment or cable damaged due to improper test procedure or test apparatus handling shall be replaced or restored to original condition by the Contractor at his expense.

h. Safety devices including but not limited to rubber gloves and blankets, screens and barriers, danger signs, padlocks, etc., shall be used to protect and warn all personnel in the vicinity of the tests.

2. Power Cable Field Tests:

a. All DC positive traction feeder cables shall be tested to ascertain that the dielectric strength of the cable insulation has not been impaired during installation, that the splices and terminations are properly made and to confirm the integrity of the cable system prior to energization. Tests shall include continuity tests, insulation resistance tests and high potential direct current tests. High potential direct current tests specified herein shall be applicable only to DC positive cables. Rectification of defects of any cable shall be done only with the specific approval of the SEPTA Project Manager.

b. After installation of any length of a cable and completing all connections, the Contractor shall perform the below listed tests on each cable circuit. To preclude damage to equipment and devices the tests shall be conducted before the cable is connected.

1) Continuity test shall be performed to prove the continuity of cable circuits.

2) Insulation Resistance Test:

a) This test shall be performed to determine the cable insulation resistance to ground.

b) Tests shall be conducted with a 1,000 V motor operated megger. Test voltage shall be applied between the conductor and ground and shall be held until the reading reaches a constant value for five (5) minutes. Insulation resistance values obtained by the megger tests shall not be less than 2 megaohms. The Contractor shall bring to the attention of the SEPTA Project Manager, the results of similar tests having unequal ratings with the variations of 25 percent or more.

c) For each test, the Contractor shall record the temperature, humidity, duration of the test and the voltage of the megger used.

3) High potential test for DC positive cables shall be performed only after the insulation resistance test has been successfully completed and shall be performed on each cable circuit installed under this Contract. Before conducting the high potential direct current tests, the Contractor shall comply with the following requirements:

a) Nearby equipment, the conductors of nearby insulated cables not under test, except those in service, and the ground stick shall be all securely tied to the manhole or Traction Power Substation (TPSS) grounding system.

b) The insulated conductor under test shall have a safe clearance from adjacent conductors and surrounding metal objects. For every 1,000 V of DC test voltage, 1/4 inch clearance is regarded as a safe distance.

c) High voltage tested gloves shall be worn by each participant.

d) The test voltages shall meet the recommendations of the cable manufacturer.

e) Danger signs and sentries shall be posted at all critical points along the entire cable route under test.

f) The operator's manual for the particular test set being used shall be read and understood.

g) All safety precautions shall be observed at the testing end and at the far end of the cable.

4) Each cable shall be tested separately while grounding test equipment and all cables not under test, except those in service. The following test procedure shall be followed:

a) The test equipment shall be supplied from a stable, constant voltage source having a maximum variation of the voltage of plus or minus 5 percent. Preferably, a motor-driven generator shall be used for the supply. The output voltage of the test set must be filtered, regulated and spike free.

b) The direct current test voltage shall be applied between conductor and ground slowly in equal steps (in steps of 5 to 7 percent of full test voltage) until the designated test voltage is reached. The rate of voltage acceleration shall be consistent under each step.

c) Sufficient time shall be allowed after each step for the leakage current to stabilize.

d) Total leakage current shall be recorded in micro-amperes after each step. The same length of time shall be allowed after each step for the total current to stabilize before taking the readings.

e) The test voltage shall be 80 percent of the original factory test voltage. The test voltage shall be maintained for five (5) minutes after it has reached the specified value.

f) Total current values shall be recorded in micro-amperes at one (1) minute intervals for the duration of the test.

g) The test set voltage control shall be set at zero at the end of each test. The residual voltage on the circuit shall be allowed to decay to approximately 1.0 kV before applying the manual grounds.

h) The insulated conductor under test shall be grounded with ground stick after each test. The conductor should remain grounded for at least thirty (30) minutes after completion of the test.

5) Failure of the initial leakage current to decrease, or any increase in the leakage current at any time during the test shall be presumed to be indicative of a cable defect and the test shall be continued until cable failure occurs.

H. Defective Cables:

1. Any Contractor furnished cable found defective before installation shall be replaced by the Contractor. Cable found defective after installation shall be repaired or replaced at Contractor's expense.

2. Any cable section installed under this Contract found defective during the testing shall be replaced with a new cable section. Rectification of defects of any cable shall be done only with the specific approval of the SEPTA Project Manager.

I. Test Reports:

1. The Contractor shall submit five (5) copies of certified test reports of all field tests for the SEPTA Project Manager's review and approval. Test reports of field tests shall be submitted no later than seven (7) days after testing. Test reports shall be self-explanatory, noting the personnel involved, and shall show the instruments used for testing and the date(s) of their last calibration. Test reports shall contain identification of each conductor tested in a manner that can be referenced to the Contract Drawings.

3.03 CABLE IDENTIFICATION TAGS

A. Install standard cable tags on new cables, two (2) cable tags to each box, one (1) cable tag on the cable in the box and one (1) cable tag on the cable below (or above) the box.

END OF SECTION

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SECTION 16123

BUILDING WIRE AND CABLE

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of material and labor for furnishing, installing, connecting, energizing, testing, cleaning and protecting building wire and cable, and accessories.

1.02 Related Sections

A. Section 01600 – Materials and Equipment

B. Section 16060 – Grounding and Bonding

C. Section 16075 – Electrical Identification

D. Section 16130 – Raceways and Boxes

E. Section 16950 – Testing

1.03 Submittals

A. Submit with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. If not available, provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of SEPTA.

B. Submit product data for the following products; indicate clearly the Project specific usage of each product:

1. Wires and cables.
2. Lugs and connectors.
3. Tools for crimp connectors.
4. Tapes and pulling lubricant.

C. Tension Calculations:

1. Submit cable pulling calculations for all underground power runs. Calculations shall include both pull load and tensions, along with safety factors, for all cables.
2. Design conduit runs so as not to exceed tension limits of the manufacturer. Provide additional pulling points as required to limit the tension.

D. Record actual installed elevation and locations of feeders, both concealed and exposed work, on the record drawings.

E. Submit record drawings, product data, and installation and maintenance instructions for Project closeout.

1.04 Quality Assurance

A. Unless products meeting the requirements of nationally recognized testing laboratories are not readily available for a category of products, provide products that are listed and labeled by Underwriters Laboratory (UL), approved by Factory Mutual (FM) or certified as meeting the standards of Underwriters Laboratory by the Electrical Testing Laboratory (ETL).

B. All work shall meet the regulatory requirements of all state and local codes and requirements.

C. Install work under supervision of skilled licensed electricians.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM B 8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium Hard, or Soft.
2. CSA FT-1, Vertical Flame Test.
3. ICEA S-95-658/NEMA WC 70, Power Cables Rated 2000 V or Less for the Distribution of Electrical Energy.
4. ICEA T-33-655, Low-Smoke Halogen Free (LSHF) Polymeric Cable Jackets.
5. IEEE 1202, IEEE Standard for Flame-Propagation Testing of Wire & Cable.
6. NEMA WC 26, Binational Wire and Cable Packaging Standard.
7. NFPA 70, National Electrical Code (NEC).
8. UL 44, Rubber-Insulated Wires and Cables.
9. UL 1277, Electrical Power and Control Tray Cables with Optional-Fiber Members.
10. UL 1569, Metal-Clad Cables.
11. UL 1581, Electrical Wires, Cables, and Flexible Cords.
12. UL 1685, Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables.

1.05 Delivery, Storage and Handling

A. Protect items from damage during delivery, storage and handling in accordance with Section 01600.

B. Packaging of wire and cable shall meet NEMA WC 26.

1.06 Qualifications

A. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

1.07 Field Samples

A. Provide one (1) 36 inch long sample of each type of wire to be used.

PART 2 - PRODUCTS

2.01 Low Voltage Copper Building Wire

A. UL listed conductors of 98 percent conductivity copper with type XHHW-2 Low Smoke Zero Halogen (LSZH) insulation meeting UL 1685 and ICEA T-33-655 and rated 600 V.

B. Provide conductors of proper size and ampacity ratings according to NEC Article 310.

C. Minimum Conductor Size:

1. No. 12 AWG in power and branch feeder circuits.
2. No. 14 AWG in control circuits.
3. No. 14 AWG in alarm and status circuits.

D. Except for control wires or where otherwise indicated on the Contract Drawings, do not exceed four (4) conductors (three (3) phase conductors and one (1) neutral) plus one (1) ground in raceways or conduits.

E. All conductors in all sizes shall be stranded copper.

F. ROMEX and BX cable and aluminum conductors are not permitted for use in this Contract.

G. Imprint insulated conductors with the date of manufacture, wire type and the manufacturer. Wire and cable manufactured more than twelve (12) months before delivery to the job site shall not be used.

H. Manufacturers:

1. Continental Cable Co.
2. Rome Cable Corp.
3. Okonite Co.
4. Southwire Co.
5. Or Approved Equal.

2.02 Shielded Instrumentation Cable (2/C Cable)

A. Provide cable which meets the following:

1. Cable fabricated using stranded (19 x 29 AWG) tin coated copper conductors with polyethylene insulation, color coded conductor insulation and overall Low Smoke Zero Halogen (LSZH) jacket.
2. Cable 100 percent shielded, utilizing aluminum polyester foil, incorporating No. 18 AWG stranded tinned copper drain wire.
3. Cable shall be NEC Class CL2 and passing the CSA Vertical Flame Test FT-1.
4. Cable UL (recognized) Style 20253 having a 600 V insulation and 90°C temperature rating, two (2) conductor, twisted pair, No. 16 AWG.
5. Manufacturers:
   a. Belden Corporation.
   b. Or Approved Equal.

2.03 Wire and Cable Connections

A. Grounding to meet Section 16060.

B. For equipment connections using service wires and cables, and wires larger than No. 6 AWG, provide connectors approved by the equipment manufacturer and of the types specified below. For all other types of connections provide connectors of one (1) of the types specified below:

1. Split bolt connectors or compression type connectors to be UL Listed connectors for making parallel or butt splices of stranded copper wire. Use companion preformed plastic insulating covers or tape insulation meeting the NEC requirements.

2. Mechanical compression connectors to be compact high copper bronze or brass alloy, two (2) hole, capable of being installed with one (1) wrench with two (2) clamping bolts, single conductor, or multiple conductor, brass or bronze bolts. Plated steel screws are unacceptable. Provide silicon bronze fasteners for bolting connectors to connections.

3. Crimped compression connectors to be two (2) hole crimped connectors of high conductivity seamless electrolytic wrought copper, electrolytically tin plated, with two (2) holes, color coded to match dies. Provide adequate area for conduction of the flowing current. Provide tooling to crimp connectors from the same manufacturer as connectors.

C. Control wiring connections to be crimped nylon insulated ring terminals for all connections at terminal boards and nylon insulated butt splices with insulation grip. When more than two (2) control wires are to be joined provide junction boxes with terminal boards as specified in Section 16130.

D. Instrumentation Cable Connector:

1. Provide companion type connectors for instrumentation cable and for the equipment being furnished under this Contract.

2. Where providing cable to equipment controllers/enclosures furnished under other sections of this Contract, connectors provided with furnished equipment.

3. Terminate wiring as required for proper installation.

4. Manufacturers:
   a. Thomas & Betts Corp.
   b. AMP Inc.
   c. IIsco Corp.
   d. Buchanan Construction Products.
   e. Or Approved Equal.

E. Provide one (1) of the following types of connectors for other conductors:

1. Any of the types listed for larger wire.

2. Screw terminals, crimped compression terminals to be nylon insulated crimped terminals with copper barrels for making terminal connections of stranded copper wire to screw terminals.

3. Wire nuts to be pre-insulated, UL Listed, hand or tool installed, solder-less connectors of the spring lock type or compression type for making splices of solid copper wire. Wire nuts for site lighting shall be of the type intended for use in wet locations and shall be pre-filled with a waterproofing compound by the manufacturer.
4. Screw lock connectors are for making terminal connections of solid copper wire.
5. Manufacturers:
    a. Thomas & Betts Corp.
    b. AMP Inc.
    c. Ilsco Corp.
    d. Burndy.
    e. Or Approved Equal.

2.04 Tape

A. Arc proofing tape to be Scotch 77.

B. Vinyl insulating tape to be Scotch 33+, black.

C. Rubber splicing tape to be Scotch 1 30C.

D. Grounding braid to be Scotch 25.

E. Heat shrinking to be Amp HST1125.

F. Manufacturers:

1. 3M, Scotch.
2. Plymouth.
3. Permacel.
4. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Inspect all conduits, junction boxes, electrical vaults, manholes and handholes for cleanliness, lack of burrs, conduits alignment, completeness and correct deficiencies.

B. Ensure that two (2) locknuts are installed on all conduits without threaded hubs, that bushings are installed in all conduits with wires larger than No. 10 AWG, that grounding bushings and fittings are installed at all places called for in Section 16060.

C. Check that proper sized boxes are installed. Boxes and conduit fittings must meet the NEC for bending requirements.

D. Swab all conduits with a nylon bush and steel mandrel.

E. Ascertain that pulling calculations have been made and are available for long runs and pulls as indicated in this Section. Ascertain that a means of controlling pulling tension is installed on mechanical assist devices for pulling cable.

F. Pre-lubricate all conduits for which the pulling tension calculations are based on a coefficient of friction less than that of a dry conduit.

3.02 Installation

A. General:

1. Install all wiring outside of equipment in conduit.
2. Do not perform wiring until work which might cause damage to the wires, cables or conduits has been completed. Take the necessary precautions to prevent the accumulation of water, dirt or other foreign material in the conduits during the execution of the work.
3. Make wire and cable splices in outlet or junction boxes per the NEC and install such boxes in accessible locations.

B. Include a green equipment ground conductor with all runs; wire type and size as specified in Section 16060.

C. Neutral Conductors:

1. Provide separate neutral conductors for all branch circuits except as follows:
   a. Common neutrals may be used for circuits from three (3) adjacent single pole circuit breakers or poles of the same multi-pole circuit breaker in 3 phase wye connected panelboards.
2. Provide separate neutrals for each single phase and each multi-phase feeder.
3. Size each neutral to the same size as the largest phase conductor.

D. Cable Pulling:

1. Meet the manufacturer's recommendations for the inspection, handling, storage, temperature conditioning prior to installation, bending and training limits, pulling limits and calculation parameters for installation of all cable. Use quadrant blocks located properly along the cable run. Remove from the job site and replace all cables that were subjected to excessive bending and tension and all cables that are cracked or have damaged or nicked outer jackets.
2. Pull cables down grade with the feed-in point at the manhole, handholes or buildings of the highest elevation. Flexible cable feeds shall be used to convey cables through the manhole opening and into the duct runs. Cable lubricant shall be soapstone, graphite or talc for rubber of plastic jacketed cables.
3. Lubricate all cables during pulling with lubricants specifically recommended by the cable manufacturer.
4. Limit cable pulling tensions to the maximum pulling tensions recommended by the cable manufacturer. Use dynamometer to measure pulling tensions on all runs pulled with mechanical assistance and for all runs where calculations are required to be submitted. If pulling tension is exceeding during pulling, cables shall be removed and marked and not reused.
5. Install cables in manholes along those walls providing the longest route and the maximum spare cable lengths. Form cables to closely parallel walls so as not to interfere

with duct entrances. Support cable on brackets and insulators spaced at a maximum of 2 feet apart. Lubricants must be used and must be approved by the cable manufacturer.

E. Wiring Identification:

1. Color code wires and cables as specified in Section 16075.
2. Identify all control wiring with wire numbers corresponding to the record drawings.
3. Identify all power wiring by circuit and panelboard, switchboard and motor control center number.

F. Cable Terminating:

1. Protect termination of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Terminations shall be made using materials and methods as indicated or specified herein or as designated by the written instruction of the cable manufacturer and the termination kit manufacturer.

G. Wire and Cable Splices:

1. Splice cables only in accessible location. Install all service and feeder conductors from end to end without splice. Install all motor conductors from starter to motor without splice.
2. Protect termination of insulated power and lighting cables from accidental contact, deterioration of coverings and moisture by the use of terminating devices and materials. Terminations shall be made using materials and methods as indicated or specified herein or as designated by the written instruction of the cable manufacturer and the termination kit manufacturer.
3. Locate splices in underground systems in accessible locations with manhole entrances above the one hundred (100) year flood elevation. Make below grade splices using a compression connector on the conductor. Insulate and waterproof below grade splices by methods suitable for continuous submersion in water using either method that follows:
    a. Gravity poured method to employ materials and equipment contained in an approved commercial splicing kit with a mold suitable for the cables to be spliced. When the mold is in place around the joined conductors, prepare and pour the resin mix into the mold.
    b. Cast type splice insulation to employ materials and equipment contained in an approved commercial splicing kit employing a thermosetting epoxy resin insulating material applied by a gravity poured method or by a pressure injected method. Fix cables in place to not be moved until the splicing materials have completely set.

3.03 Field Quality Control

A. Field test prior to energizing wire and cable as specified in Section 16950.

END OF SECTION

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SECTION 16129

FIBER OPTIC CABLE

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for providing (furnishing and installing) fiber optic cable.

B. Cabling shall be installed in such a manner so that SEPTA's normal day-to-day operations are not affected and that interruptions to SEPTA's normal workday activities are kept to a minimum.

C. Work along the right of way of this Section may require track outages that must be performed during the hours of 12:00 AM and 4:00 AM.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 07841 – Penetration Fire Stopping

C. Section 07842 – Joint Fire Stopping

D. Section 16760 – Fiber Optic Network

E. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

F. Section 16950 – Testing

1.03 Submittals

A. Submit proof of the manufacturer's certification, within ten (10) business days of the Contract Award, that the Contractor is manufacturer-certified to install the specified cabling systems. Certify that warranty is a minimum of five (5) years.

B. Submit for approval to SEPTA's Project Manager, sets of catalog cut sheets for all materials to be used in this installation, in accordance with Section 01300. Each cut sheet shall be identified with the manufacturer's name, part number, acquisition lead time and date of submittal. SEPTA will not be responsible for any materials ordered prior to SEPTA's approval for the cut sheet item in question.

C. Failure to provide a complete cut sheet submittal for a specific item will result in rejection. Upon rejection, resubmit the specified documentation for re-approval.

D. Submit cut sheet submittals in a timely manner to permit proper consideration and approval. Coordinate the timing of each submission to assure adequate lead time for procuring items required by this Contract and inform SEPTA's Project Manager of any time constraints concerning submittal approvals that are critical to the completion of the Contract. Delays attributable to rejected cut sheet submittals shall not serve as a basis for extending time for Contract completion.

E. After an item has been approved, changes in make, manufacturer or part number shall not be permitted, unless:

1. Satisfactory written evidence is presented, and approved by SEPTA, that the manufacturer cannot make the scheduled delivery date of an approved item; or
2. Other conditions become apparent indicating approval of the item to be substituted will be in the best interest of SEPTA.

F. Submit a cable and outlet identification plan and an interconnection block diagram to SEPTA's Project Manager for approval before final cable and faceplate labels are installed.

G. Submit pulling calculations (tensions and side wall pressure).

H. Submit field monitored pulling tension forces measured during actual installation of the cable.

I. As part of the "as-built" submission, submit copies of the completed test results (in accordance with Section 01300) within fifteen (15) working days of test completion, in both electronic and printed format. The submission shall include copies of the print outs of all cables tested.

J. Submit copies of the marked-up "as-built" drawing(s) to SEPTA's Project Manager within fifteen (15) working days of completion of the work (or each stage of the work). As a minimum, annotate on a clean set of prints, the following information:

1. The approximate routing of cabling installed.
2. Other pertinent information, such as actual pulled lengths, concerning the performance of the work regarding "as-built" conditions that will provide a more accurate set of drawings.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI/TIA/EIA 568-B.1, Commercial Building Telecommunications Cabling Standard - General Requirements.
2. ANSI/TIA/EIA 568-B.3, Commercial Building Telecommunications Cabling Standard - Optical Fiber Standard.
3. ANSI/TIA/EIA 568-C.3, Fiber Cabling Component Standard.
4. ANSI/TIA/EIA 569-A, Commercial Building Standards for Telecommunications Pathways and Spaces.
5. BICSI, Telecommunications Distribution Methods Manual.
6. NFPA 70, National Electric Code (NEC).
7. Telecordia GR-20, Generic Requirements for Optical Fiber and Optical Fiber Cable.

1.05 Performance Requirements

A. Work shall be performed in a professional manner, using practices of good craftsmanship.

B. Provide cables with the specified connectors affixed using the tools specified by the manufacturer.

C. Terminate cables using the tools specified by the manufacturer.

D. Remove trash, debris, spent reels and all other refuse related to this installation, daily.

1.06 Qualifications

A. Provide the services of personnel having at least five (5) years of experience in the installation and termination of single mode optical fiber.

1.07 Operations and Maintenance Data

A. Develop and submit:

1. Certified factory test reports.
2. Pulling calculations.
3. Certified detailed field test reports that verify the total db losses.
4. As-built documents with maintenance guide.

1.08 Warranty

A. Provide the standard warranty with a five (5) year minimum term from the date of final acceptance by SEPTA, as indicated in this Section.

1.09 System Acceptance

A. Final acceptance will be made by SEPTA upon satisfactory completion of the work. Additionally, SEPTA's acceptance is based upon the submission and approval of all test records, cable run summaries and as-built drawings.

B. The work will not be considered complete until:

1. It has been inspected and accepted by SEPTA.
2. All discrepancies have been resolved.
3. All test records, cable run summaries and as-built documentation have been received.

PART 2 - PRODUCTS

2.01 General

A. Items not listed in this Section or shown on the Contract Drawings, but necessary for the complete and proper performance of the work as specified, shall be considered part of the work. Verify exact types and quantities of all materials with SEPTA before purchase.

2.02 Outside Plant Fiber Optic Cable

A. Provide Single Mode Fiber (SMF) for outside plant operations that can be applied in underground duct, in aerial duct and lashed to an aerial messenger wire as offered by the following manufacturers:

1. Superior Essex (Series F1), single flex tube all dielectric.
2. Or Approved Equal.

B. Fiber and cable characteristics for cable to be supplied are as follows:

1. Fiber count to be twenty-four (24), unless shown otherwise on the Contract Drawings.
2. Nominal diameter to be 0.47 inches.
3. Minimum bending radius to be 9.5 inches.
4. Outer construction consisting of:
   a. Rigid dielectric outer strength members imbedded just under a UV resistant jacket.
   b. Rip cords to remove outer jacket.
   c. A dielectric water blocking strength member layer over a single gel-filled tube.
   d. Surrounding the core tube with up to eight (8) fiber bundles of twelve (12) fibers, each.
5. The inner construction of the cable shall be a loose tube design, highly flexible and dry, with individual Type 3, reduced water peak, single mode fibers.

2.03 Inside Plant Fiber Optic Cable

A. Provide inside plant fiber optic cable compatible with the equipment specified in Section 16910.

2.04 Cable Terminations

A. Provide terminations as per Section 16760.

PART 3 - EXECUTION

3.01 General

A. Do not exceed the recommended pulling tension of the cable manufacturer. Assume responsibility to pay all costs associated with the replacement of any cable that exhibits evidence of cuts, crimps, severe abrasions and damage due to exceeding the manufacturer's specified pulling tension.

B. Install, dress and terminate cabling in a professional manner, using practices of good craftsmanship.

C. Place all new sleeves and penetrations required for successful cable installation.

3.02 Cable Termination

A. Each element of the specified fiber optic cabling installed shall be connectorized using the specified SC connectors, and shall be mounted into the specified fiber optic patch panels and SC insert panels.

B. Furnish and install all termination equipment according to the manufacturer's instructions, using the required tooling and materials.

3.03 Floor and Wall Penetrations, Fire Stops

A. Provide fire stops for all wall and floor penetrations per Section 07841 and Section 07842.

3.04 Installation in Duct Banks and on Aerial Structures

A. In the duct bank manholes, apply a wrap of fireproofing tape and mastic between the entry points into the manhole. Install fire stop material at each duct entry point. The intent is to provide protection to vital fiber optic cables passing through manholes where unrelated C&S and traction power cables may cause a fire.

3.05 Splices

A. SEPTA intends that outside plant cabling shall be installed in one (1) continuous run between termination locations. No splices will be permitted.

B. Install inside plant fiber optic cable without splicing between terminations at Supervisory Control and Data Acquisition (SCADA) equipment or between outside plant to inside plant splice panels and SCADA equipment (i.e. no splices between termination points shown on a final fiber plant block diagram).

3.06 Damage

A. Any cuts, abrasions, burns, stretched segments and/or other damage that will be detrimental to the performance of that cable shall be cause for replacement of that entire segment of cable.

B. Incidental damage to cables and connectors shall be corrected at the Contractor's expense before testing and final acceptance of cables.

3.07 Cable Labeling and Identification

A. Submit a cable and outlet identification plan to SEPTA for approval before final cable labels are installed.

B. Each cable, patch panel port and termination block position shall be labeled individually with a unique cable number, using machine printed labels.

C. Each outlet shall be labeled individually with a unique identification number, using machine printed labels.

D. Cable labels that are cut off during the installation process shall be replaced with new labels after final dress and termination in such a position that permits the label to be easily read.

3.08 Testing

A. Factory and field testing shall be performed in accordance with the requirements of Section 16950.

END OF SECTION

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SECTION 16130

RACEWAYS AND BOXES

PART 1 - GENERAL

1.01 Description

A. This Section covers the requirements for the following conduits and ducts:

1. Metal conduits.
2. Non-metallic conduits. PVC raceways are not permitted in any SEPTA City Transit Division Traction Power Substation (TPSS) construction work.
3. Metallic pull boxes and splice boxes.

1.02 Related Sections

A. Section 16060 - Grounding and Bonding

1.03 Submittals

A. Submit catalog cuts of proposed conduits.

B. Submit drawings and catalog cuts of proposed pull and splice boxes.

C. Submit pull and splice box size calculations and/or diagrams.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI C80.1, American National Standard for Electric Rigid Steel Conduit (ERSC).
2. ASTM D 149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulation Materials at Commercial Power Frequencies.
3. ASTM D 150, Standard Test Methods for AC Loss Characteristics and Permittivity (Dielectric Constant) of Solid Electrical Insulation.
4. ASTM D 348, Standard Test Methods for Rigid Tubes Used for Electrical Insulation.
5. ASTM D 570, Standard Test Method for Water Absorption of Plastics.
6. ASTM D 648, Standard Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
7. ASTM D 695, Standard Test Method for Compressive Properties of Rigid Plastics.
8. ASTM D 696, Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C with a Vitreous Silica Dilatometer.
9. ASTM D 790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
10. ASTM D 792, Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

11. ASTM D 2105, Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Finer-Reinforced Thermosetting-Resin) Pipe and Tube.
12. ASTM D 2583, Standard Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
13. NEMA TC 14, Reinforced Thermosetting Resin Conduit and Fitting Series.
14. NFPA 70, National Electrical Code (NEC).
15. UL 1, Flexible Metal Conduit.
16. UL 6, Electrical Rigid Metal Conduit - Steel.
17. UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
18. UL 514B, Conduit, Tubing and Cable Fittings.
19. UL 1684, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Non-Metallic Conduit:

1. Polyvinyl Chloride Conduit (PVC): Not permitted.

B. Flexible Metal Conduit (FMC):

1. Flexible metal conduit shall be galvanized steel meeting UL 1.
2. Connectors shall be of the twist-in, insertion type with insulated throats.
3. FMC shall only be installed in heated spaces.

C. Flexible Conduit:

1. Liquid tight flexible metal conduit shall consist of continuous lengths of wound and interlocked galvanized steel, over which is an extruded polyurethane jacket certified and tested as a low smoke zero halogen type.
2. Provide liquid tight flexible metal conduit from the following manufacturers:
   a. AFC Cable Systems (product Liquid-Tuff LSZH®)
   b. Or Approved Equal.
3. Connectors for liquid tight flexible metal conduit shall be of the throated insulated type and shall be provided with a bonding locknut.
4. Liquid tight flexible metal conduits less than 1 1/2 inches in diameter shall have continuous copper bonding conductor between convolutions and be approved for grounding or have a separate grounding conductor. Conduit sizes 1 1/2 inch and larger shall be provided with separate grounding conductor.

D. Rigid Metallic Conduit (RGS):

1. Do not use RGS conduit, conduit bends and fittings for the installation of traction power cables.

2. Provide conduits fabricated of mild steel piping, galvanized or electro-plated inside and outside, and protected against corrosion by a dichromate rinse or a zinc chromate coating. Each conduit shall bear the UL label, shall be defect free, furnished in 10 foot lengths minimum, threaded both ends, one (1) end fitting with a coupling and of the following types:
   a. Galvanized Rigid Steel (RGS) conduit and fittings to meet the requirements of NEC for materials and uses.
3. Connectors and coupling shall be threaded galvanized malleable iron or steel.
4. Locknuts shall be of the type with sharp edges that bite into enclosure where connected.
5. Bushings shall be brown or black, high temperature type, lay-in grounding type, unless indicated otherwise.
6. Rigid Steel Conduit and Fittings:
   a. Hot dip galvanized inside and out, with threads galvanized after cutting, meeting UL 6 and ANSI C80.1.
   b. Rigid steel conduit and fittings shall be such as manufactured by the following:
      1) Allied Tube and Conduit.
      2) Or Approved Equal.

E. Rigid Non-Metallic Conduit:

1. Glass Fiber Reinforced Thermosetting Resin Conduit (RTRC) Electrical Conduit and Fittings:
   a. Refer to Table 16130-1 thru 16130-4 physical properties of RTRC electrical conduit and fittings.

Table 16130-1 Physical Properties of RTRC Electrical Conduit and Fittings

Property	Value	Standard
Specific Gravity	1.94 g/cubic cm	ASTM D 792
Barcol Hardness	54 + 2	ASTM D 2583
Glass Content	68% + 3%	-
Water Absorption	< 1%	ASTM D 570
Color	Black	-
Application	Above Ground and Underground	-
Coefficient of Friction (PVC Cable Jacket)	0.385 + .06	-

Table 16130-2 Electrical Properties of RTRC Electrical Conduit and Fittings

Property	Value	Standard
Dielectric Strength	500 volts/mil	ASTM D 149
Dielectric Breakdown Voltage	29.7 kV	ASTM D 149
Dissipation Factor	0.5%	ASTM D 150

Table 16130-3 Thermal Properties of RTRC Electrical Conduit and Fittings

Property	Value	Standard
Coefficient of Thermal Expansion	1.37 E-5 in./in./°F	ASTM D 696
Thermal Conductivity	2 BTU.in/ft2.h.°F	-
Flammability	HB	UL 94
Heat Deflection Temperature	312°F	ASTM D 648
Flame Retardant	Satisfactory	UL 1684 Sect. 5.12

Table 16130-4 Mechanical Properties of RTRC Electrical Conduit and Fittings

Property	Value	Standard
Tensile Strength	>=9000 psi	ASTM D 2105
Elasticity Modulus	1.3 E + 6 psi	ASTM D 2105
Resin	Epoxy	-
Glass	E-Glass	-
Toxicity	No chlorine or trace halogens	-

b. Use RTRC conduit and fittings that meet the requirements of NEMA TC 14, Type HW.

c. Manufactured from pure, high grade, filament wound fiberglass epoxy having the following properties as a minimum:
   1) Low smoke and zero halogen.
   2) Longitudinal tensile strength to be 7,000 psi when tested per ASTM D 2105.
   3) Axial compressive strength to be 12,000 psi when tested per ASTM D 695.
   4) Ultimate elongation to be 2 percent when tested per ASTM D 2105.
   5) Modules of elasticity in tension to be 1,250,000 psi when tested per ASTM D 2105.
   6) Modules of elasticity in bending to be 1,250,000 psi when tested per ASTM D 790.
   7) Thermal conductivity to be 2.0 BTU/Hr./Sq. Ft./°F/Inch.
   8) Coefficient of linear thermal expansion to be 1.25 x 10-5 inch/inch/°F.
   9) Specific gravity to be 1.94.
   10) Temperature range to be minus 65°F to plus 300°F.
   11) Dielectric strength to be 500 volts/mil when tested per ASTM D 348.
   12) Dissipation factor to be 0.5 percent average at room temperature when tested per ASTM D 348.

d. RTRC conduit in 4 inch size and larger to be heavy wall thickness of 0.096 inches, minimum, and rated for impact resistance (vandal resistant).

e. Conduit and fittings (watertight) shall be such as manufactured by the following:
   1) Champion.
   2) FRE Composites Inc.
   3) Or Approved Equal.

F. Miscellaneous Fittings:

1. Expansion and deflection fittings to be concrete tight and weatherproof with ground continuity, shall allow 4 inch movement and 3/4 inch or 30 degrees of deflection from normal, and shall have factory installed packing ring and pressure ring designed to exclude moisture.
2. Hub fittings to have nylon insulated throat.
3. Through wall and floor seals to be insulating and watertight type.
4. Elbows:
   a. Radius not less than twelve (12) times the conductor diameters but in all instances, the cable manufacturer's requirements shall supersede this paragraph.
   b. Fittings for conduits and outlet boxes to meet UL 514B.

G. Accessories:

1. Conduit pull lines to be polypropylene, 1/4 inch, tensile strength not less than 1,000 pounds. Pull lines to be manufactured by one (1) of the following manufacturers:
   a. NEPTCO Muletape WP2SOOP.
   b. Or Approved Equal.
2. Conduit thread compound to be lead free, corrosion resistant, anti-seize, conductive.
3. Conduit sealant to be silicon foam manufactured by the following:
   a. Chase Technology Corp.'s PR855.
   b. Or Approved Equal.
4. Galvanize repair coating to be cold liquid type.

H. Pull and Splice Boxes:

1. Metal Pull and Splice Boxes:
   a. Metal boxes that are to be installed in heated or unheated spaces shall be extra duty hot dipped galvanized steel. All boxes shall be sized in accordance with the NEC.
      1) Provide grounding means in each metal box.
   b. Boxes shall have metal covers to meet the NEC.

PART 3 - EXECUTION

3.01 Preparation

A. Transmit submittals and deliverables required by this Section.

B. Furnish products as indicated in Part 2 in this Section.

C. Ensure substrates are in suitable condition to receive the work of this Section.

3.02 Installation, Application or Execution

A. Install wiring in raceways, unless otherwise specified herein.

B. Raceways shall be exposed, or concealed in ceilings, walls, floors or underground as specified herein.

C. Size conduit as required or as specified herein. Minimum raceway size shall be 3/4 inch. Flexible cable connections, sized 1 1/2 inches to recessed lighting fixtures are acceptable.

D. Changes and offsets due to structural conditions, and coordination with equipment, piping and ductwork, shall be made.

E. Raceways that pass-through expansion joints shall be provided with expansion fittings.

F. Exposed raceways shall be run parallel with or at right angles to the building walls.

G. Lateral runs of raceways in masonry shall not exceed 3/4 inch trade size.

H. Raceways shall be secured in place and protected to prevent damage to the work during construction.

I. Installation of raceways shall be complete and shall be blown-out and swabbed clear of water and trash prior to pulling wire.

J. Install junction or pull boxes to avoid excessive runs or bends. Several such boxes are indicated on the Contract Drawings. The locations shown may be varied and additional boxes installed.

K. Provide pull lines in all empty raceways. At each end, leave 12 inches of slack coiled in the box, or at the end of the conduit where boxes are not installed.

L. Provide connectors with phenolic-insulated throat and collar with grounding lugs at enclosures with concentric knockouts. Make metallic conduit and raceways electrically and mechanically continuous and ground them in accordance with Section 16060.

M. Cut conduit square, in a manner, which will result in conduit openings not being restricted. Clean cut ends and remove burrs.

N. Install conduit spacers in accordance with the manufacturer’s printed installation instructions.

O. Field bend conduit with tools designed for this purpose.

P. Bending radius shall not be less than nine (9) conduit diameters for standard conduit.

Q. System wide 4 inch conduit bends shall not total more than 270 degrees (three (3), 90 degree bends) in any one run between an outlet, pull box, handhole or manhole.

R. Fasten conduit to hubless boxes with two (2) locknuts and a grounding bushing.

S. Inject sealant into conduits at exterior boxes and wire ways, and at first box on conduit entering dry areas from wet areas.

T. Conduits emerging from earth or gravel, floor slabs or underground walls shall be rigid non-metallic conduit.

U. Install suitable caps or plugs in empty conduits for future expansion.

V. Install end bells or bushings on all conduit terminations.

3.03 Approved Use of Liquid-Tight Flexible Metal Conduit

A. Liquid-tight flexible metal conduit is approved for use in the following situations:

1. Connections to dry type transformers.

2. Connections to motors.
3. Connections to all electrical equipment subject to movement or vibration where exposed to rain, spray, or a corrosive atmosphere and located in equipment mechanical rooms and shops.
4. Connections to equipment subject to oil or grease.

3.04 Cleaning

A. Rod and clean conduit and ducts using appropriately sized mandrels and swabbing mandrels.

3.05 Field Quality Control

A. Confirm that all conduit bends and sweeps are properly sized during the cleaning process. Replace all bends that are improperly sized.

3.06 Demonstration

A. Test metallic conduit and boxes for electrical continuity. Perform the test in the presence of SEPTA.

B. Arrange with SEPTA's Project Manager for inspection and approval of embedded conduit and boxes prior to concrete placement.

END OF SECTION

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SECTION 16131

BUS DUCT

PART 1 - GENERAL

1.01 Description

A. This Section specifies furnishing, installing and testing of bus duct.

1. The following types of bus ducts are required:
   a. 1000 V AC non-segregated phase anode bus duct assembly for connecting the rectifier transformer to the rectifier. Bus duct shall be complete with AC heaters for the outdoor sections of the equipment.
   b. 1000 V DC positive cathode bus duct assembly for connecting the rectifier positive terminal to the DC switchgear.
   c. 1000 V DC negative cathode bus duct assembly for connecting the rectifier negative terminal to the negative and drainage switchboard.
2. Provide all accessories and terminations.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01300 – Submittals

C. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. The Contractor shall submit the following shop drawings and data for the SEPTA Project Manager's review in accordance with Section 01300:

1. Shop drawings, catalog cuts and other forms of descriptive data delineating the construction of the bus ducts specified herein.
2. Certified dimensioned bus duct cross section diagrams and weights.
3. Bus duct installation and layout drawings.
4. Special storage instructions, if applicable.
5. Bus duct installation and test instructions.
6. Calculations for mounting supports.
7. Recommended termination materials and procedures.
8. Five (5) certified copies of test reports of all the tests conducted at the factory and in the field for the SEPTA Project Manager's approval. Test reports shall be submitted to SEPTA within two (2) weeks after completion of tests. In case of "Factory Tests", test reports shall include original data, detailed calculation of test data to arrive at the results and interpretation of results. Test reports shall contain the characteristics, curves, etc. where required for interpretation of results. Authorization to ship will not in any way relieve the Contractor of this responsibility under this Contract.

9. Certificate certifying that the bus ducts meet the requirements specified herein, meet the standards designated herein and have been tested as specified herein.
10. The following technical data for each bus duct specified in this Section for approval of the SEPTA Project Manager. The characteristics of the bus duct shall be fully explained by providing the following information:
    a. Bus bar material.
    b. Bus bar coating (plating).
    c. Insulation material.
    d. Insulation thickness in mils.
    e. Maximum Copper Temperature:
        1) Continuous in °C.
        2) Emergency in °C.
        3) Short circuit in °C.
    f. Electrical Requirements (Insulation):
        1) AC voltage test in kV/min.
        2) DC voltage test in kV/min.
        3) Insulation resistance (minimum) in megaohms.
    g. Ampacities:
        1) Conductor temperature 90°C.
    h. Electrical Characteristics (Indicate Conditions):
        1) Resistance in ohms/1000 feet.
        2) Reactance (inductive) in ohms/1000 feet.
        3) Impedance in ohms/1000 feet.
    i. Bus duct weight in pounds/1000 feet.

1.04 Quality Assurance

A. All electrical equipment furnished under this Contract shall be in accordance with the latest applicable standards of NEMA, IEEE, ANSI, AAR, ICEA, OSHA and UL with regard to material, design, construction and testing, except for variations as specified in this Section.

B. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
2. IEEE C37.23, IEEE Standard for Metal-Enclosed Bus.

1.05 Delivery, Storage and Handling

A. Ship bus duct covered to protect the bus duct assembly from injury during shipment. Seal, secure and protect bus bar ends from injury. Make both bus duct ends available for testing, unless size or construction precludes that possibility.

B. Store bus duct to protect them from injury.

1.06 Definitions

A. Anode is the AC input to the rectifier.

B. Cathode is the DC positive and negative outputs of the rectifier.

PART 2 - PRODUCTS

2.01 Description

A. General:

1. AC anode bus duct and DC positive and negative cathode bus ducts shall be furnished for interconnection of the rectifier transformer, rectifier, the DC switchgear and the negative and drainage switchboard. The Contract Drawings indicate the desired arrangement of AC and DC bus ducts. The Contractor shall bring to the SEPTA Project Manager's attention and approval any deviations the Contractor proposes to make from the arrangement shown.

2. The following types of bus ducts shall be furnished:

a. 1000 V AC non-segregated phase anode bus duct assembly for connecting the rectifier transformer to the rectifier. Bus duct shall be complete with AC heaters for the outdoor sections of the equipment.

b. 1000 V DC positive cathode bus duct assembly for connecting the rectifier positive terminal to the DC switchgear.

c. 1000 V DC negative cathode bus duct assembly for connecting the rectifier negative terminal to the negative and drainage switchboard.

B. Assembly Requirements:

1. Metal Enclosure:

a. Each bus duct assembly shall be metal enclosed, ventilated, non-segregated phase type, conforming to IEEE C37.23, except that an approved low impedance type bus duct may be applied as the AC anode bus, providing such requirement is dictated by the design of the transformer and rectifier package. The enclosure shall be fabricated from steel or aluminum as specified. Removable covers shall be provided to allow access to bolted bus duct connections and insulators for cleaning and inspection. Removable covers shall be secured with bolts to the frame.

b. Metal enclosures shall be finished to match finish of traction power equipment to which it is connecting. Two (2) quarts of matching touch-up paint shall be shipped with the bus duct assemblies.

2. Copper Bus Bars:

a. Bus bars shall be of high conductivity rectangular copper with round edges finished to required size by cold rolling or drawing. Bus bars shall have uniform shape and dimensions, free from defects in material and workmanship. All bus bars shall be individually insulated, properly supported and braced to each other and to the enclosure with approved, high quality, high strength, and non-tracking insulators to withstand short circuit stresses to be encountered in use. 1000 V AC anode, 1000 V DC cathode positive and negative bus bars shall be individually insulated. All bus taps and connections shall be tightly bolted. Contact surfaces of bolted joints shall be factory silver plated. The Contractor may propose the use of non-insulated DC bus bars for approval by the SEPTA Project Manager.

b. Bus bars shall be rated for the current and voltages specified. They shall be amply designed for continuous operation under the specified load conditions.

c. The temperature rise of bus bars at the hottest spot for the specified duty shall not exceed 65°C over an ambient of 40°C, thus limiting the maximum operating temperature of bus bar to 105°C.

3. Lengths and Fittings:

a. Bus duct assemblies shall be supplied complete with connection flanges, taps, elbows, insulated housing sections, offsets, splicing plates, terminal connectors and associated accessories. Bus duct assemblies shall be furnished in accordance with the arrangement, dimensions and details depicted on the final SEPTA Project Manager approved shop drawings.

b. The shipping sections shall be pre-assembled in the factory so that minimum installation is required at site. It is the responsibility of the Contractor to furnish the equipment as specified here and shown on the Contract Drawings so that they can be installed as a complete, integrated system without any modifications or requiring additional materials and labor at the site, except to carry out the manufacturer's installation instructions.

4. Hardware and Supports:

a. All hardware required to make the field connections between sections and terminations to the equipment shall be furnished in sufficient quantity.

b. Supports required for bus ducts between equipment enclosures shall be hanger type. Location of supports, arrangements of each support, anchoring details, and the support components shall be shown on the Contractor’s equipment arrangement drawings and are subject to approval by the SEPTA Project Manager. Supports for the 1000 V DC positive and negative cathode bus ducts shall be provided with approved insulators to insulate the bus enclosure from the Traction Power Substation (TPSS) building structure for a minimum of 1000 V DC.

c. The Contractor shall provide calculations to demonstrate that the proposed hangers will support the weight of the equipment and also withstand the additional mechanical and thermal forces experienced during a short circuit condition.

5. Expansion Joints:

a. Expansion joints shall be provided by the Contractor wherever required for proper operation of the equipment.

6. Induced Heating:

a. Bus ducts are intended for operation at high values of current. The design of bus ducts shall be such as to minimize the induced magnetic heating and induced circulating currents in the metallic enclosure of the bus duct, adjacent enclosures and supporting structures.

7. Insulated Sections:

a. Insulated sections of bus duct housing, where shown on the Contract Drawings, shall be designed for phase-to-ground potential existing in these sections. The material and detailed design of insulated sections are subject to approval of the SEPTA Project Manager.

C. 1000 V AC Anode Bus Duct Assemblies:

1. The 1000 V AC anode bus duct assemblies shall meet all the applicable requirements of Article 2.01/A in this Section, conform to IEEE C37.23 and meet the following additional requirements:

a. Rated maximum voltage to be 1000 V AC.
b. Rated nominal voltage to be 700 V AC.
c. Rated insulation level power frequency withstand to be 2.2 kV for one (1) minute, dry.

2. Bus duct copper bus bars shall be rated to carry continuously the current of the rectifier transformer and rectifier operated at 160 percent of rated full load. The temperature of the bus bars shall not exceed maximum limit of 105°C over a 40°C ambient under these loading conditions. The bus duct assembly shall be compatible in design and construction with the provisions made at the rectifier transformer and rectifier and shall operate as an integral unit when assembled.

3. Enclosure of bus duct assemblies shall be ventilated, made of high strength, corrosion-resistant aluminum. 1000 V AC anode bus duct with steel enclosure may be acceptable if the Contractor can prove to the satisfaction of the SEPTA Project Manager that the induced magnetic heating will not increase the temperature of the enclosure above safe limits during the two (2) hour overload cycle for the rectifier.

4. A single bus duct assembly containing the bus bars from both secondary windings of rectifier transformer shall be provided as shown on the Contract Drawings. The Contractor may furnish two (2) separate 1000 V AC anode bus ducts, one (1) from each secondary winding of the rectifier transformer, only upon the approval of the SEPTA Project Manager.

5. If needed or directed by the SEPTA Project Manager, each 1000 V AC anode bus duct assembly shall be provided with bus taps, rated not less than one-third (1/3) of the continuous current rating of the main bus to enable connection of future bus ducts for harmonic suppression filters with minimum of labor and without involving drilling of main bus bars.

6. Grounded bus duct enclosure(s) shall be insulated from the high-resistance grounded rectifier enclosure by installation of boxed glastic or approved fiberglass sections in the vertical portion at the rectifier, providing a minimum of 6 inches clearance between the metal enclosure of the bus duct and nearest metal on the rectifier. An acceptable alternate arrangement is an insulated section in horizontal bus run near the rectifier, providing a minimum 2 feet of clearance between the metal bus enclosure and the nearest metal connected to the rectifier enclosure.

7. Suitable support of bus duct enclosures shall be provided as may be required to ensure a rigid structure and workmanlike installation of the system.

8. The bus duct bus bars, because of the inherent characteristics of the circuit, remain at a DC potential relative to the bus enclosure while energized. Construction of the bus duct and the materials used shall be proper for this type of service.

9. At both rectifier transformer and rectifier, flexible bus conductor terminations shall be provided. The termination details shall be fully coordinated with the rectifier transformer and rectifier. These connections shall be provided with an easily removable insulating boot.

10. Space heaters rated 240 V AC, operating at 120 V AC, shall be provided in all outdoor 1000 V AC anode bus duct sections to prevent condensation. The space heaters shall be completely factory wired with no exposed wiring inside the bus housing. Heaters shall be thermostatically controlled. The entire circuit shall be wired to an accessible

terminal block providing for a single connection to the 120 V AC power source. Space heaters shall be accessible from the outside of the bus duct. A drip shield will be provided over the space heater opening to prevent entry of water into the enclosure. The space heater power supply shall be provided from the rectifier transformer control compartment.

11. A fire resistant divider or barrier shall be provided at all points where the bus duct extends through the building wall. The barrier shall have a minimum rating of (3) three hours. The Contractor shall propose suitable material for this purpose.

D. DC Positive and Negative Cathode Bus Assemblies:

1. DC positive and negative cathode bus assemblies shall meet all the applicable requirements, conform to IEEE C37.23, and shall meet the following additional requirements. Current ratings shown are applicable for use with 3000 kW rectifiers:
   a. Rated maximum voltage to be 1000 V DC.
   b. Rated nominal voltage to be 700 V DC.
   c. Rated continuous current to be 8000 A.
2. DC positive and negative cathode bus assemblies shall be rated to carry continuously the current of their associated rectifier operating at 160 percent of full load. The temperature of the bus bars shall not exceed a maximum limit of 105°C over a 40°C ambient under these loading conditions. The bus duct assembly shall be compatible in design and construction with the rectifier and DC switchgear and shall operate as an integral unit when assembled.
3. Enclosure of bus duct assemblies shall be ventilated and made of high strength, corrosion-resistant aluminum.
4. DC positive and negative cathode bus enclosures and supports shall be insulated from the TPSS building structure for 1000 V DC. In addition, the bus enclosures shall be insulated from the high-resistance grounded rectifier enclosure and the high-resistance grounded DC switchgear enclosures by installation of boxed glastic or fiberglass sections in the vertical portions at the rectifier and DC switchgear. This insulation shall provide a minimum of 6 inches clearance between the metal enclosure of bus duct and nearest metal on rectifier or DC switchgear. An acceptable alternate arrangement is an insulated section in horizontal bus duct run near the rectifier and DC switchgear, providing a minimum 2 feet of clearance between the metal bus enclosure and the nearest metal connected to the rectifier enclosure or DC switchgear enclosure. A suitably sized jumper across the insulating collar at the DC switchgear shall be provided.
5. Suitable support of bus duct enclosures shall be provided as required to ensure a rigid structure and workmanlike installation of the system.
6. If needed or directed by the SEPTA Project Manager, to enable connection of future harmonic suppression filters, the DC positive and negative cathode bus assembly shall be provided with bus taps, rated not less than one-third (1/3) of the continuous current rating of the main bus. The exact location where the tap will be provided in the bus shall be furnished by the Contractor for approval of the SEPTA Project Manager. Taps provided shall enable connection of future bus ducts with minimum of labor and without involving drilling of main bus bars.

7. Flexible terminations shall be provided at each end of DC positive and negative cathode bus ducts for connecting the bus duct bus bars to equipment. DC positive and negative cathode bus duct termination details shall be fully coordinated with the rectifier, the DC switchgear and the negative and drainage switchboard board. All flexible connections shall be provided with an easily removable insulating boot.

PART 3 - EXECUTION

3.01 General

A. The Contractor shall install all equipment specified in this Section in accordance with requirements of this Section, Section 01010, and the Contract Drawings, with SEPTA Project Manager approved changes only, if any. The completed installation shall provide a fully coordinated and fully operational traction power system.

B. The Contractor shall take every precaution in handling, setting, aligning and assembling the equipment to avoid distortion of frames. The Contractor shall become thoroughly familiar with the manufacturers' instructions before attempting to handle, install and operate the equipment. The Contractor shall ensure that all personnel working with the equipment fully understand the operation of the various components to avoid mis-operation, damage to equipment and possible personnel injury.

C. All equipment assembly connections to mechanically assemble the units shall be made by the Contractor, including all bolted connections between shipping units, between equipment and bus duct enclosures and anchoring the equipment to the floor.

D. All electrical connections between shipping units, including all bolted bus connections and connections of control and auxiliary circuits, shall be made by the Contractor.

E. All structural steel members used for support of electrical equipment and materials to be furnished shall be hot-dip galvanized in accordance with ASTM A 153.

F. The complete installation shall be tested and checked out in accordance with this Section and Section 16953.

G. The Contractor shall be responsible for all equipment during transportation, delivery and installation. All equipment shall be suitably packaged at all times meeting the requirements of the equipment manufacturers. Equipment packaged for transport and storage shall be protected from damage due to environmental conditions and properly secured. 'Shockwatch' labels shall be applied to all main equipment during transport. Where necessary equipment shall be heated or stored in a controlled environment during storage. Any signs of equipment deterioration or damage during shipping or storage shall be rectified to the satisfaction of and at no expense to SEPTA.

3.02 Installation

A. 1000 V AC Anode Bus Duct and 1000 V DC Positive and Negative Cathode Bus Ducts:

1. The bus ducts interconnecting the rectifier transformer, rectifier, DC switchgear, negative and drainage switchboard shall be fully assembled and completely installed in accordance with the SEPTA Project Manager's approved manufacturer's plan and detail drawings as shown on the Contract Drawings.

2. Bus ducts shall be provided with suitable mounting hangers supported from the ceiling slab or structural members, or as directed by the SEPTA Project Manager. The Contractor shall furnish and install all strut assemblies, brackets, rods, clamps, suspension fittings and miscellaneous steel to provide a complete, firm and rigid support system for the bus ducts under all operating conditions and during short circuits. Supports shall be designed and installed in a manner to minimize induced circulating currents and induced magnetic heating.
3. All ferrous elements of the support system shall be hot dipped galvanized in accordance with ASTM A 153/ A 153M. Hangers supporting ungrounded portions of cathode buses shall be provided with approved insulators to insulate the bus enclosures from the building structure.
4. Bus ducts shall be assembled in such manner as to ensure proper alignment between the shipping sections and the associated equipment. After alignment and leveling, the bus duct enclosure shall be bolted to the equipment and then the bus duct enclosure splice plates shall be attached and securely fastened.
5. Insulated bus duct enclosure sections shall be installed as shown in the Contract Drawings.
6. Before electrical connections are made, all contact surfaces shall be wiped clean (sandpaper or abrasive tools shall not be used) and covered with a coat of approved electrical antioxidant compound. Joints in bus bar shall be made using splice plates on each side of each bus bar. Connections to equipment terminals shall be made with flexible connectors. All joints shall be made with a minimum of four (4) 1/2 inch silicon bronze bolts and nuts. All nuts shall be provided with approved locking devices. All bolts shall be tightened to the torque of 40 foot-pounds, or as directed by the SEPTA Project Manager, using an accurate torque wrench.
7. After completion, all joints shall be covered by die-molded, flame retardant zero halogen (non-polyvinyl chloride) boots; Or Approved Equal; providing full voltage insulation for the joint. These boots shall be easily removable and reusable for inspection of the joint without destruction of the boot.

END OF SECTION

SECTION 16138

DUCTWORK AND ELECTRICAL MANHOLES AND HANDHOLES

PART 1 - GENERAL

1.01 Description

A. This Section specifies furnishing and installing new buried conduits, handholes and manholes for electrical and communication cables.

B. The Contractor is also required to identify and remove abandoned cables from active and abandoned duct banks after they have been confirmed, de-energized and cut by SEPTA forces.

C. Investigate in detail, entering confined spaces as part of the process, the manholes and handholes nearest to each Traction Power Substation (TPSS). After the detailed investigation, continue work at those manholes and handholes for purposes of splicing new cables from the TPSS to existing SEPTA cables in the power and communications networks, and to remove each abandoned cable back to the respective TPSS, after capping the ends of abandoned cables that continue into the SEPTA cable network.

1.02 Related Sections

A. Section 01720 – Project As-Built Documents

B. Section 02081 – Asbestos Abatement

C. Section 02220 – Excavation, Backfill and Compaction

D. Section 02724 – Manholes

E. Section 16075 – Electrical Identification

F. Section 16130 – Raceways and Boxes

1.03 Submittals

A. Submit data sheets for each specified product.

B. Submit mix design for each specified concrete mix.

C. Submit shop drawings:

1. Manholes:
    a. Drawings for each cast-in-place manhole with details of reinforcing, covers, frames and other appurtenances.
    b. Drawings for each size configuration of precast manhole and pullbox with details of joints, covers, frames and other appurtenances.
    c. Diagrams showing dimensioned locations for openings and knockout panels for duct penetrations of manhole walls.
    d. Diagrams from investigation and as-built reporting of the contents of each manhole and pullbox, using a form similar to the sample figure at the end of this Section.
2. Underground duct accessories and joints.

3. Duct, raceway, manhole, handhole identifier label list.

D. Submit working drawings:

1. Location plan, arrangement and profile of manholes.
2. Location plan, arrangement, profile of duct bank, number, size and type of ducts.
3. Plan of existing utilities and the proposed locations of manholes and ducts.
4. Field conditions discrepancies (if any) reports, noting conditions which impact construction.

E. Submit loading design calculations for handholes and manholes, to demonstrate compliance with required load bearing capacity, as certified by a Professional Engineer licensed in the Commonwealth of Pennsylvania.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. AASHTO M199, Standard Specification for Precast Reinforced Concrete Manhole Sections.
2. AASHTO H20, Wheel Loading.
3. ACI 304, Measuring, Mixing, Transporting, and Placing Concrete.
4. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
5. ASTM A 48/A 48M, Standard Specification for Gray Iron Castings.
6. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
7. ASTM A 536, Standard Specification for Ductile Iron Castings.
8. ASTM A 615/A 615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
9. ASTM A 1064/A 1064M, Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
10. ASTM C 33/C 33M, Standard Specification for Concrete Aggregates.
11. ASTM C 150/C 150M, Standard Specification for Portland Cement.
12. ASTM C 260/C 260M, Standard Specification for Air-Entraining Admixtures for Concrete.
13. ASTM C 478, Standard Specification for Circular Precast Reinforced Concrete Manhole Sections.
14. ASTM C 494/C 494M, Standard Specification for Chemical Admixtures for Concrete.
15. ASTM C 579, Standard Test Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
16. ASTM C 857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.

17. ASTM C 858, Standard Specification for Underground Precast Concrete Utility Structures.
18. ASTM D 348, Standard Test Methods for Rigid Tubes Used for Electrical Insulation.
19. ASTM D 2000, Standard Classification System for Rubber Products in Automotive Applications.
20. ASTM D 2105, Standard Test Method for Longitudinal Tensile Properties of "Fiberglass" (Glass-Fiber Reinforced Thermosetting-Resin) Pipe and Tube.
21. FS FF-S-325, Shield, Expansion; Nail, Expansion; and Nail, Drive Screw (Devices, Anchoring, Masonry).
22. FS WW-C-581, Conduit, Metal, Rigid, and Intermediate; and Coupling, Elbow, and Nipple, Electrical Conduit; Steel, Zinc Coated.
23. IEEE C2, National Electric Safety Code (NESC).
24. MIL-C-82052, Coating Compound, Waterproofing, Mineral-Filled, Solvent-Type, Asphalt-Base.
25. NFPA 70, National Electrical Code (NEC).
26. Occupational Safety and Health Administration (OSHA).
27. UL 514B, Conduit, Tubing and Cable Fittings.
28. UL 651A, Type EB and a Rigid PVC Conduit and HDPE Conduit.

B. Inspection of the material/equipment will be made at the point of delivery. However, SEPTA's Project Manager reserves the right to make any tests or inspection that he may deem necessary at the Contractor's plant.

1. In the event inspection is made at the plant, grant SEPTA's Project Manager and/or Representative free entry at all times while work under this Specification is being performed, to all parts of the plant that concern the manufacture of the pertinent material/equipment. Make available all facilities to satisfy SEPTA's Project Manager that the material/equipment is being furnished in accordance with this Section.
2. If the Contractor is not the manufacturer of the material/equipment, it shall impose these conditions in its Contract with the manufacturer. In all cases, notify SEPTA's Project Manager when the finished material/equipment is ready for shipment in order that plant inspection of the material/equipment may be made if desired.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Duct Bank:

1. Electrical duct and fittings to meet the requirements of Section 16130.
2. Traction power medium voltage cables and communication and signaling duct banks require non-metallic duct.
3. Provide spacers as recommended by the conduit manufacturer.

4. Pull line to be 5/8 inch nylon or polyester type braided tape with markings at 1 foot intervals, NEPTCO Muletape WP2500P; Or Approved Equal.
5. PVC duct or raceway is not permitted in SEPTA City Transit Division substations for any new work. Refer to Section 16130 for zero halogen low smoke properties for nonmetallic ducts and raceways.

B. Manholes, Handholes and Pull Boxes:

1. Provide chimneys, frames and covers, cable pulling irons, cable racks, cable rack supports, ground rods, ground cable, and sump for each new or modified manhole.
2. Design manholes and handholes for AASHTO requirements for H20 loading on top and design for E-80 soil surcharge loading on the sidewalls. Meet the type and shape and inside dimensions indicated on the Contract Drawings.
3. Manholes and handholes constructed of precast concrete.
   a. Precast concrete to meet ASTM C 478.
      1) Manholes to include lifting rings, ladder, lids, pulling eyes, sump, and seal or sealant for sealing joints between sections; include precast extensions where required.
      2) Handholes to be the same format as for manholes except no ladder is required.
4. Pull Boxes Constructed of Polymer Concrete:
   a. Polymer concrete to meet ASTM C 579.
   b. Lid strength to meet ASTM C 857.
   c. Loading to be select based upon exposure to vehicular traffic. Heavy duty industrial type is minimum acceptable loading.
   d. Manufacturers:
      1) Carson Industries.
      2) Synertech Molded Products.
      3) Or Approved Equal.
   e. Lid to have “SEPTA” cast or embedded in center.
   f. Bolt-on lids having stainless steel fasteners.
5. Provide hole in floor for ground rod.
6. Cable pulling irons to be fabricated of plain steel reinforcement bar, ASTM A 615/A 615M, Grade 400 (60). Hot dip galvanized after fabrication, ASTM A 123/A 123M, and nylon encapsulated.
7. Provide cable support assemblies consisting of the following:
   a. Concrete inserts of size, number and spacing as required to accommodate cable racks.
   b. Cable racks to be non-metallic polyester or nylon stanchions, arms or saddles as manufactured by the following:
      1) Unistrut.
      2) Or Approved Equal.
   c. Cable rack fasteners to be stainless steel.
   d. Cable rack ties to be electrical grade black nylon cable ties, 1/4 inch minimum width.
8. Frames and Covers:
   a. Round frames and covers to be cast iron, ASTM A 48/A 48M, Class 35; with SEPTA logo.

9. Provide 12 inch diameter drains with strainer tops set flush with the floor. Alternatively, provide a pervious concrete floor system. Provide stone fill beneath new manholes to allow for proper drainage. Refer to Section 02724 for additional information on manholes.

C. Precast Concrete Manholes and Handholes:

1. Cable Racks:
   a. Provide UL listed, channel shaped racks and accessories including arms, saddle racks and slings to meet cable requirements.
   b. Provide wall brackets and support brackets fabricated from, non-metallic, electrical insulating, fiberglass reinforced epoxy structural resin.
   c. Support brackets shall be of a removable type.
   d. Provide only stainless steel expansion anchors meeting Federal Specification FF-S-325 Group II, Type 4 and Class 1. Provide galvanized threaded bolts.

D. Expansion Couplings:

1. Rigid type, have minimum 4 inch travel distance with either gasket or O-ring meeting ASTM D 2000, Grade 2, Type FE.

E. Tags:

1. Refer to Section 16075 for requirements.

F. Underground Warning Tape:

1. Tape shall be printed polyethylene material, 4 mils minimum thickness with minimum 1 inch high lettering, over coated graphics to read, "CAUTION-BURIED ELECTRIC LINE" for electric lines, colored red.

PART 3 - EXECUTION

3.01 Preparation

A. Transmit submittals and deliverables required by this Section.

B. Furnish products as indicated. Note that exposed risers are to be glass fiber Reinforced Thermosetting-Resin (RTRC) that are impact rated (vandal resistant) grade conduit. Refer to Section 16130.

C. Ensure substrates are in suitable condition to receive the work of this Section.

D. Coordinate to provide the following:

1. Ducts shall be flush with the vault walls using bell end fittings as required by the Contract Drawings.

2. All duct openings shall be provided with watertight cable seals of the proper size and configuration for the cables.

3. All unused duct openings shall be provided with blank reusable watertight seals.

4. Substrate Preparation for Manhole Installation:
   a. When excavation for manholes and duct banks has reached the required depth, the bottoms shall be graded smooth. Where rock, soft spots, or sharp-edged materials are encountered,

the bottom shall be excavated an additional 3 inches, then filled and tamped level to the proper grade with bedding material. Excavate trenches and determine elevations and directions of pitch of underground ducts to provide the cover or invert as shown on the Contract Drawings.

b. Tamp the bottom of trenches firm and even. Do not allow the cover for underground duct banks to be less than 36 inches below the top of the rail tie when run under the track and not less than 36 inches below the final grade when not under the track.

E. Provide excavation, dewatering, treatment of water as required, temporary shoring, backfill, manholes, forms, miscellaneous steel, reinforced concrete and compaction associated with the duct banks.

F. Provide ducts, fittings and spacers, including setting in place. Coordinate the layouts and associated materials of the duct bank.

G. Thoroughly review the Contract Drawings and Specifications in preparation for installation of the materials and equipment. Procure, store and plan for use all materials in a manner, which minimizes waste and substitutions, and maximizes installation efficiency and quality of the end product.

H. Examine all Contract and Reference Drawings and examine sites, to verify and properly coordinate the work. Check all relevant drawings including civil, mechanical, structural, architectural, electrical and shop drawings.

3.02 Installation of Ducts

A. Verify locations, distance levels and other conditions in the field prior to the commencement of installation of work. Significant deviations shall be brought to the attention of SEPTA upon discovery.

B. Duct Installation:

1. Encase the ducts in steel reinforced concrete in the configuration that is shown on the Contract Drawings.

2. Lay the duct in the trench in the designed formation using SEPTA approved duct spacers. Place duct spacers every 60 inches and staggered. Connect duct spacers. In rock excavations, assemble the duct bank on a protective course of a minimum of 3 inches of clean sand. Stagger joints 6 inches minimum, both in vertical and horizontal runs. No two (2) joints shall be within 6 inches of each other in any plane. Lay straight ducts as straight in alignment as possible with a minimum permissible offset of 3 inches in a 50 foot length. Install all bends so that they are tangent at the point of joining.

3. When changes in the formation of a bank of ducts within a duct run are necessary, install the transition in as straight an alignment as possible.

4. Repairs to ducts are prohibited. Remove and replace all individual broken, cracked, chipped or impaired lengths of duct with new ducts.

5. After the duct is in place with the proper spacing and joints made up tight, firmly anchor the run in position. Make flush the end of the duct bell with the inner surface of the manhole, TPSS cable vault, where applicable.

6. Where necessary, support the sides of the trench excavations for ducts by suitable sheeting or shoring. Where the duct is close to the main or running track, brace the

sides of trench excavation, except in rock or shale, to prevent slipping or settlement of the roadbed. No bracing within 10 feet of the nearest rail shall extend above the top of rail or be attached in any way to the rails or ties.

7. Remove all obstructions, such as rocks, concrete and pipes (which extend into the trench and which would prevent the proper formation of the duct and manholes) unless such projections are part of a permanent structure. If they are part of a permanent structure, notify SEPTA's Project Manager for further instructions.
8. Arrange the work in the vicinity of the tracks so that any excavation, laying of the ducts and backfilling will proceed in one (1) continuous operation to the maximum extent possible. The intent is to keep the trench open for the least possible time and only to such an extent as is considered necessary for the economical and practical construction of the work. Do not leave open trenches unattended or unprotected. Trenches must be closed up at the end of each workday or suitably covered and roped off with appropriate warning flags or markers.
9. Pass a flexible duct rodding device through the completed duct run to check for continuity and cleanliness. Following the duct rodding, draw a test mandrel, with an outside diameter 1/4 inch smaller than the inside diameter of the duct, through to test bore and alignment. If difficulty is encountered in passage of the duct rodding device, draw a series of wire brushes through the duct, once in each direction using a trailing line. Use wire brushes 1/8 inch smaller than the diameter of the duct. If the correct size cannot be passed through on the initial attempt, the operation must be repeated until accomplished as specified.
10. When the duct is partially or fully obstructed with mud, dirt or gravel, all attempts must be made to clear the obstruction.
11. After the ducts have been wire brush cleaned, pull nylon cord in and leave in each duct, including all spare ducts. Leave at least 24 inches of nylon cord extended beyond each duct end.
12. Broken, cracked, chipped or impaired lengths of conduit will not be acceptable.

C. Constructing Concrete Encased Non-Metallic Duct Bank:

1. Use heavy-wall conduit under tracks and standard wall conduit elsewhere.
2. The concrete encasement surrounding the duct bank shall provide at least 3 inches of cover on all sides of the duct bank and no less than 2 inches minimum cover over steel reinforcement.
3. Lay conduits using spacers to provide tier spacing shown on the Contract Drawings. Locate spacers at a maximum center spacing of 4 feet.
4. Construct duct lines to slope downward towards manholes with a pitch of not less than 3 inches in 100 feet. Except at conduit risers, changes in direction of runs exceeding a total of 10 degrees, either vertical or horizontal, shall be accomplished be long sweep bends having a minimum radius of curvature of 25 feet unless otherwise indicated; sweep bend may be made up of one (1) or more curved or straight sections or combinations. Manufactured bends shall have a minimum radius of 24 inches or the minimum cable manufacturer bending radius, whichever is greater.

5. Conduits shall terminate in end bells where duct lines enter underground structures. Stagger joints of the conduits by rows and layers to provide a duct line having maximum strength. During construction, protect partially completed duct lines from debris such as mud, sand and dirt by inserting plugs in the open ends of the conduits.
6. Properly place concrete around conduits to assure complete encasement without voids. Finish off with a mechanical vibrator. Where concrete encased duct lines connect to underground structures, construct a flared section adjacent to the manhole to provide shear strength. Construct the underground structure to provide for keying the concrete envelope of the duct line into the wall of the structure.
7. Wherever a construction joint is necessary in a duct line, fit concrete envelope of a partially complete duct line with reinforcing steel extending a minimum of 2 feet back into the envelope and a minimum of 2 feet beyond the end of the envelope. Provide one (1) number 4 bar in each corner, 3 inches from the edge of the envelope. Secure corner bars with two (2) number 3 bars, spaced approximately 1 foot apart, all around.
8. Prior to backfilling, temporarily close ends of conduits with plugs.
9. In the presence of the SEPTA's Project Manager, prove conduit clear and clean by one (1) of the following methods:
    a. Rodding and pulling approved test mandrel from structure to structure.
    b. Blowing approved device from structure to structure with compressed air.
10. Install and leave approved pull tape in each conduit.

D. Existing Direct Buried Ducts:

1. Bring to the attention of SEPTA’s Project Manager, details about existing buried ducts or cables encountered during excavation. If such existing installations are determined to be abandoned, cut off, remove cables from abandoned ducts and remove the materials. Protect all remaining duct and cable so as not to interfere with construction.
2. At certain locations, existing ducts and cables are buried beneath tracks and along the right-of-way. Extreme care must be exercised when excavating. Repair any damaged ducts or cables, as a result of work performed during excavation.
3. In temporarily open trench areas, furnish and install reflective signs, flags or warning tape to warn of an open trench. Submit protection materials and method of installation to SEPTA’s Project Manager for review. Cover all open trenches in an approved manner upon completion of each day’s work.
4. Provide backfill material that is clean, free of large stones, cinders and ashes. Provide backfill free of stone greater than 1 inch that is to be placed within 12 inches of the duct.
5. Place all backfill material placed in layers not exceeding 12 inches in depth and compact by hand tamping backfill that is placed within 18 inches above the duct. Machine tamp the balance of the backfill material.
6. In rock areas, where the duct trench bottoms cannot be kept clear of stone, place a 3 inch minimum cushion of sand prior to duct installation.

3.03 Construction of Manholes and Handholes

A. Install precast underground structures as specified below.

B. Excavate in accordance with Section 02220.

C. Provide for location of duct entrances and windows to facilitate cable racking; build duct formation into walls of the structure and seal flush around opening.

D. Install frame and cover, adjusting to finished grade.

E. Place ground rod.

F. When installing sections of precast manholes, prevent damage to joint seals.

G. Coat exterior surfaces of structures with a cold applied, fibrous asphalt damp proofing meeting Military Specification MIL-C-82052; Or Approved Equal; applied to a minimum thickness of 3/32 inch.

3.04 New Duct into Existing Manholes

A. Inspect manhole to ensure that work will not damage existing cables/conduit.

B. After exposing manhole side wall, core bore wall to accommodate new duct.

C. Clean and roughen manhole wall surface around new entry to facilitate a good bond with new concrete duct bank. This seal shall be watertight.

D. Repair any damage to interior wall and fill in and seal flush around all new ducts.

E. Provide end bells on all conduit terminations at new manholes.

3.05 Demolition of Abandoned Cables, Conduit and Manholes

A. The Contractor shall remove abandoned cables as per the Contract Drawings.

1. Prior to any work, ascertain that all cables are dead by having SEPTA sever the cables.

2. Determine if demolition involves asbestos containing material. Refer to Section 02081.

B. The Contractor shall then remove the abandoned ducts in their entirety and the abandoned manholes. Refer to the Contract Drawings for the extents of the selective demolition.

C. After removal, the Contractor shall backfill and compact as per Section 02220.

3.06 Cleanup

A. Remove debris from conduits, manholes and handholes and ensure complete installation is left in neat and finished condition.

3.07 Clearing and Cleaning of Existing Duct Banks that Remain

A. Survey the impacted manholes and on-site duct bank system and remove all abandoned and dead cables from manhole to manhole or manhole to TPSS.

B. Provide (furnish and install) new cable supports after repairing walls so that all new cable added or spliced within the existing manholes or handholes is supported off the walls of the chamber.

C. Clear existing spare ducts after ascertaining if asbestos abatement is required per Section 02081.

D. After removal of any existing cables, pull or fish wires, mandrel each duct for its entirety then thoroughly clean with a pull brush.

E. Place new pull tape in each duct after clearing.

F. Plug duct ends with a reusable duct plug.

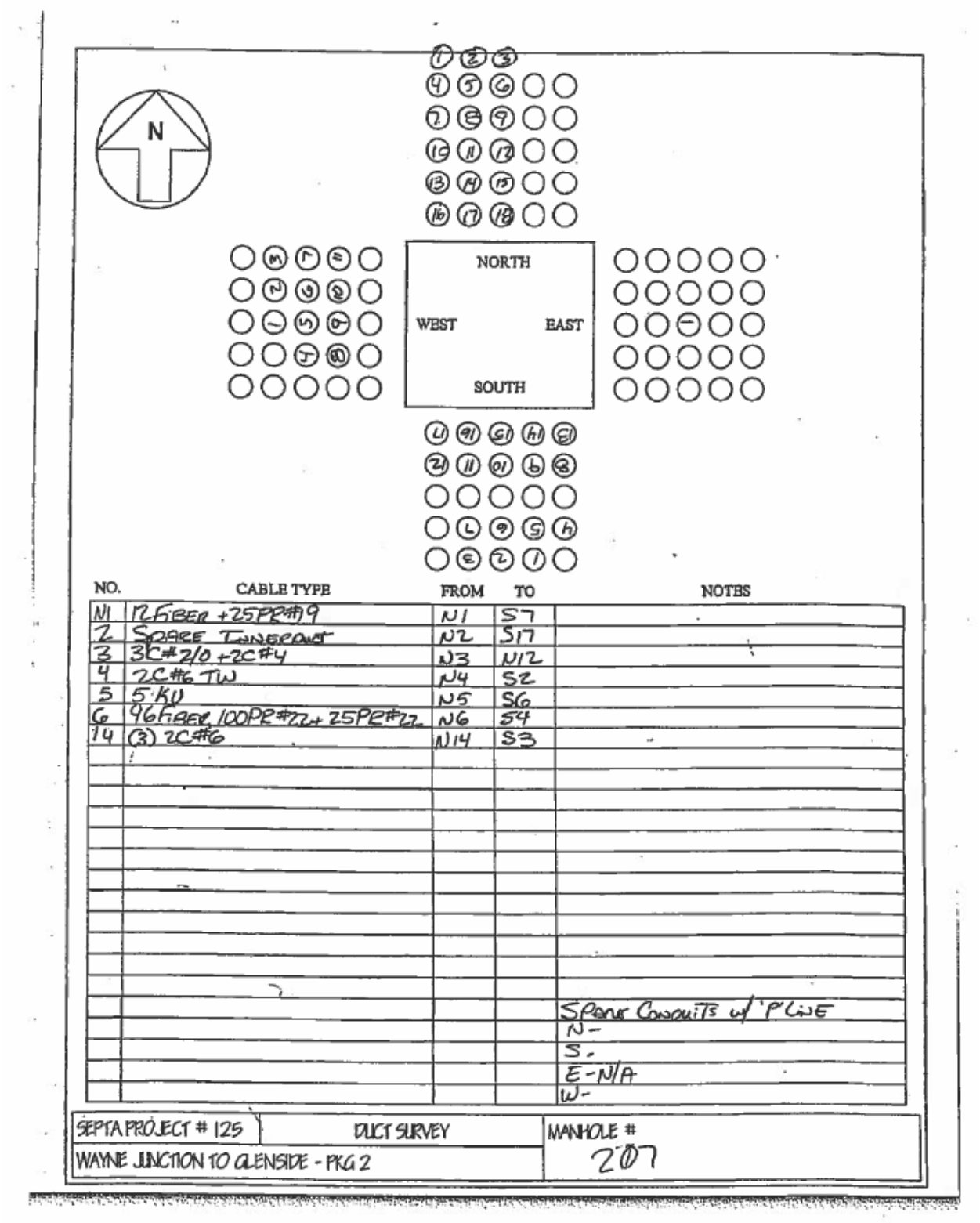
G. Where ducts cannot be cleared, the Contractor shall attempt to clear the ducts using a pneumatic type system. If the ducts still cannot be cleared, report all findings to SEPTA's Project Manager.

H. After cable removal and clearing of the ducts, the Contractor shall remove all rubbish and debris and broom clean surveyed manholes. Power washing will not be permitted.

I. Maintain a "job set" of inspection forms in accordance with Specification Section 01720.

END OF SECTION

ATTACHMENT – DUCT SURVEY



NO.	CABLE TYPE	FROM	TO	NOTES
N1	96 FIBER + 25PR #19	N1	S7	
2	SPARE TINNEPOWT	N2	S17	
3	3C #2/0 + 2C #4	N3	N12	
4	2C #6 TW	N4	S2	
5	5 KV	N5	S6	
6	96 FIBER, 100PR #22 + 25PR #22	N6	S4	
14	(3) 2C #6	N14	S3	
				SPARE CONDUITS W/ P LINE
				N-
				S-
				E- N/A
				W-

SEPTA PROJECT # 125	DUCT SURVEY	MANHOLE # 207
WAYNE JUNCTION TO GLENSIDE - PKG 2		

SECTION 16140

WIRING DEVICES

PART 1 - GENERAL

1.01 Description

A. The work of this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning, and protecting wiring devices and cover plates.

1.02 Related Sections

A. Section 01400 – Quality Requirements

B. Section 16060 – Grounding and Bonding

C. Section 16075 – Electrical Identification

D. Section 16123 – Building Wire and Cable

E. Section 16130 – Raceways and Boxes

F. Section 16950 – Testing

1.03 Submittals

A. Submit all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

B. Submit product data:

1. List of all products and accessories.

2. Catalog cuts of all products and accessories to be furnished and installed.

C. Submit device identification label list.

D. Submit product data, and installation and maintenance instructions for Contract closeout.

1.04 Quality Assurance

A. All quality control work shall meet Section 01400.

B. Provide products that are listed and labeled by Underwriters Laboratory, approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) unless products meeting the requirements of these testing laboratories are not readily available, or unless standards do not exist for the products. Provide products that are for the location installed and listed and labeled or approved for the voltages and currents applied for the applications the items are intended.

C. Perform all electrical work under the supervision of a licensed electrician.

D. Meet the applicable provisions of the most recent issues of the following references:

1. American Iron and Steel Institute (AISI).

2. NEMA WD 1, General Color Requirements for Wiring Devices.
3. NEMA WD 6, American National Standard for Wiring Devices - Dimensional Requirements.
4. NFPA 70, National Electrical Code (NEC).
5. UL 20, General-Use Snap Switches.
6. UL 231, Power Outlets.
7. UL 498, Attachment Plugs and Receptacles.
8. UL 943, Ground Fault Circuit-Interrupters.
9. UL 1681, Standard for Wiring Device Configurations.

PART 2 - PRODUCTS

2.01 Switches and Receptacles

A. Provide UL listed specification grade switches meeting NEMA WD 1 and WD 6; and UL listed specification grade receptacles meeting NEMA WD 1 and WD 6 for voltage and current indicated. Provide switches and receptacles with screw terminals. A mixture of manufacturers' products is not permitted.

B. Toggle handle snap switches to be 20 A, single pole, 3 way or 4 way as indicated, quiet design:

1. Control switches, Single Pole Double Throw (SPDT) with center OFF and maintained contacts or SPDT with center OFF and momentary contacts to be of the same basic type, construction and rating as specified above for toggle handle snap switches. See the Contract Drawings for additional information.

C. Standard Face Design Receptacles:

1. Industrial specification grade to be duplex, 125 V AC, 20 A, 2 pole, 3 wire, grounding.

D. Ground Fault Circuit Interrupter (GFCI) Receptacles:

1. Industrial specification grade to be duplex, 125 V AC, 20 A, 2 pole, 3 wire, grounding, UL 943, solid state circuitry.

E. Manufacturers:

1. Hubbell.
2. Pass & Seymour.
3. Or Approved Equal.

2.02 Wall Plates

A. Provide a wall plate for each switch, receptacle and special purpose outlet. Do not use sectional gang plates. Use multi-gang outlet plates for multi-gang boxes. Use wall plates of AISI 302 stainless steel (0.040 inches thick) with satin finish.

B. Use wall plates for pushbutton and buzzer outlets that have openings to suit the pushbuttons and buzzers. Use plates having the same finish mentioned above.

C. Provide wet location device covers for use at locations subject to wet or rain conditions. Provide receptacle covers marked “Suitable for Wet Locations While In Use” for the same.

D. Use 316 stainless steel type screws for the installation of wiring devices and wall plates.

E. Manufacturers:

1. Hubbell.
2. Pass & Seymour.
3. Appleton.
4. Crouse-Hind.
5. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Inspect area to check all surfaces for completeness, correct number, type and location of anchors, size and levelness. Check for spalled concrete, honeycombs and other concrete defects, correcting defects encountered.

B. Check pull and junction boxes for correct type, size and location.

1. Flush boxes should be plumb and level to 1/8 inches and flush or protrude no more than 1/16 inch from the finish surface.
2. Surface mounted boxes should be plumb and level to 1/16 inch.
3. Size of box shall meet the NEC.
4. Check wiring pigtails for sufficient length to re-terminate wiring twice and leave 6 inches of slack within the box.

C. Check ground wires for correct type, size and location.

D. Correct any and all defects.

E. Remove any over sprayed paint from interior of boxes and from wiring.

F. Clean interior of boxes of dirt and debris.

3.02 Installation

A. Install equipment under supervision of skilled electricians and in accordance with the manufacturer's printed installation instructions.

B. Where two (2) or more switches or receptacles are shown on the Contract Drawings at the same location, they shall be ganged and covered with one (1) coverplate.

C. Use stainless steel hardware in all locations.

D. Adjust final switch and devices to be plumb and level and wall plates of flush boxes to be set flush to wall.

E. Unless otherwise specifically instructed, locate mounting heights from finished floor to centerline of devices.

1. Lighting control switches to be 48 inches to centerline of switch above finished floor and on strike side of door, unless indicated otherwise on the Contract Drawings. Mount switches in tandem where not possible to mount side-by-side with a common device plate.
2. Duplex convenience outlets to be mounted 18 inches to centerline of outlet above finished floor, unless indicated otherwise on the Contract Drawings.

F. Ground all devices to meet Section 16060.

G. Make up all connections to devices to meet Section 16123.

H. Provide outlet boxes and supports to meet Section 16130.

I. Identify all devices to meet Section 16075.

J. Protection:

1. Mask all items during painting operations.
2. Protect items against damage during other work.

3.03 Field Quality Control

A. Inspect all boxes for proper operation and visual appearance and mounting height.

B. Test receptacles per Section 16950.

END OF SECTION

SECTION 16210

ELECTRIC UTILITY SERVICES

PART 1 - GENERAL

1.01 Description

A. This Section specifies the supply of electrical services from PECO UTILITY and describes the equipment and service installation requirements.

B. The following equipment assemblies are to be furnished and installed as indicated on the Contract Drawings to supply traction power and auxiliary power at 60 Hz.

1. Service entrance switchgear.
2. Utility metering.
3. Underground medium voltage cables from the PECO connection point.

1.02 Related Sections

A. Section 16060 – Grounding and Bonding

B. Section 16121 – Medium Voltage Cable

C. Section 16130 – Raceways and Boxes

D. Section 16138 – Ductwork and Electrical Manholes and Handholes

E. Section 16340 – Medium Voltage Switchgear Assemblies (60 Hz)

F. Section 16950 – Testing

1.03 Submittals

A. Submit plan, elevations and details of the routing of distribution circuits between PECO Point-Of-Connection (POC) and the service entrance equipment in the Traction Power Substation (TPSS).

B. Submit electrical inspection certification to demonstrate that the work meets the local code requirements and the requirements of PECO.

C. Submit arc flash hazard study and printed arc flash labels for affected equipment.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. NFPA 70, National Electrical Code (NEC).
2. NFPA 70E, Standard for Electrical Safety in the Workplace.

B. Provide the services of an electrical inspection agency (that is recognized by authority having jurisdiction) to review the submittals and inspect the finished equipment and construction of the 60 Hz electric services inside and outside the TPSS.

C. Comply with PECO service requirements and invite and notify SEPTA to witness each PECO field activity.

PART 2 - PRODUCTS

2.01 Service Meter Box

A. Refer to PECO requirements.

2.02 TPSS Incoming Service AC Switchgear

A. Provide service entrance rated AC switchgear per Specification Section 16340.

B. Ratings:

1. As specified elsewhere, per PECO requirements and as indicated on the Contract Drawings.

C. Test the existing ground grid, analyze the capability to limit ground potential rise to limit fault step and touch potentials, design and provide ground grid enhancements to meet calculated results of the ground grid analysis. Modifications of the ground grid to comply with Section 16060.

PART 3 - EXECUTION

3.01 Preparation

A. Test the equipment ground grid prior to installing the AC switchgear.

B. Coordinate the final concrete pad size and mounting bolt locations.

C. Coordinate PECO inspections and approvals prior to energizing the service.

D. The electrical utility construction will require advance preparation to provide SEPTA's Project Manager, for approval, a construction plan, a request for TPSS entries, a request for a Traction Power Substation Maintainer and planned outages to perform the work.

E. All field work shall be coordinated and performed in the presence of a Traction Power Substation Maintainer.

3.02 Installation

A. Lift AC switchgear into place using integral lifting eyes.

3.03 Testing

A. Perform factory and field tests in accordance with the requirements of Sections 16340 and 16950.

END OF SECTION

SECTION 16230

GENERATOR ASSEMBLIES

PART 1 - GENERAL

1.01 Description

A. Provide complete factory assembled generator set equipment with digital electronic controls.

B. Provide factory test, startup by a supplier authorized by the manufacturer, and on-site testing of the system.

C. The generator set manufacturer shall warranty all equipment provided under this Section, whether or not the product is manufactured by the generator set manufacturer, so that there is one (1) source for warranty and product service. Technicians specifically trained and certified by the manufacturer to support the product and employed by the generator set supplier shall service the generator sets.

1.02 Related Sections

A. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

B. Section 01810 – Commissioning of Systems

C. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

D. Section 16050 – Basic Electrical Materials and Methods

E. Section 16060 – Grounding and Bonding

1.03 Submittals

A. Submit manufacturer’s product literature and performance data, sufficient to verify compliance to Specification requirements.

B. Submit certification of Pennsylvania Department of Environmental Protection (DEP) regulations.

C. Submit manufacturer's certification of prototype testing.

D. Submit manufacturer's published warranty documents.

E. Submit shop drawings showing plan and elevation views with certified overall dimensions, as well as wiring and piping interconnection details.

F. Submit shop drawings of the generator exhaust piping including supports and insulation.

G. Submit interconnection wiring and piping diagrams showing all external connections required; with field wiring terminals marked in a consistent point-to-point manner.

H. Submit manufacturer's installation instructions including recommended spare parts list. Refer to Section 01752 for spare parts requirements.

I. The generator set for Broad Street Traction Power Substation (TPSS) has been planned to have a proposed capacity of 500 kW. The Contractor to submit the following electric load calculations:

1. Generator load design.
2. Load calculation while running all emergency loads.
3. Available power left on generator for future use.

J. Submit operations and maintenance manual. Refer to Section 01832.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI/NEMA MG 1, Motors and Generators.
2. IEEE 446, IEEE Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications.
3. ISO 8528-4, Reciprocating Internal Combustion Engine Driven Alternating Current Generating Sets – Part 4: Control gear and Switchgear.
4. ISO 9001, Quality Management Systems – Requirements.
5. NFPA 54, National Fuel Gas Code.
6. NFPA 70, National Electrical Code (NEC).
7. NFPA 110, Standard for Emergency and Standby Power Systems.
8. UL 499, Electric Heating Appliances.
9. UL 508, Industrial Control Equipment.
10. UL 2200, Stationary Engine Generator Assemblies.
11. Pennsylvania DEP Regulations.

B. The generator set manufacturer shall be certified to ISO 9001 international quality standard and shall have third party certification verifying quality assurance in design/development, production, installation and service, in accordance with ISO 9001.

1.05 Warranty

A. The generator set and associated equipment shall be warranted for a period of not less than five (5) years from the date of acceptance against defects in materials and workmanship. The warranty starts from the date of acceptance.

B. The warranty shall be comprehensive. No deductibles shall be allowed for travel time, service hours, repair parts cost, etc.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Provide a generator set from one (1) of the following manufacturers:

1. Cummins.
2. Generac.
3. Caterpillar.
4. Or Approved Equal.

2.02 Generator Set

A. Ratings:

1. The generator set shall have a nominal output voltage of 480 V AC.
2. The generator set shall be rated at as indicated on the Contract Drawings, based on site conditions of the following:
   a. Altitude of 300 feet.
   b. Ambient temperatures range of 0°F to 95°F.
   c. Fuel to be diesel fuel.
3. The generator engine shall meet the Pennsylvania DEP Regulations, including the emission limitations and fuel sulfur content.
4. The generator set rating shall be based on emergency/standby service.
5. The Generator shall be equipped with integrated load bank rated at 25% of full load capacity. The generator load bank shall be combined resistive/reactive or as recommended by manufacturer.

B. Performance:

1. Voltage regulation shall be plus or minus 0.5 percent for any constant load between no load and rated load for both parallel and non-parallel applications. Random voltage variation with any steady load from no load to full load shall not exceed plus or minus 0.5 percent.
2. The diesel engine generator set shall be capable of single step load pick up of 100 percent nameplate kW, less applicable de-rating factors, with the engine generator set at operating temperature.
3. Motor starting capability shall be as indicated on the Contract Drawings. The generator set shall be capable of sustaining a minimum of 90 percent of rated no load voltage with the specified kW load applied to the generator set.
4. The time required to automatically start, accelerate to rated speed and voltage, and synchronize the generator set to the system bus on a normal power failure shall not exceed ten (10) seconds under normal power failure conditions, assuming that the generator set is in an ambient temperature of 20°F or greater, and water jacket heaters are operating properly.

C. Construction:

1. The engine generator set shall be mounted on a heavy duty steel base to maintain alignment between components. The base shall incorporate a battery tray with hold down clamps within the rails
2. All switches, lamps and meters in the control system shall be oil tight and dust tight and the enclosure door shall be gasketed. There shall be no exposed points in the control (with the door open) that operate in excess of 50 V.

D. Connections:

1. The generator set load connections shall be composed of silver or tin plated copper bus bars, drilled to accept mechanical or compression terminations of the number and type as shown on the Contract Drawings. Sufficient lug space shall be provided for use with cables of the number and size as shown on the Contract Drawings.
2. Power connections to auxiliary devices shall be made at the devices, with required protection located at a wall mounted common distribution panel.
3. Generator set control interfaces to other system components shall be made on a common, permanently labeled terminal block assembly.

2.03 Engine and Engine Equipment

A. The engine shall be diesel fueled, radiator and fan cooled. The horsepower rating of the engine at its minimum tolerance level shall be sufficient to drive the generator and all connected accessories.

B. Complete engine fuel system, including all pressure regulators, strainers and control valves. The fuel system shall be plumbed to the generator set skid for ease of site connections to the generator set.

C. An electronic governor system shall provide automatic regulation. The governing system dynamic capabilities shall be controlled as a function of engine coolant temperature to provide fast, stable operation at varying engine operating temperature conditions. The control system shall actively control the fuel rate and excitation as appropriate to the state of the generator set. Fuel rate shall be regulated as a function of starting, accelerating to start-disconnect speed, accelerating to rated speed, and operating in various isochronous or parallel states.

D. Skid mounted radiator and cooling system rated for full load operation in 104˚F (40°F ambient) as measured at the generator air inlet, based on 0.5 in H_2O external static head. Radiator shall be sized based on a core temperature which is 20°F higher than the rated operation temperature, or prototype tested to verify cooling performance of the engine/radiator/fan operation in a controlled environment. Radiator shall be provided with a duct adapter flange. The equipment manufacturer shall fill the cooling system with a 50/50 ethylene glycol/water mixture. Rotating parts shall be guarded against accidental contact.

E. Electric starter(s) capable of three (3) complete cranking cycles without overheating.

F. Positive displacement, mechanical, full pressure, lubrication oil pump.

G. Full flow lubrication oil filters with replaceable spin-on canister elements and dipstick oil level indicator.

H. Replaceable dry element air cleaner with restriction indicator.

I. Flexible fuel lines.

J. Engine mounted battery charging alternator of suitable capacity and solid state voltage regulator.

K. Coolant heater:

1. Engine mounted, thermostatically controlled, coolant heater. Heater voltage shall be as shown on the Contract Drawings. The coolant heater shall be UL 499 listed and labeled.

2. The coolant heater shall be installed on the engine with silicone hose connections. Steel tubing shall be used for connections into the engine coolant system wherever the length of pipe run exceeds 12 inches. The coolant heater installation shall be specifically designed to provide proper venting of the system. The coolant heaters shall be installed using quick disconnect couplers to isolate the heater for replacement of the heater element. The quick disconnect/automatic sealing couplers shall allow the heater element to be replaced without draining the engine cooling system or significant coolant loss.

3. The coolant heater shall be provided with a 24 V DC thermostat, installed at the engine thermostat housing.

4. The coolant heater(s) shall be sized as recommended by the engine manufacturer to warm the engine to a minimum of 100°F in a 40°F ambient, in compliance with NFPA 110 requirements, or the temperature required for starting and load pickup requirements of this Section.

L. Provide vibration isolators, spring/pad type, quantity as recommended by the generator set manufacturer. Isolators shall include seismic restraints if required by site location. Refer to the Contract Drawings for site specific seismic/geotechnical requirements.

M. Starting and control batteries shall be sized as recommended by the engine manufacturer, complete with battery cables and connectors.

N. Provide a complete exhaust system including exhaust silencer for the engine of size and type as recommended by the generator set manufacturer and approved by the engine manufacturer. The mufflers shall be critical grade. Exhaust system shall be installed according to the engine manufacturer’s recommendations and applicable codes and standards. Engine exhaust design shall be submitted with generator package. Skin temperature of the assembly with aluminum jacket shall be approximately 140°F for personnel protection.

O. A UL listed certified voltage regulated battery charger shall be provided for the engine generator set. Input AC voltage and DC output voltage shall be as required. Chargers shall be equipped with float, taper and equalize charge settings. Operational monitors shall provide visual output for remote indication of:

1. Loss of AC power to be a red light.

2. Low battery voltage to be a red light.

3. High battery voltage to be a red light.

4. Power ON to be a green light (normally open relay contact).

2.04 DC Generator

A. The DC generator shall be; drip proof construction, single pre-lubricated sealed bearing, air cooled by a direct drive centrifugal blower fan, and directly connected to the engine with flexible drive disc. All insulation system components shall meet ANSI/NEMA MG 1 temperature limits for Class H insulation system. Actual temperature rise measured by resistance method at full load shall not exceed 125°C.

B. The generator shall be capable of delivering rated output (kW) at any voltage not more than 5 percent above or below rated voltage.

C. A Permanent Magnet Generator (PMG) shall be included to provide a reliable source of excitation power for optimum motor starting and short circuit performance. The PMG and controls shall be capable of sustaining and regulating current supplied to a fault at approximately 300 percent of rated current for not more than ten (10) seconds.

2.05 Generator Set Control

A. The generator set shall be provided with a microprocessor based control system that is designed to provide automatic starting, monitoring and control functions for the generator set. The control system shall also be designed to allow local monitoring and control of the generator set, and remote monitoring and control as described in this Section. The remote monitoring shall be performed at the SEPTA Power Department Control Center located at 1234 Market Street, Philadelphia, PA. The control shall be mounted on the generator set. The control shall be vibration isolated and prototype tested to verify the durability of all components in the system under the vibration conditions encountered. The generator set mounted control shall include the following features and functions:

1. The mode select switch shall initiate the following control modes. When in the Run or Manual position the generator set shall start and accelerate to rated speed and voltage as directed by the operator. In the OFF position the generator set shall immediately stop, bypassing all time delays. In the AUTO position the generator set shall be ready to accept a signal from a remote device to start and accelerate to rated speed and voltage.
2. Depressing the emergency stop switch shall cause the generator set to immediately shut down and be locked out from automatic restarting.
3. The reset switch shall be used to clear a fault and allow restarting the generator set after it has shut down for any fault condition.

B. The generator set shall be provided with a DC output metering set including the following features and functions:

1. Digital voltmeter, ammeter and kilowatt (KW) meter. Ammeter and KW meter scales shall be color coded in the following fashion:
   a. Readings from 0 percent to 90 percent of generator set standby rating to be green.
   b. Readings from 90 percent to 100 percent of standby rating to be amber.
   c. Readings in excess of 100 percent to be red.
2. Digital metering set, 0.5 percent accuracy, to indicate generator voltage and current, output current, output KW and KW hours.
3. Both analog and digital metering is required.

C. Generator Set Alarm and Status Display:

1. The generator set shall be provided with alarm and status indicating lamps to indicate non-automatic generator status, and existing warning and shutdown conditions. The lamps shall be high intensity LED type. The lamp condition shall be clearly apparent under bright room lighting conditions. The generator set control shall indicate the existence of the following alarm and shutdown conditions on an alphanumeric digital display panel and include a digital output for use in remote monitoring at the SEPTA Power Department Control Center for each of the following conditions:
    a. Low diesel fuel (alarm).
    b. Low coolant temperature (alarm).
    c. High coolant temperature (alarm).
    d. Engine temperature sender failure (alarm).
    e. Low coolant level (alarm).
    f. Fail to crank (alarm).
    g. Fail to start/over crank (alarm).
    h. Over speed (alarm).
    i. Low DC voltage (alarm).
    j. High DC voltage (alarm).
    k. Weak battery (alarm).
    l. Overcurrent (warning).
    m. Overcurrent (alarm).
    n. Short circuit (alarm).
    o. Ground fault (alarm).
    p. Overload (alarm).
    q. Emergency stop (alarm).

D. Engine Status Monitoring:

1. The following information shall be available from a digital status panel on the generator set control:
    a. Engine oil pressure (psi).
    b. Engine coolant temperature (°F).
    c. Engine oil temperature (°F).
    d. Engine speed (rpm).
    e. Number of hours of operation (hours).
    f. Number of start attempts.
    g. Battery voltage (DC volts).
2. The control system shall also incorporate a data logging and display provision to allow logging of the last ten (10) warning or shutdown indications on the generator set, as well as total time of operation at various loads, as a percent of the standby rating of the generator set.

E. Engine Control Functions:

1. The control system provided shall include a cycle cranking system, which allows for user selected crank time, rest time and number of cycles.

2. The control system shall include an idle mode control, which allows the engine to run in idle mode in the RUN position only. In this mode, the generator excitation system shall be disabled.
3. The control system shall include an engine governor control, which functions to provide steady state regulation as noted elsewhere in this Section. The governor control shall include adjustments for gain, damping, and a ramping function to control engine speed and limit exhaust smoke while the unit is starting.
4. The control system shall include time delay start (adjustable from zero (0) to three hundred (300) seconds) and time delay stop (adjustable from zero (0) to six hundred (600) seconds) functions.
5. The control system shall include sender failure monitoring logic for speed sensing, oil pressure, and engine temperature which is capable of discriminating between failed senders or wiring components, and an actual failure conditions.

F. Generator Control Functions:

1. The generator set shall include an automatic digital voltage regulation system that is matched, and prototype tested with the governing system provided. It shall be immune from mis-operation due to load induced voltage distortion. The voltage regulation system shall control buildup of DC generator voltage to provide a linear rise and limit overshoot. Adjustments shall be broad range, and made via digital raise lower switches, with an alphanumeric LED readout to indicate setting level. Rotary potentiometers for system adjustments are not acceptable.
2. Controls shall be provided to monitor the output current of the generator set and initiate an alarm (overcurrent warning) when load current exceeds 110 percent of the rated current of the generator set for more than sixty (60) seconds. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the generator. The protective functions provided shall be in compliance to the requirements of the NEC.
3. Controls shall be provided to individually monitor the output current for short circuit conditions. The control/protection system shall monitor the current level and voltage. The controls shall shut down and lock out the generator set when output current level approaches the thermal damage point of the generator (short circuit shutdown). The protective functions provided shall be in compliance to the requirements of the NEC.
4. Controls shall be provided to monitor the KW load on the generator set and initiate an alarm condition (overload) when total load on the generator set exceeds the generator set rating for in excess of five (5) seconds. Controls shall include a load shed control, to operate a set of dry contacts (for use in shedding customer load devices) when the generator set is overloaded.
5. A DC over/under voltage monitoring shall be provided. The system shall initiate shutdown of the generator set when generator output voltage exceeds 110 percent of the operator set voltage level for more than ten (10) seconds, or with no intentional delay when voltage exceeds 130 percent. Under voltage shutdown shall occur when the output voltage of the generator is less than 85 percent for more than ten (10) seconds.

6. A battery monitoring system shall be provided which initiates alarms when the DC control and starting voltage is less than 25 V DC or more than 32 V DC. During engine starting, the low voltage limit shall be disabled, and if DC voltage drops to less than 14.4 V for more than two (2) seconds a "weak battery" alarm shall be initiated.
7. When required by the NEC or indicated on the Contract Drawings, the control system shall include a ground fault monitoring relay. The relay shall be adjustable from 3.8 A to 1200 A and include adjustable time delay of zero (0) to ten (10) seconds. The relay shall be for indication only and not trip or shut down the generator set. Note grounding and bonding requirements for the generator set and provide relay that will function correctly in system as installed.

G. The generator set shall be provided with a network communication module to allow communication with the generator set control by remote devices. The control shall communicate all engine and generator data and allow starting and stopping of the generator set via the network in both test and emergency modes.

H. Provide and install a twenty (20) light LED type remote alarm annunciator with horn in a location that can be conveniently monitored by facility personnel. The remote annunciator shall provide all the audible and visual alarms called for by NFPA 110 for level 1 systems; and in addition, shall provide indications for high battery voltage, low battery voltage and loss of normal power to the charger. Spare lamps shall be provided to allow future addition of other alarm and status functions to the annunciator. Provisions for labeling of the annunciator in a fashion consistent with the specified functions shall be provided. Alarm silence and lamp test switches shall be provided. LED lamps shall be replaceable and indicating lamp color shall be capable of changes needed for specific application requirements. Alarm horn shall be switchable for all annunciation points. Alarm horn; when switched on; shall sound for first fault, and all subsequent faults, regardless of whether first fault has been cleared, in compliance with NFPA 110.

I. The generator set shall be provided with a mounted main line circuit breaker, sized to carry the rated output current of the generator set on a continuous basis.

J. Control Interfaces for Remote Monitoring:

1. All control and interconnection points from the generator set to remote components shall be brought to a separate connection box. No field connections shall be made in the control enclosure or in the DC power output enclosure.

PART 3 - EXECUTION

3.01 Installation

A. Equipment shall be installed by the Contractor in accordance with final submittals and the Contract Documents. Installation shall meet the applicable state and local codes as required by the authority having jurisdiction. Install equipment in accordance with the manufacturer's instructions and instructions included in the listing or labeling of UL listed products.

B. Installation of equipment shall include furnishing and installing all interconnecting wiring between all major equipment provided for the on-site power system. The Contractor shall

also perform interconnecting wiring between equipment sections (when required), under the supervision of the equipment supplier.

C. Equipment shall be installed on concrete housekeeping pads. Equipment shall be permanently fastened to the pad in accordance with the manufacturer's instructions and seismic requirements of the site. Refer to the Contract Drawings for site specific seismic/geotechnical information.

D. Equipment shall be initially started and operated by representatives of the manufacturer.

E. All equipment shall be physically inspected for damage. Scratches and other installation damage shall be repaired prior to final system testing. Equipment shall be thoroughly cleaned to remove all dirt and construction debris prior to final testing of the system.

F. All generator exhaust piping shall be installed by a Pennsylvania licensed plumber or gas fitter.

3.02 Sequence of Operation

A. Generator set shall start on receipt of a start signal from remote equipment. The start signal shall be via hardwired connection to the generator set control.

B. Present a detailed sequence of operation to SEPTA for review.

3.03 Factory Testing

A. The generator set supplier shall perform a complete operational test on the generator set and provide a certified test report to SEPTA prior to shipping from the factory. Equipment supplied shall be fully tested at the factory for function and performance.

B. Factory testing may be witnessed by SEPTA. The Contractor's costs for travel expenses will be the responsibility of the Contractor. The supplier is responsible to provide a two (2) week notice to SEPTA for testing.

C. Generator set factory tests shall be performed at rated load. The test procedure shall be reviewed by SEPTA before commencement of the tests.

3.04 On-Site Acceptance Test

A. The complete installation shall be tested for compliance with this Section following the completion of all site work. Initial startup testing must be conducted by representatives of the manufacturer in the presence of PECO, the Contractor, SEPTA and State Plumbing Inspector. SEPTA shall be notified in advance and shall have the option to witness the tests.

B. Installation acceptance tests to be conducted on-site shall include a "cold start" test, a two (2) hour full load test, and a one (1) step rated load pickup test in accordance with NFPA 110. The Contractor must provide a portable resistive load bank rated for the generators full load and make all temporary connections and disconnections for the full load test.

C. Perform a power failure test on the entire installed system. This test shall be conducted by opening the power supply from the DC bus and observing proper operation of the system for at least two (2) hours. Coordinate timing and obtain approval for start of test with site personnel and SEPTA.

D. Provide written and signed test results.

E. Refer to Section 01832 for operations and maintenance manual requirements.

F. Refer to Section 01752 for spare parts and maintenance material requirements.

3.05 Training

A. The equipment supplier shall provide training for the facility operating personnel covering operation and maintenance (O&M) of the equipment provided. The training shall be for six (6) separate groups. One (1) class for O&M of the generator and a second class for O&M of the electrical and control equipment. The training program shall be not less than four (4) hours in duration for each group and the class size shall be limited to five (5) persons. Training date shall be coordinated with SEPTA.

3.06 Service and Support

A. The manufacturer of the generator set shall maintain service parts inventory at a central location which is accessible to the service location twenty-four (24) hours per day, three hundred and sixty-five (365) days per year. The generator set shall be serviced by a local service organization that is trained and factory certified in generator set service. The supplier shall maintain an inventory of critical replacement parts at the local service organization, and in service vehicles.

END OF SECTION

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SECTION 16240

BATTERY EQUIPMENT

PART 1 - GENERAL

1.01 Description

A. This Section specifies the manufacturing, testing, and furnishing requirements for the following station battery equipment:

1. Battery system.
2. Battery racks and containment.
3. Battery accessories.
4. Battery chargers.
5. Battery charger accessories.
6. Dropping resistors.
7. DC distribution panelboard.
8. Fused DC disconnect switches.
9. Battery transfer panel.

B. Design the battery system, having the equipment as described above, as a fully integrated system and within the specified space limitations. The design of the integrated system shall provide features for the safety of personnel during installation, operation, and maintenance.

C. Provide Supervisory Control and Data Acquisition (SCADA) supervisory and alarm indications.

D. The Contractor to design and provide ICE units on the battery installation.

1.02 Related Sections

A. Section 01810 – Commissioning of Systems

B. Section 16950 – Testing

1.03 Submittals

A. Submit the following to SEPTA's Project Manager for review and approval. The review and approval of a submission, in part or in whole, shall not constitute acceptance of any errors, omissions, changes, or other deviations from this Section. Wherever possible, submittals shall be text searchable .pdf files. References or hyperlinks to information on the internet are not acceptable.

1. Product data, which shall include manufacturer's catalog cuts, descriptive literature, and diagrams that clearly illustrate conformance with this Section. In particular, the documentation shall demonstrate a fifteen (15) year design life of the entire battery system under the application and environmental conditions described in this Section.

2. Battery:
   a. Submit shop drawings, catalog cuts, illustrations, specification, schedules, and material lists showing complete details.
   b. Submit sizing calculation for sixty-four (64) hours of support for traction power equipment controls.
   c. Submit ventilation requirements.
   d. Submit maintenance and installation instruction manual(s).
   e. Submit battery rack tier and step configuration.
   f. Submit dimensions of the battery rack.
   g. Submit dimensions of the spill containment barrier, including its volume.
   h. Submit dimensions and mass of the monoblocs.
   i. Submit volume of liquid within the individual monoblocs.
3. Battery Charger:
   a. Submit manufacturer's product description, catalog data, and information.
   b. Submit manufacturer's arrangement, wiring, and detail outline dimensions drawings, floor plans, and one line diagrams.
   c. Submit design calculations for battery and battery charger.
   d. Submit certified test reports for the following tests on battery chargers having identical requirements as described in this Section:
      1) Dielectric tests.
      2) Voltage adjustment.
      3) Temperature rise.
      4) Current limit.
      5) Short circuit.
      6) Static voltage deviation.
      7) Efficiency measurement.
      8) Power factor measurement.
      9) Ripple voltage measurement.
      10) Audible noise.
      11) Stability and response.
      12) Transient voltage withstand.
      13) No load.
   e. Submit battery charger control wiring diagram and schematics.
   f. Submit typical values for the following battery charger test results:
      1) Dielectric test.
      2) Full load tests with a 190 ampere-hour Valve Regulated Lead Acid (VRLA) battery.
      3) Voltage test.
      4) Current limit test.
      5) Ripple voltage measurement.
      6) Charging capability within twelve (12) hours, of a battery already discharged to 105 V DC from its nominal 136 V DC value.
      7) Float voltage tests.
      8) Temperature compensation.

9) Automatic “Equalizing Charge” capability.

g. Submit field test plan.

4. Dropping Resistors:
   a. Submit manufacturer's product description, catalog data, and information.
   b. Submit manufacturer's arrangement, wiring, and detail outline dimensions drawings, floor plans, and one line diagrams.
   c. Submit design calculations for dropping resistors.
   d. Submit certified test reports for the following tests on dropping resistors having identical requirements as described in this Section:
      1) Dielectric tests.
      2) Voltage adjustment.
      3) Temperature rise.
      4) Current limit.
      5) Short circuit.
      6) Static voltage deviation.
      7) Efficiency measurement.
      8) Ripple voltage measurement.
      9) Audible noise.
      10) Stability and response.
      11) No load.
   e. Submit dropping resistor control wiring diagram and schematics.
   f. Submit typical values for the following dropping resistor test results:
      1) Dielectric test.
      2) Full load test.
      3) Voltage test.
      4) Current limit test.
      5) Ripple voltage measurement.
      6) Temperature compensation.
   g. Submit field test plan.
5. Nameplate information.
6. Training course instructor’s outline and a copy of the presentation materials.
7. All applicable Safety Data Sheets (SDSs); formerly known as Material Safety Data Sheets (MSDSs); for all hazardous chemicals in the battery system, including, but not necessarily limited to, the batteries and the electrical contact grease.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:
   1. ANSI Z535, Safety Alerting Standards.
   2. American Society of Quality Statistics (ASQ).
   3. Environmental Protection Agency (EPA).
   4. 49 CFR 173.159a(d), Exceptions for Non-Spillable Batteries.

5. IATA Section 4.4, Special Provisions A67, Dangerous Goods Regulations.
6. IEC 60896, Stationary Lead-Acid Batteries - Part 21: Valve Regulated Types - Methods of Tests.
7. IEC 60896, Stationary Lead-Acid Batteries - Part 22: Valve Regulated Types - Requirements.
8. IEEE 485, IEEE Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications.
9. IEEE 1187, IEEE Recommended Practice for Installation Design and Installation of Valve-Regulated Lead-Acid Batteries for Stationary Applications.
10. IEEE 1188, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
11. IEEE 1189, IEEE Guide for Selection of Valve-Regulated Lead-Acid (VRLA) Batteries for Stationary Applications.
12. International Fire Code (IFC).
13. NEMA AB 1, Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures.
14. NEMA FU 1, Low Voltage Cartridge Fuses.
15. NEMA PB 1, Panelboards.
16. NEMA PE 5, Utility-Type Battery Chargers.
17. NFPA 70, National Electrical Code (NEC).
18. Occupational Safety and Health Administration (OSHA).
19. Telcordia GR-4228, Valve-Regulated Lead Acid (VRLA) Battery String Certification Levels Based on Requirements for Safety and Performance.
20. UL 67, Panelboards.
21. UL 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
22. UL 877, Circuit Breakers and Circuit Breaker Enclosures for use in Hazardous (Classified) Locations.
23. Applicable Local Codes.

B. All products supplied shall be listed as approved for their intended use by a Nationally Recognized Testing Laboratory (NRTL), e.g., Underwriters Laboratories, and shall be marked or labeled as such.

C. Utilize manufacturers that are regularly engaged in the manufacture of batteries and battery chargers and only provide products that have proven reliability in similar applications. The manufacturers of the supplied equipment shall not have less than fifteen (15) years' experience in the production of the specified products.

D. Each component of the battery system shall be engineered and manufactured by firms which are certified to comply with an internationally-recognized quality management system, e.g., ISO 9001.

E. Workmanship shall conform to recommended practices for the manufacture of a product suitable for application in a Traction Power Substation (TPSS) environment.

F. Rejection:

1. SEPTA reserves the right to reject any product that does not meet any of the requirements of this Section. Upon notice to the manufacturer, any such rejected material shall be removed promptly form SEPTA's property, and shall be replaced, at no additional cost to SEPTA, with material that complies fully with every requirement of this Section.

G. Patented Material:

1. In the event that any product delivered to SEPTA under this Section is protected by any patent or copyright, the vendor agrees to and shall defend, indemnify, and save harmless SEPTA from any and all suits, claims, judgements, costs, and causes of action at law or in equity arising out of or related to the sale, purchase, or use of any such article, which sale, purchase, or use is alleged to be in violation of any rights under a patent or copyright.

1.05 Delivery, Storage and Handling

A. Permit no more than ninety (90) days to elapse between the final manufacturing date of batteries and installation with a functional battery charger and dropping resistors.

1.06 Operations and Maintenance Data

A. Installation, operation, and maintenance/repair manuals.

B. As-built drawings.

C. Parts list manual.

D. Nameplate information.

E. Manufacturer’s arrangement, wiring, and detail outline dimensions drawings, floor plans and one line diagrams.

F. Design calculations for battery, battery charger, and dropping resistors.

G. Certified test reports.

H. Spare parts.

1.07 Warranty

A. The manufacturers of each component within the complete battery system shall warrant their respective components to be free from defects in workmanship and material for a period of five (5) years from the date of delivery.

B. The manufacturers of each component within the complete battery system shall warrant their respective components to operate per this Section for a period of five (5) years from the date of delivery, except that the warranty on the batteries shall be extended and pro-rated for a period of ten (10) years.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Manufacturers:

1. Battery Charger 60 Hz:
   a. Provide battery charger manufactured by one (1) of the following:
      1) Hindle Power AT10.1 Series, Cabinet Style 5018, Group 2, AT10130075E208SXSXAGXXX
      2) EnerSys, Inc.
      3) C & D Technologies, Inc.
      4) Saft NiFe.
      5) Alcad.
      6) Or Approved Equal.
2. Battery:
   a. Provide batteries manufactured by one (1) of the following:
      1) EnerSys, Inc PowerSafe SBS front terminal SBS 190F.
      2) C & D Technologies, Inc.
      3) ALCAD.
      4) Chloride.
      5) GNB.
      6) Or Approved Equal.
3. Dropping Resistors:
   a. Provide dropping resistors manufactured by one (1) of the following:
      1) Nova Electric.
      2) Energetech Solar.
      3) Or Approved Equal.

2.02 Equipment Characteristics

A. Batteries:

1. General Requirements:
   a. The battery system shall be used in an unattended, non-climate-controlled TPSS. The ambient temperature will vary from -4 °F to 113 °F.
   b. The battery shall be a 120 V, 190 ampere-hour pure lead VRLA Absorbent Glass Mat (AGM) stationary battery of flat plate construction, comprised of ten (10) monoblocs; a.k.a. multi-cell unit or monoblock; at 12 V each. Each monobloc shall be comprised of six (6) cells, and shall have terminals accessible from the front, not the top, of the package. All acid shall be immobilized in the AGM. No free acid shall be present in the cell.
   c. The batteries shall be lead acid chemistry with a design life of fifteen (15) years in float service operation under the environment and application described in this Section. End-of-life is defined as retaining 80 percent of rated capacity and a voltage of 1.75 V per cell; 10.5 V per monobloc.
   d. The battery shall be comprised of ten (10) monoblocs, connected in series.
   e. The monobloc and cell construction shall be as follows:

1) Monobloc containers and lids shall be constructed using flame retardant ABS with a UL94 rating of V0 and an LOI (Limiting Oxygen Index) of at least 28 percent and shall have leak-proof joints.
2) Monobloc containers shall incorporate integrated handles designed for lifting.
3) The monobloc containers and the lid-to-container joint shall be capable of withstanding an internal pressure of at least four (4) times the normal working pressure. Monoblocs shall be equipped with a low-pressure self-resealing one-way safety pressure relief valve, which will prevent ambient air entering the cell/monoblocs.
4) The cell plate shall be a rolled and punched grid type. Recycled lead shall not be used in the manufacturing process. No antimony or calcium shall be used in the plates. The grid thickness of the positive plate shall not exceed 0.049 inches.
5) Monobloc internal terminals shall consist of lead-tin coated inserts machine cast into the lead.
6) The design of the cell/monobloc shall be sufficiently robust to withstand external short circuits in full compliance to IEC 60896 Part 21.
7) The battery shall have a recombining efficiency greater than 98 percent during normal float charge operation.
8) Monobloc external terminals shall consist of stainless steel front access, with top access copper alloy insert.
9) The external links between the monoblocs shall be made from insulated flexible connectors.

f. Monoblocs shall not exceed the following physical characteristics:
   1) Length to be 22.08 inches.
   2) Width to be 4.92 inches.
   3) Height to be 12.44 inches.
   4) Mass to be 132.3 pounds.
g. The battery shall consist of ten (10) monoblocs to provide a nominal 120 V output voltage.
h. Monoblocs shall have a short circuit current rating of 3800A.
i. Monoblocs shall have an internal resistance of 3.30 milliohms.
j. Monoblocs shall have a lead weight of 95.8 pounds.
k. Monoblocs shall have a volume of 2.34 gallons.
l. Monoblocs shall have a weight of 25.3 pounds.
m. Monoblocs shall have M6M type terminals.
n. The nominal capacity at the eight (8) hour discharge rate at 77°F to 1.75 V per cell; 10.5 V per monobloc; shall be no less than 190 A.
o. Each cell in the battery system shall have the following discharge rates down to 1.75 V per cell at 77°F:
   1) 23 A minimum at eight (8) hours.
   2) 131 A minimum at one (1) hour.
   3) 328 A minimum at fifteen (15) minutes.
p. Each cell in the battery system shall have the following discharge rates down to 1.90 V at 77°F:
   1) 23 A minimum at eight (8) hours.
   2) 127 A minimum at one (1) hour.
   3) 306 A minimum at fifteen (15) minutes.

q. Design the battery system for float service as follows:
   1) Provide a battery system having sixty (60) VRLA batteries to provide a nominal output float voltage of 136 V DC.
   2) Normal continuous demand of TPSS loads, including circuit breakers, relays, indicating lamps, local annunciator panel and SCADA control.
   3) Simultaneous closing followed by tripping of all circuit breakers in the TPSS, once per twenty-four (24) hour period while no battery charger input is available.
   4) Specific gravity shall be 1.300 at 77°F with float volts of 2.25 to 2.27 per cell.
   5) Require that the battery manufacturer clearly and permanently identify polarity of cell terminals posts.
   6) Provide moonoblocs with inter monobloc, inter tier, inter step, end-to-end inter rack, back-to-back inter rack connectors, terminal lugs and terminal plates as required. Provide connectors, plates and lugs having tin plated solid copper. Specify that the bolt hardware be stainless steel.

2. Battery Rack:
   a. A battery rack shall be furnished which shall support and distribute the weight of the connected monoblocs in the battery system.
   b. The rack frame shall be coated with an acid-resistant epoxy paint.
   c. The battery rack rails shall be polyethylene coated or acid-resistant epoxy painted.
   d. The battery support system shall provide rack rail insulation.

3. Battery Electrolyte Spill Containment System:
   a. Provide electrolyte spill containment system for the battery system.
      1) Each rack of batteries or group of racks shall be provided with a liquid tight, electrolyte-resistant plastic spill containment barrier with 4 inch lip extending not less than 1 inch beyond the battery rack in all directions. The volume of the containment system shall be at least equal to the volume of the liquid within the batteries.

4. Nameplate:
   a. Provide the battery system with a stainless steel nameplate. Attach nameplate to the battery rack by stainless steel rivets and marked with the following information:
      1) Manufacturer’s name.
      2) Month and year of manufacture.
      3) Battery and cell type.
      4) One (1) minute, one (1) hour, and eight (8) hour ampere rating.
   b. Each cell shall be marked or labeled with the following information:
      1) Manufacturer's name.
      2) Month/year of manufacture.
      3) Manufacturer's model number.
      4) Unique serial number.

B. Battery Accessories:

1. Furnish accessories for normal operation and maintenance of the battery system for each battery and shall include the following:
   a. One (1) installation, operation, and maintenance manual.
   b. Battery lifting sling complete with strap and spreader bar.

c. Battery logbook.
d. Three (3) 0.24 ounce containers of electrical contact grease NO-OX-ID "A-Special", as manufactured by Sanchem, Inc.; Or Approved Equal.
e. Set of special tools for maintenance, as required.
f. Set of inter battery connectors.
g. One (1) set of connecting bolts.
h. Inter-step, inter-row, inter-tier, end-to-end inter-rack, and back-to-back inter-rack prefabricated cable jumper connectors with lead-tin plated lugs.
i. Individual adhesive backed battery numbers, 1 inch character height, numbers from “1” through “10”.

C. Battery Charger:

1. The battery charger shall be solid state, fully automatic and specifically designed to support the battery system of the type specified herein. The battery charger shall be built to charge and maintain ("float") the sixty (60) VRLA batteries to 136 V DC nominal. If the battery manufacturer recommends equalization, the battery charger shall have equalizing capabilities. The battery charger shall operate as a battery eliminator, i.e., operating as a power supply in addition to charging.
2. The battery charger shall be engineered for thirty (30) year life expectancy with a minimum MTBF of sixty thousand (60,000) hours.
3. The battery charger shall have a continuous output rating of at least 75 A.
4. The battery charger shall be a group 2 style charger.
5. The battery charger shall have a cabinet style 5018 enclosure.
6. The battery charger shall have the following physical characteristics:
   a. Width to be 20.91 inches.
   b. Depth to be 16.77 inches.
   c. Height to be 37.95 inches.
   d. Mass to be 375 pounds.
7. The battery charger shall have an AC input circuit breaker with a standard AIC circuit breaker rating.
8. The battery charger shall have a DC output circuit breaker with a standard AIC circuit breaker rating.
9. The battery charger nominal input voltage to be 208 V AC, three phase unless otherwise specified. The input frequency to be 60 Hz.
10. The battery charger output voltage (nominal) to be 136 V DC.
11. The battery charger shall have a current limit adjustment range of 50 percent to 110 percent of the rated output.
12. The battery charger shall have a continuous rating of 110 percent rated current at maximum equalize voltage at 122°F.
13. The battery charger shall have an electrical noise rating not to exceed 32dBrnc.

14. The battery charger shall be at least 85 percent efficient under all modes of operation, as calculated by output power divided by input power.
15. The battery charger's input and output circuits shall be electrically isolated from each other and from the battery charger's ground.
16. The battery charger shall have a heat loss rating of 602 W.
17. Means shall be provided to prevent a faulty battery charger from shorting the battery system. To meet this requirement, a blocking diode or overcurrent protection device, adequate to handle the short circuit capability of the battery system, may be placed in the ungrounded output of the battery charger.
18. The battery charger shall be cooled only by air convection.
19. The battery charger shall be of the floor mounting type.
20. The battery charger's cabinet shall be NEMA-1 rated, with knockouts for cable or conduit, and with its front panel hinged for access.
21. The battery charger shall maintain float voltage within plus or minus 0.5 percent from zero to full load current.
22. The battery charger's float voltage shall be adjustable in 100 mV increments from 95 percent of the nominal float voltage to 105 percent of the nominal float voltage.
23. The battery charger shall fully recharge the battery system in not more than twelve (12) hours after the battery system has been discharged to a level of 80 percent of the system's nominal voltage.
24. The output ripple of the battery charger shall not exceed any of the following limits:
    a. 100 mV (rms) when on battery.
    b. Plus or minus 2 percent when off battery.
    c. 100 mV (rms) when used as a battery eliminator.
25. Battery Charger Standard Features:
    a. Universal main control board that operates in any AT series battery charger.
    b. Alarm assembly with local Light Emitting Diodes (LEDs) and summary relay contact for AC failure, DC failure, high V DC, low V DC, and positive and negative ground fault.
    c. High DC voltage shutdown.
    d. Float/equalize selector switch with indicating lights.
    e. Manual equalize timer; 0 to 255 hours; with indicating lights.
    f. AC line failure automatic equalize timer; 0 to 255 hours; with indicating lights.
    g. AC on indicating light.
    h. 1 percent digital LED meter for V DC, A DC, timer hours, and alarm settings.
    i. Membrane front panel.
    j. Front panel controls can be disabled for security.
    k. A redundant analog circuit for LVDC alarm, independent of the microprocessor.
    l. Redundant control loops for higher reliability.
    m. Local or remote voltage sense with redundancy to protect against remote sense failure.
    n. Self-diagnostics.
    o. Input and output Metal Oxide Varistor (MOV) surge suppressors.

p. Reverse polarity protection via freewheeling diodes.

q. Switchboard wire ULVW-1.

r. Enclosure pre-treated using a five (5) stage iron phosphate process with baked epoxy powder coat in color 61 as specified in ANSI Z535.

26. In all cases, the battery manufacturer's published instructions regarding equalization shall be adhered to rigorously and without exception. If the battery manufacturer recommends against equalization, any equalization function shall be disabled.

D. Dropping Resistors:

1. Dropping resistors shall be rated as follows:

a. DC input voltage to be 630 V DC.

b. DC output voltage to be 125 V DC.

c. Total harmonic distortion to be less than 3 percent.

d. Efficiency to be 97.8 percent.

e. Operating temperature range to be -4°F to 113°F.

E. Fuse Disconnect Switch:

1. Manufacturers:

a. Square D Company.

b. Siemens Energy and Automation.

c. Or Approved Equal.

2. Provide a two (2) pole, external handle operated, fused disconnect switch to permit isolation of the battery system. Coordinate the fuse rating and switch size with the DC output circuit breaker in the battery charger. Mount the disconnect switch and fuse in a NEMA Type 4X stainless steel enclosure with mechanical defeatable door interlock to prevent opening door when the switch is in “ON” position, adjacent to the battery rack. Require that the fuses meet NEMA FU 1 and that they provide short circuit protection for the battery and main cables to the DC distribution panelboards.

a. Provide the fused disconnect switch with the required auxiliary contacts for providing local and remote alarms. Arrange the fuse disconnect switch to alarm when fused disconnect switch is opened.

b. Fuse shall be rated 60 A, 1000 V DC, as manufactured by one (1) of the following manufacturers:

1) Ferraz Shawmut.

2) Cooper Bussmann.

3) Or Approved Equal.

F. DC Distribution Panelboard:

1. General:

a. Provide a DC panelboard that meets the requirements of NEMA PB 1 and certified to UL 67 and shall be suitable for two (2) wire, 250 V DC ungrounded power distribution service. Equip the panelboard with branch circuit breaker type disconnects meeting NEMA AB 1.

b. Manufacturers:

1) Square D Company.

2) Siemens Energy and Automation.

3) ABB.
4) Or Approved Equal.

2. Interior:
   a. Provide a main lugs only style panelboard interior sized per the Contract Drawings to accept 2 pole 250 V DC rated circuit breakers.
3. Enclosure:
   a. Provide a panelboard that is suitable for surface mounting that is the dead front type and housed in a NEMA Type 1 extra heavy galvanized steel enclosure with hinged front cover, lockable handle and two (2) point latch.
   b. Furnish and attach a moisture resistant circuit directory to the inside face of the cover.
      1) For each circuit breaker, print complete information concerning the circuit controlled.
      2) Permanent numerical identification by each circuit breaker space.
4. Circuit Breakers:
   a. Rated at 25 kA RMS symmetrical interrupting at 250 V DC, 2 pole, UL 877, with appropriate ratings.
   b. The circuit breaker trip element to be enclosed and compensated for temperature rises and calibrated to 40°C ambient temperature.
   c. Circuit breakers of the same ratings to be interchangeable, quick make, quick break, front of panel bolt-on type.
   d. Terminals to be rated solder-less type, suitable for copper conductors sized at maximum rated terminal capacity.
   e. Populate the panelboard interior with a minimum of six (6) double pole circuit breakers. Define the quantity plus at least two (2) spares as part of the TPSS traction power equipment control system design.
5. Finish:
   a. Thoroughly cleaned, phosphatized or equivalent coated with at least one (1) coat of corrosion resistant paint.
   b. Paint light gray enamel paint ANSI 61 color as specified in ANSI Z535.

G. Battery Transfer Panel:

1. Manufacturers:
   a. Square D Company.
   b. Siemens Energy and Automation.
   c. Or Approved Equal.
2. Interior:
   a. Provide two (2) 250 V DC, 2 pole contactors for each power source shown on Contract Drawings E114, TP134, E214, TP234, E310, TP334, E406, and TP434. Contactors to be controlled locally or through SCADA. The Contractor to determine ampacity rating of contactors.
3. Enclosure:
   a. Provide a battery transfer panel that is suitable for surface mounting that is the dead front type and housed in a NEMA Type 1 extra heavy galvanized steel enclosure.
4. Finish:

a. Thoroughly cleaned, phosphatized or equivalent coated with at least one (1) coat of corrosion resistant paint.
b. Paint light gray enamel paint ANSI 61 color as specified in ANSI Z535.

H. Accessories:

1. Auxiliary alarm relay board.
2. Copper ground bus.
3. Barrier type alarm terminal block; 2 From C:EJ5130-02.

PART 3 - EXECUTION

3.01 Preparation

A. Transmit submittals and deliverables required by this Section.

B. Furnish products as indicated.

C. Batteries shall be delivered fully charged.

D. All components of the battery system shall be packed and shipped in a manner that avoids damage. Damaged shipments will be rejected.

E. Ensure substrates are in suitable condition to receive the work of this Section.

F. The entire battery system, including all the components thereof, shall be delivered to the address given in the Bid Request or Purchase Order.

3.02 Installation

A. Install battery system and specified equipment per the manufacturer's recommendation, plumb and level and in true alignment with related adjoining work.

B. Install supporting members, fastenings, framing, hangers, bracing, brackets, straps, bolts, and angles, as required to set and rigidly connect the work. Securely fasten the battery racks to the floor.

C. Assemble batteries on the battery racks and give an equalizing charge, following the installation of the TPSS circuit breakers and related equipment.

D. The electrolyte spill containment system shall be properly installed in compliance with the IFC, prior to the installation of the battery rack and lead acid battery system.

E. After installation of the new batteries, the Contractor will be responsible for the removal and disposal of the old batteries from each TPSS.

F. Assembly and installation on-site by the Contractor if specified in the Bid Request or Purchase Order. Final connections to be made by SEPTA.

3.03 Testing

A. Furnish technical assistance necessary for installation and startup of the equipment. Include inter-battery resistance readings in the Certified Test Report.

B. Provide factory and field testing of the batteries, battery charger, and dropping resistors in accordance with Section 16950.

3.04 Training

A. Provide, arrange for, and establish battery system maintenance training for thirty (30) substation maintainers. Provide all training materials, notes, CD-ROM, and classroom presentation equipment.

END OF SECTION

SECTION 16260

TRACTION POWER RECTIFIER

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for the furnishing and testing of traction power rectifiers.

1. Rectifiers shall be indoor, metal enclosed, natural convection cooled; using building air for cooling under ambient conditions. Rectifiers shall be twelve (12) phase multiple double way rectification.

2. The number of rectifiers to be furnished and shipped to each Traction Power Substation (TPSS) by the Contractor shall be as indicated on the Contract Drawings.

B. The Contractor shall install traction power equipment and accessories as described in the related Sections and in accordance with the configurations shown on the Contract Drawings.

1.02 Related Sections

A. The General Provisions of the Agreement.

B. Section 01300 – Submittals

C. Section 01810 – Commissioning of Systems

D. Section 09662 – Electrically Insulated Floor Covering

E. Section 16060 – Grounding and Bonding

F. Section 16273 – Traction Power Rectifier Transformers

G. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Refer to Sections 01300 for submittal requirements.

B. Submit documentation and calculations to substantiate the design and performance requirements as described in Article 1.05 in this Section.

1.04 Quality Assurance

A. The rectifier unit shall be designed in accordance with the appropriate codes and standards and to meet the harmonic requirements of IEEE 519.

B. Meet the applicable provisions of the most recent issues of the following references:

1. IEEE 519, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.

2. IEEE 1653.2, IEEE Standard for Uncontrolled Traction Power Rectifiers for Substation Applications up to 1500 V DC Nominal Output.

3. NEMA TR 1, Transformers, Step Voltage Regulators and Reactors.

4. NFPA 70, National Electrical Code (NEC).
5. IEEE C2, National Electrical Safety Code (NESC).

1.05 Design and Performance Requirements

A. General:

1. Rectifiers shall be supplied with AC traction power directly from the rectifier transformer to serve as the source of supply for the DC switchgear. Rectifiers shall be operated with enclosure high-resistance grounded. Rectifiers shall be designed to meet the requirements of IEEE 1653.2 for extra heavy duty traction service.
2. Rectifiers shall be designed for non-attended operation. Rectifiers shall function as an integrated unit with associated rectifier transformer and DC switchgear. Rectifiers and accessories shall also be capable of parallel operation with existing rectification equipment at adjacent SEPTA TPSSs.
3. The Contractor shall submit a set of complete design calculations for each type and/or rating of rectifier to be provided under this Contract for the SEPTA Project Manager's approval. If computer simulations are submitted in lieu of calculations, all program input data, technical assumptions, and results must be clearly documented to the SEPTA Project Manager's satisfaction. Complete design calculations shall include but not be limited to the following:
   a. Voltage regulation curve.
   b. No load voltage.
   c. Power factor versus load curve.
   d. Efficiency versus load curve.
   e. Harmonic amplitude versus load curve for 11th, 13th, 23rd and 25th harmonics.
   f. Commutation reactance for X/R = 8.
   g. Momentary peak and sustained short circuit current for a single rectifier, and for all TPSS rectifiers in operation.
   h. Commutation factor.
   i. Calculations to show compliance with Specification on number of parallel diodes furnished.
   j. Interphase transformer design criteria.

1.06 Inspection

A. Inspection of the material/equipment will be made at the point of delivery. However, the SEPTA Project Manager reserves the right to make any tests or inspection that it may deem necessary at the manufacturer's plant. In the event inspection is made at the plant, the Contractor shall grant the SEPTA Project Manager free entry at all times while work under this Section is being performed, to all parts of the plant which concern the manufacture of the concerned material/equipment. The Contractor shall render all facilities to satisfy the SEPTA Project Manager that the material/equipment is being furnished in accordance with this Section. In all cases, the Contractor shall notify the SEPTA Project Manager when the finished material/equipment is ready for shipment in order that plant inspection of the material/equipment may be made if desired.

1.07 Warranty

A. Provide a two (2) year warranty against defective materials and workmanship, from the date of final acceptance.

PART 2 - PRODUCTS

2.01 Structures

A. Rectifier units shall be metal enclosed, provided with self-supported, electrically welded steel structures. The rectifier assembly shall consist of a power rectifier section and a control/auxiliary section, arranged to form a continuous, free-standing unit. The enclosures shall be constructed of structural members of sufficient strength to support the bus ducts which interconnect the rectifier to the rectifier transformer, DC switchgear and negative and drainage switchboard.

B. Rectifier section shall be provided with hinged front and rear doors for easy access to diodes, fuses, surge protection devices, heat sinks and buses for inspection, maintenance and cleaning. Each door shall be provided with safety glass windows, arranged to permit inspection of all indicating fuses and fuse failure indicating lights of surge protection devices. All doors shall be securely fastened in the closed position by vibration resistant fasteners with provision for padlocking, and easily opened without the use of tools. Doors shall be provided with stops to hold them securely open at 90 degrees.

C. The control/auxiliary section shall be completely isolated from the rectifier section by suitable sheet steel barriers. It shall contain the instruments and devices required for control and monitoring of the rectifier transformer, rectifier and the rectifier DC main circuit breaker. The control/auxiliary section shall be provided with hinged front and rear doors, for access to devices and terminal blocks and for mounting of relays, instruments and control devices. The doors shall be formed of sheet steel and shall be properly reinforced against distortions by suitable flanges or stiffening members. The door shall be securely fastened in the closed position and easily opened without the use of tools.

D. All control and supervisory circuit devices located in the control/auxiliary section are operated on 136 V DC. Where the use of higher voltage is unavoidable, such circuits shall be connected with red colored wire.

E. All doors of the rectifier section and the doors of control/auxiliary section compartments containing exposed buses or devices operated on 700 V nominal DC positive potential shall be provided with interlocks designed to prevent energization of the rectifier while any of the doors are open, and to de-energize and lockout the rectifier when any of the doors are opened while the rectifier is in operation. Control devices and wiring operated on 700 V DC nominal shall be grouped in separate compartments as far as possible so that the devices operated at lower voltage are accessible for maintenance without the need for de-energizing the rectifier.

F. All components within the control/auxiliary section shall be located for easy access for maintenance and inspection. The arrangement of devices will be subject to the approval of the SEPTA Project Manager.

G. Openings in doors or fixed panels on the rectifier section which are utilized for circulation of air through the rectifier, shall be screened for personnel safety. Screens shall be expanded

metal of gauge approved by the SEPTA Project Manager, with openings approximately 1/4 inch by 1 inch. Cooling air shall enter the rectifier enclosure no less than 6 inches above floor level.

H. All surfaces of the enclosure shall be finished to match finish of traction power equipment to which it is connecting. One (1) quart of matching touch-up paint shall be shipped with each rectifier.

2.02 Buses and Power Connections

A. Rectifier internal buses shall be copper. Aluminum may be used for diode heat sinks, and for certain current carrying sub-assemblies as approved by the SEPTA Project Manager. Appropriate barriers shall be provided to separate the positive and negative buses within the rectifier. Suitable means, approved by the SEPTA Project Manager, shall be employed to prevent corrosion at connections of dissimilar metals.

B. Permanent corrosion inhibiting coatings shall be provided for all bolted connections to reduce maintenance.

C. Rectifier anode (AC) and positive and negative cathode (DC) terminals shall be copper, located at the top of the enclosure, in an air-filled terminal chamber or in a flanged throat, arranged for direct, bolted connection to the anode and cathode bus ducts as approved by the SEPTA Project Manager. Bolted, readily removable flexible links covered with insulating boots shall be provided for connecting the bus duct bus bars to rectifier terminals. The terminal enclosure and bus enclosure shall be joined by an approved bolted-on insulating collar, providing electrical insulation and a ready means for separating the bus duct from the rectifier. Openings with bolted-on covers shall be provided for access to the connecting links.

2.03 Ratings

A. Each rectifier shall have a continuous full load output rating of 4000 kW at a maximum ambient room temperature of 40°C during initial operation. Rated full load output voltage for determining the continuous current rating of the rectifier shall be taken as 700 V DC. After constant temperature rise is reached following continuous full load, it shall be capable of operating at an overload equal to 150 percent of full load current for two (2) hours and superimposed cyclic overload consisting of five (5) periods of 300 percent full load current for one (1) minute, equally spaced throughout the two (2) hour period, followed by one (1) period of 450 percent full load current for fifteen (15) seconds at the end of the two (2) hour period. The rectifiers shall be designed for two (2) two (2) hour overload cycles within a twenty-four (24) hour period, spaced six (6) hours apart.

B. Each rectifier shall be capable of carrying the specified overload with one (1) diode removed from service in each phase leg of the rectifier without exceeding the safe junction temperature of the remaining diodes.

C. Loss of one (1) diode in each phase leg shall not adversely affect the ability of the rectifier to withstand a short circuit.

D. Each rectifier shall be capable of withstanding a bolted short circuit on the rectifier output terminals immediately following (within one (1) second or less) the two (2) hour overload

period specified above until fault is cleared by the rectifier AC circuit breaker, without damage to any component, including protective fuses and rectifier elements.

E. Each rectifier shall have a full load overall efficiency of not less than 94 percent with a displacement power factor above 95 percent, lagging. The voltage regulation characteristic, based on the minimum short circuit supply MVA and the X/R ratio of the incoming 13.2 kV AC services shall be such as to provide output voltage within the limits set forth in Table 16260-1, the Contractor to complete table as part of final design, when the AC system voltage at no load corresponds to rectifier transformer tap voltage. These limits shall be met on all rectifier transformer taps. All DC values shall be based on use of averaging type meters.

Table 16260-1 Rectifier Transformer and Rectifier Output Voltage Regulation

Output Current	Output Voltage
0.5% Full load	TBD
100% Full load	TBD to 700
150% Full load	TBD
300% Full load	TBD
450% Full Load	TBD to 535

F. The rectifier transformers, AC and DC bus ducts and the DC switchgear assemblies specified herein shall be capable of continuous operation under the voltages specified above.

2.04 Number of Diodes Required

A. The manufacturer shall provide a sufficient number of diodes per phase leg to fulfill all the requirements of this Section (“N + 1” design). The Contractor shall submit detailed calculations to the SEPTA Project Manager demonstrating the adequacy of the number of diodes proposed.

2.05 Rectifier Protection

A. Rectifiers shall be designed so that the diodes and other rectifier elements are protected against overcurrents and fault currents by the existing phase and ground instantaneous and time overcurrent relays, Devices 50/51, 50N/51N, and 51R (where present). The overcurrent relays shall be selective with the individual diode fuses so that the fuses will not blow on a through fault. Diode fuses shall blow on a diode shorting failure only.

B. Rectifier heat sinks shall be provided with two (2) stage thermal devices, Device 26RA and 26RT. The second stage thermal device, Device 26T, will activate the lockout relay, Device 86, which shall take the rectifier out of service and prevent rectifier operation under any conditions where the rectifier elements and fuses are no longer afforded complete protection by the overcurrent relays. These thermal devices shall be mounted and wired to permit easy removal.

C. Provide rectifier diode fuse failure detection (Device 58A/58T) and monitoring system (two (2) stage). The first stage shall be an alarm condition indicating a single diode fuse failure via the rectifier annunciator. The second stage shall activate upon failure of a second diode fuse

on the same phase leg. The second stage shall trip the associated AC and DC circuit breakers via the rectifier lockout 86-T device.

D. Rectifier cathode circuit breaker shall be provided with directional instantaneous overcurrent trip device (reverse current), Device 32.

E. Rectifier shall be provided with blown fuse in surge protection circuit device, Device 99X.

F. Rectifier shall be provided with rectifier ground relay - structure grounded alarm device, Device 64N.

G. Rectifier shall be provided with rectifier ground relay - structure ground trip device, Device 64P.

H. Rectifier shall be provided with undervoltage relay, Device 27.

I. Rectifier shall be provided with phase sequence relay, Device 47.

J. Rectifier shall be provided with alarm relay, Device 74.

K. Rectifier shall be provided with rectifier incomplete sequence relay, Device 48.

L. Rectifier shall be provided with rectifier compartment door safety interlock, Device 33R.

M. Rectifier shall be provided with ground detection relay, Device GDR.

N. Each rectifier unit shall be adequately protected against transient surge voltages caused by lightning, faults or switching operations and the DC spikes caused by operation of rolling stock. The Contractor shall submit the proposed surge protection method and devices proposed to be used to the SEPTA Project Manager for approval.

2.06 Wiring and Terminal Blocks

A. Wiring for control and auxiliary circuits and terminal blocks shall be rated for 1000 V DC service, minimum.

B. Minimum size of wiring shall be No. 12 AWG, except internal wiring of devices and device pigtails may be No. 16 AWG.

C. Circuits requiring external connections shall be wired to outgoing wiring terminal blocks in the control/auxiliary section for connection of field wiring entering from above via cable tray, unless otherwise indicated on the Contract Drawings. Minimum wire size of outgoing wiring shall be No. 12 AWG.

D. All elements of control devices operated on 700 V DC nominal shall be connected with red colored wire.

2.07 Control Sources

A. Rectifier control and alarm circuits will receive the 136 V DC supply from the station battery. Rectifier lockout relay and annunciator circuits shall be connected to this supply through a separate set of disconnect switches and properly sized fuses, rated for 1000 V DC service, minimum. The Contractor shall furnish an undervoltage relay, Device 27A and Device 27T, for the rectifier DC control circuits to provide local alarm.

B. Terminal blocks, rated for 1000 V DC service, minimum, shall be provided in the control/auxiliary section.

2.08 Special Requirements

A. The control/auxiliary compartment of the rectifier shall be provided with electric strip heaters to prevent condensation within the compartment during shutdown periods. An ammeter shall be provided to monitor the heater circuit. The ammeter shall be properly scaled and marked for the heater load. In addition, an indicating blue Light Emitting Diode (LED) light shall be provided to indicate operation of the heaters, and an ON-OFF switch.

B. LED lighting fixtures with conveniently located and properly labeled external toggle switch shall be provided in the rectifier section and in each compartment, which contains relays, control devices and outgoing wiring terminal blocks. The light switch for the rectifier section shall be mounted on the control compartment door and switch for the relay compartment shall be mounted inside the compartment itself. The lighting fixtures in the rectifier section shall be located so that adequate lighting is provided for normal maintenance and observation, and to permit inspection of all indicating fuses, nameplates and other devices within the unit.

C. The heater and lighting circuits shall be rated for operation on a single phase, three (3) wire, 120 V AC circuit. All devices shall be completely wired by the Contractor and the circuit extended to a suitable terminal block for top connection to supply conductors, unless otherwise indicated on the Contract Drawings. The lighting fixtures, light switches, space heater devices and terminal blocks shall be insulated from rectifier enclosure for a minimum of 1000 V DC.

2.09 Audible Sound Level

A. The maximum average audible should level produced by the entire rectifier unit under no-load condition shall not exceed 60 decibels (A). Major sound-producing components, their supports and rectifier enclosure shall be acoustically treated, if required, to meet this criterion.

B. The rectifier unit shall be tested in accordance with NEMA TR1, treating the rectifier (instead of the rectifier transformer) as the sound source.

2.10 Nameplates

A. The Contractor shall provide nameplates, mounted in the front and rear of each rectifier assembly, engraved "700 VOLTS DC PRESENT IN RECTIFIER COMPARTMENT". The nameplate shall have white letters, 2 inches high minimum, on red background. Similar nameplates, engraved with 1 inch high letters "700 VOLTS DC PRESENT IN THIS COMPARTMENT" shall be provided on the door of each compartment which contains control devices operated on nominal 700 V DC.

B. The legend of nameplates shall be submitted to the SEPTA Project Manager for approval.

C. Equipment identification nameplates shall be engraved "RECTIFIER No. 1 - 3000 kW" and “RECTIFIER No. 2 – 3000kW”.

2.11 Supervisory Indication

A. Two (2) normally open contacts for each of the following devices, wired to outgoing wiring terminal blocks, shall be provided within each rectifier for remote indication via SEPTA's supervisory systems:

1. Device 26R and 26T (transformer oil over-temperature stages 1 and 2) (Only for Castor TPSS).
2. Device 26RA and 26RT (rectifier heat sink over-temperature stages 1 and 2).
3. Device 27A and 27T (loss of DC auxiliary supply).
4. Device 33R (rectifier compartment door safety interlock).
5. 5. Device 33T (rectifier transformer compartment door safety interlock).
6. Device 48 (rectifier incomplete sequence).
7. Device 49A and 49T (transformer winding over-temperature stages 1 and 2).
8. Device 58A and 58T (rectification failure stages 1 and 2).
9. Device 64N (rectifier ground relay - structure grounded).
10. Device 64P (rectifier ground relay - structure hot).
11. Device 74 (alarm relay).
12. Device 86 (lockout relay).
13. Device 99X (blown fuse in surge protection circuit alarm relay).
14. Device GDR (ground detection relay).

2.12 Detailed Equipment Requirements

A. Each rectifier assembly shall include, but not be limited to, the following:

1. Several air-filled terminal chambers or flanged throats, connectors and hardware for direct bolted connections to AC anode bus and DC positive and negative cathode buses.
2. Silicon diode and heat sink assembly. Single diodes shall be connected in series for each leg and shall have a minimum repetitive peak reverse voltage rating of 2,200 V. Each individual silicon diode shall be hermetically sealed and mounted on air-cooled heat sink adequate for maximum heat dissipation. A current balancing arrangement employing reactors, or other equivalent means, shall be provided to ensure constant current balance between paralleled diodes of each individual phase and to maintain each individual diode current within guaranteed capability under all load conditions up to and including the current peaks with one (1) fuse per phase leg open. With any diode fuse open at any and all rated loads, the current in any other parallel diode in the same phase leg shall not exceed its pro-rated share by an amount greater than 1 percent times the number of paralleled diodes in that phase leg, or by an amount not greater than 20 percent, whichever is greater. Pro-rated share is defined as the total rated phase leg current divided by the number of paralleled diodes in that phase leg. The current balancing method is subject to approval by the SEPTA Project Manager. Reliance upon matched diodes for current balancing purpose will not be acceptable, unless the Contractor can prove to the satisfaction of the SEPTA Project Manager that each diode selected at random from a production run of diodes of the type to be installed in the rectifier has a tolerance sufficiently close to ensure the specified current balance between the paralleled diodes.
3. Set of Current Limiting Fuses:

a. One (1) fuse shall be connected in series with each diode, complete with fuse monitoring system. Fuse monitoring system shall consist of a mechanical target which is clearly visible when illuminated by the lights provided with the rectifier unit.

4. Set of Heat Sink Over-Temperature Devices:
   a. A total of twenty-four (24), circuit opening on rising temperature, bi-metallic thermal devices shall be furnished and mounted on diode heat sinks. Twelve (12) devices, six (6) on positive and six (6) on negative heat sinks, shall be connected to provide first step high temperature alarm, Device 26R. Twelve (12) devices, six (6) on positive and six (6) on negative heat sinks shall be connected to provide second step high temperature trip and lockout, Device 26RH. The devices shall be selected to allow for overloads specified in this Section. Circuit shall be self-monitoring with provisions to actuate the alarm or trip circuits, after a time delay of approximately one (1) second, in the event of detection of high temperature, device or circuit failure or loss of DC auxiliary power to Devices 26RX and 26RHX. Suitable isolating transformers shall be provided to isolate thermal switches from control circuits and from other thermal switches on heat sinks not rigidly at the same potential.
5. Set of Surge Protective Devices:
   a. The surge protective devices shall limit the repetitive reverse voltage surges, induced during lightning, faults and switching or by operation of trains, across the diode to within 75 percent of the peak reverse voltage (PRV) rating of the diodes. The transient surge voltage is assumed to have a crest of 3000 V and 1.5 x 40 microsecond wave shape of either polarity, applied to all rectifier terminals, while operating at rated current and full rated temperature. In addition, the rectifier shall withstand lightning surges of 75 kV crest and 1.5 x 40 microsecond wave shape, applied to rectifier output terminals. Where surge protective devices are protected by a circuit interrupting component, a monitoring circuit employing a neon lamp shall be provided to indicate an inoperative circuit. The monitoring circuits shall be provided with a relay, Device 99Y, to actuate alarm in the event of fuse or surge protective device failure.
6. Interphase transformer or a set of mutually coupled reactors, for interconnecting the negative side of the two (2) 3 phase double-way rectifier circuits. Interphase transformer shall have the voltage and current ratings and the ability to withstand short circuits equal to those for the rectifier.
7. Set of interlock switches designed to de-energize the rectifier when any one (1) rectifier access door is opened exposing 700 V DC nominal "live" parts. The interlocks shall trip Device 86-T and actuate alarm, Device 33R. Activation of Device 33R shall be transmitted to the annunciator. A door interlock shall not be provided on the control/auxiliary compartment if this compartment is completely isolated from the rectifier section by suitable sheet steel barriers.
8. Include strip heaters, lights, and accessories to be approved by the SEPTA Project Manager.
9. Control/auxiliary compartment, completely wired, with all relays, controls and auxiliary devices, including but not limited to the following equipment and quantities:
   a. One (1) master control relay, electrically reset type (Device 4).
   b. One (1) annunciator, solid state type, with back-lit nameplates consisting of thirty (30) alarm positions, arranged five (5) high and six (6) wide. Annunciator shall be rated for operation on 136 V DC and shall be provided with three (3) push buttons for acknowledge, reset and test functions. Annunciator cabinets shall be insulated from rectifier enclosure for a minimum of 1000 V DC. List of nameplate inscriptions shall be provided for review by the SEPTA Project

Manager. All alarm points for which the actuating contacts are remote from rectifier unit and all retransmitting contacts shall be wired to outgoing wiring terminal blocks for connection to field wiring entering from top.

c. One (1) rectifier transformer auxiliary DC circuit undervoltage relay (Device 27RA).
d. One (1) rectifier and rectifier transformer auxiliary AC circuit undervoltage relay (Device 27RB).
e. One (1) two (2) stage diode fuse failure monitoring relay (Device 58A/58T).
f. One (1) set of 136 V DC control power disconnect devices with overload protection, all rated at 1000 V DC and wired to terminal blocks for supply conductors entering from top.
g. One (1) set of ground detector circuit components, including relays, Devices 64R and 64RX, DC power supply and related devices in this Section.
h. One (1) lockout relay, manually reset type (Device 86-T).
i. One (1) undervoltage relay (Device 27R).
j. One (1) set of auxiliary relays for heat sink overtemperature devices (Devices 26RA and 26RT).
k. One (1) temperature indicator to show the air temperature within the rectifier enclosure.
l. One (1) set of insulated anchor blocks for rectifier assembly, as required. These shall be shipped in advance of equipment.

PART 3 - EXECUTION

3.01 Preparation

A. The Contractor shall thoroughly review the Contract Drawings and Specifications in preparation for the development of detailed installation plans and procurement of the materials and equipment. Materials shall be procured, stored, and planned for use which minimizes waste, and substitutions, and maximizes installation efficiency and quality of the end product. The Contractor shall be responsible for developing all site details, including foundations details as applicable and equipment interconnections for complete installation of the equipment supplied. All installation details shall be subject to approval of the SEPTA Project Manager.

B. The Contractor shall examine all approved and reference drawings, to verify and properly coordinate the work; check all relevant drawings including shop drawings.

3.02 Installation and Execution

A. General:

1. Install the silicon rectifier and associated connections as per the manufacturer's recommendations and standard industry practice.
2. Silver plate surfaces of any bus connections and bolt the connections.
3. The completed installation shall be checked out and tested in accordance with the applicable portions of Section 16953.

B. Rectifier:

1. The rectifier unit shall be completely assembled and installed.

2. The floor area at the rectifier unit shall be covered with a layer of insulating material. Care shall be taken that the insulated floor area is not scraped or otherwise damaged during installation. Bolt the rectifier unit to the floor using insulated mounting bolt assemblies. The dielectric floor shall have an insulation resistance as per Section 09662.
3. Grouting shall not be allowed after installation of the insulating floor topping.
4. Furnish, install and connect the control supply, auxiliary power supply cables, control and interlocking circuit cables necessary for intended operation of the rectifier and its auxiliary circuits in accordance with all applicable requirements.
5. The rectifier unit shall be connected to the rectifier transformer and to the cathode circuit breaker. Rectifier, negative terminal shall be connected to the negative and drainage switchboard.

3.03 Testing

A. General:

1. Test the rectifier as specified in this Section as per the required IEEE Standards and as specified in Section 16953.
2. All equipment to be furnished and installed shall be subject to the following test program. Testing shall include factory tests and field tests.
3. The Contractor shall formulate an overall test program for all equipment furnished under this Section, which shall include but not be limited to the tests specified in this Section, to ensure equipment compliance with the relevant standards, this Section, and satisfactory and reliable performance in intended operation. The overall test plan and expected schedule for testing should be submitted to the SEPTA Project Manager for review and acceptance at least four (4) weeks prior to the first expected factory test. All factory tests shall be identified in the overall test plan, and all tests shall be offered for witnessing in accordance with Article 3.03/B in this Section.
4. The Contractor shall furnish detailed, step-by-step test procedures for each factory and field test. The test procedures shall be submitted for approval by the SEPTA Project Manager in accordance with Article 3.03/B/1 in this Section. Blank sample test record and result sheets shall be included for approval. Where applicable, test pass/fail criteria shall be included in the test procedure and check off boxes shall be provided to indicate when each step has been successfully performed.
5. The Contractor shall maintain a consolidated factory and field testing punch list listing all items requiring repair, further testing and steps omitted for execution at a later date. All factory test punch list items must be addressed, and the SEPTA Project Manager notified of such prior to the equipment being released from the manufacturer's premises. All punchlist items shall be resolved to the satisfaction of the SEPTA Project Manager prior to equipment handover to SEPTA.
6. Tests at the factory shall include but not be limited to:
    a. Manufacturer's standard tests.
    b. Tests as listed in Article 3.03/C in this Section.
    c. Tests as per relevant NEMA, IEEE and ANSI Standards not included in Article 3.03/C in this Section.

d. Any other tests to ensure satisfactory performance of equipment.

7. Tests in the field shall include but not be limited to:
   a. Tests as listed in Article 3.03/D in this Section.
   b. Tests as per relevant NEMA, IEEE and ANSI Standards not included in Article 3.03/D in this Section.
   c. Acceptance tests as per current NETA acceptance testing specifications.
   d. Any other tests to ensure satisfactory performance of equipment, including full detailed functional tests specific to the operational requirements of the equipment detailed in this Section.
8. The Contractor shall meet the requirements in Article 3.03/B in this Section for testing and shall furnish certified test reports as specified in Article 3.03/E in this Section for obtaining clearance for packing and shipment of equipment tested.

B. Conditions for Tests:

1. General Conditions:
   a. Prior to testing of any equipment specified in this Section, all of the following conditions shall be fulfilled by the Contractor:
      1) The Contractor has made the "For Record" submittal of shop drawings of the equipment scheduled for testing to the SEPTA Project Manager. Please note that the "For Record" submittal shall be made only after the previous submittal has been approved by the SEPTA Project Manager.
      2) The Contractor prepared test plan and detailed step by step test procedure has been submitted to and approved by the SEPTA Project Manager.
      3) Upon completion of (1) and (2) above, a minimum of four (4) weeks advance notification shall be given to the SEPTA Project Manager on the scheduled date of tests to enable them to witness the tests.
   b. Witnessing Tests:
      1) The SEPTA Project Manager will witness complete testing of all equipment unless a waiver is granted, in which case test reports of equipment, and associated cleared punch list, for which waiver was granted shall be submitted for review to obtain clearance for packing and shipping. Waiver of witnessing tests on any one (1) piece of equipment shall not be construed as a waiver for all remaining equipment either of the same type or different type.
      2) Prior to witness testing, the manufacturer shall have previously tested the equipment to prove compliance with the test procedure and equipment requirements. A copy of these completed test documents should be made available to the SEPTA Project Manager for review prior to the witness testing.
   c. Responsibility:
      1) The Contractor shall assume full responsibility during the factory and field testing of all equipment and installation provided by the Contractor. Should there be any loss or damage to such equipment, materials or the building as result of these tests, the Contractor shall be fully responsible for replacing the damaged equipment and repairing the building. Replacement of damaged equipment shall include all costs, including but not limited to, transportation of, and installation and testing of replacement equipment.
   d. Rejection and Re-testing:
      1) Failure of equipment to withstand tests or to meet specified ratings or requirements shall be sufficient grounds for rejection of equipment.

2) Any equipment rejected shall be re-tested in presence of the SEPTA Project Manager, and/or his representative, after rectification. If the modifications or changes are such as to affect any of the drawings, diagrams or any other documents submitted and accepted by the SEPTA Project Manager, revised drawings of diagrams shall be submitted, showing proposed changes and the SEPTA Project Manager's approval obtained before changes or modifications are made on the equipment. Modification or changes which do not warrant revision of any drawing, shall be furnished to the SEPTA Project Manager along with notice of re-testing.

3) If it is not possible to rectify rejected equipment, new equipment shall be manufactured and the requirements of the drawings and design calculations of the original unit shall be applicable for the new unit.

e. Cost of Rectification or New Unit:

1) The entire cost of rectification or new unit shall be borne by the Contractor including retesting and cost of witnessing retesting.

f. Costs of Tests:

1) The price for conducting all factory and field tests and witness testing in presence of the SEPTA Project Manager, and/or his representative, including entire cost of rectification, and re-testing, shall be deemed to be included in the Contract Price. The expense related to travel, lodging and boarding for the SEPTA Project Manager and/or his representative for witnessing of test will, however, be borne by SEPTA at no expense to the Contractor, except when re-testing is required. In the latter case, all expenses for travel and lodging will be borne by the Contractor as directed by the SEPTA Project Manager.

C. Factory Tests:

1. General:

a. If facilities for conducting any of the tests listed below are not available at the manufacturer’s plant, these tests shall be conducted elsewhere by the manufacturer or by an independent agency as approved by the SEPTA Project Manager. The Contractor shall, however, clearly indicate in the Contractor’s proposal the tests for which the manufacturer does not have facilities and intends to submit test reports from an independent agency. This should also be clearly identified in the overall test plan as required in Article 3.03/A/2 in this Section.

2. Rectifier:

a. The following tests listed in IEEE 1653.2 shall be performed on one (1) rectifier:

1) Rated current test.

2) Harmonic analysis test which shall be performed on the AC input and DC output circuits.

3) Audible sound level test, in accordance with NEMA TR 1 but applied to a rectifier, rather than a rectifier transformer. The audible sound level test of the rectifier shall be conducted at no load with the rectifier energized at rated voltage and frequency.

4) Reduced voltage, 160 percent full load current balance test. With load on and temperature stabilized, measure temperature of ambient air in and air out of the rectifier unit, temperature of each of four (4) selected diodes and their associated heat sinks using same positions on each unit and current in each diode. Increase current by 7 percent waveform and conduction angle adjustment factor to compensate for loadings by reduced voltage and short circuit.

b. The following production tests specified in IEEE 1653.2 shall be performed on each rectifier at the manufacturer’s facility:

1) Dielectric tests.

2) Rated voltage test and efficiency.
3) Rectifier loss tests.
4) Rectifier balance test at 100 percent load.
5) Additional manufacturer's standard tests.
6) Functional tests.
7) Nameplate check.

D. Field Tests:

1. General:

a. The Contractor shall perform the following field tests on all equipment specified in this Section after installation of the equipment. Field tests are to be performed to supplement the factory tests and to ensure proper operation of equipment and proper calibration and coordination of protective devices. The Contractor shall furnish and set up all special equipment required for these tests, including relay test set, switches, properly calibrated indicating instruments, recording oscillographs, timing devices, shorting devices, loading devices and other associated appurtenances as may be required.

b. The work includes furnishing of labor, material, test instruments and services necessary to perform required testing and checking of electrical equipment and installation.

c. All tests shall be successfully completed to show that the installation meets the Specification requirements and that the equipment and devices operate as intended, before final acceptance by SEPTA.

d. Tests and checkouts shall be conducted in accordance with the Contractor supplied and SEPTA Project Manager approved test procedures as specified herein and in National Electrical Code and applicable Standards and specifications of ANSI, NEMA, IEEE, ICEA, AEIC and NETA.

e. The Contractor shall provide properly qualified personnel who shall be responsible for supervising, coordinating, and performing all electrical field testing and checking work and who maintains a written record of all tests conducted and all punch list items for later correction or re-testing. The results of all field tests shall be verified by an independent test laboratory employed by the Contractor.

f. Testing and checkouts shall be performed in the presence of the SEPTA Project Manager.

g. The Contractor shall furnish five (5) copies of all test results to the SEPTA Project Manager. Results sheets shall include date of test, personnel involved, items tested, type of tests and test data and shall be signed off by the test engineer in charge. The Contractor shall also submit the punch list signed off to showing completion.

h. Any equipment or material damaged due to improper test procedure or test apparatus handling shall be replaced or restored to original condition by the Contractor at Contractor’s expense.

i. Safety devices including but not limited to rubber gloves and blankets, screens and barriers, danger signs, padlocks, etc., shall be used to protect and warn all personnel in the vicinity of the tests.

j. All test instruments used shall have a certified calibration sticker showing last date of calibration and expiration date.

2. Field Test Requirements:

a. The Contractor shall formulate a complete, detailed step by step field test procedure for all equipment to be furnished and installed under this Section and associated equipment interfaces associated with the work. Test procedure shall be comprehensive and shall include the required tests as specified in relevant standards of ANSI, NEMA, IEEE and NETA,

supplementing the factory test procedure. The field test procedure shall also include an index of all the proposed tests, estimated duration, overall schedule, test sequence and shall identify SEPTA personnel requirements to fulfill the test program. The detailed procedure for performing the specified short circuit tests shall include step-by-step test procedure supplemented by circuit diagrams, details of instrumentation, safety interlocks and back-up trips provided.

b. The Contractor shall submit the detailed, step-by-step test procedures to the SEPTA Project Manager for review and approval well in advance of the commencement of field tests. The Contractor may submit the procedures individually per equipment. The SEPTA Project Manager reserves the right to add, delete or make necessary changes in the test procedure. The Contractor is responsible for the performance and installation of the equipment furnished under this Section, he shall, therefore, prior to testing, verify that the installation is proper and in accordance with all applicable installation instructions specified herein.

c. Perform continuity and dielectric tests to prove the correctness of circuitry per the SEPTA Project Manager approved shop drawings.

d. Each and every rectifier shall be thoroughly inspected and certified by the Contractor and approved by the SEPTA Project Manager.

e. Check relay and trip device settings and coordination.

f. Perform functional and operational tests of all equipment and of all devices and circuits including operations between pieces of equipment.

g. Perform phantom load tests on rectifier transformer AC switchgear protective devices to ensure calibration. Phantom load tests may be carried out by secondary injection to the protection relays.

h. Equipment and Instruments:

   1) Check alignment and proper operation of all equipment including relays, operating mechanisms, clearances, adjustment of contacts and accessory equipment.

   2) Test indicating instruments, such as ammeters, voltmeters, and other instruments, by checking and adjusting pointers on zero scale with no load or voltage applied, also at midpoint and full scale.

   3) Check the isolation amplifiers/transducers for linearity and gain from 1-V-to-1-V through 1-V-to-100-V.

i. Supervisory Equipment:

   1) The Contractor shall test and verify all wiring installed in the Contract, including wiring to the Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU).

   2) The supervisory equipment at the TPSS interfacing with the supervisory system at the SEPTA Power Department Control Center shall be end–to-end tested in accordance with a Contractor prepared, SEPTA approved test procedure.

   3) All status, control and analog functions shall be individually tested and checked out and the results recorded, individually, in the test report. Analog devices shall be checked for linearity at zero, 50 percent and 100 percent output and calibrated for proper output to SCADA.

j. 1000 V Wire and Cable:

   1) Test in accordance with Section 16953.

k. Grounding:

   1) Test in accordance with Section 16060.

E. Test Reports:

1. The Contractor shall submit five (5) certified copies of test reports for all the tests conducted at the factory and in field for the SEPTA Project Manager's approval. Test reports shall be submitted to the SEPTA Project Manager within seven (7) days after completion of tests. In case of "Design Tests" and tests on rectifier packages, test reports shall include original data, detailed calculation of test data used to arrive at the results and interpretation of results. Test reports shall contain the characteristics, curves, etc. where required for interpretation of results.

END OF SECTION

SECTION 16271

AUXILIARY POWER TRANSFORMERS

PART 1 - GENERAL

1.01 Description

A. Furnish and install auxiliary power transformers complete with all connections. Each auxiliary power transformer shall furnish AC power at proper voltage and phase relation for operation of low tension, auxiliary equipment which may have existing alternate feeds. The transformer shall be designed for a best efforts design goal of at least forty (40) years of life, taking into consideration this Section as well as all conditions which may reasonably be expected in actual service.

B. Furnish and install indoor dry type air cooled auxiliary power transformers complete with all primary and secondary connections.

C. Provide integral sensors for protective and measuring devices including wiring connections.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

C. Section 01810 – Commissioning of Systems

D. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

E. Section 16950 – Testing

1.03 Submittals

A. Submit the following in accordance with Section 01300 and the requirements of this Section.

1. Product data for specified items.
2. Shop drawings for the auxiliary power transformer and accessory components. Include dimensional plans, sections, and elevations showing minimum clearances, installed devices, major features and materials lists.
3. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field installed wiring.
4. Manufacturer's certification signed by the manufacturer certifying that they meet the Specification requirements. Upon request submit evidence of experience.
5. Product certification signed by the manufacturer of equipment certifying that products meet the Specification requirements.
6. Installer’s certification signed by the installer certifying that they meet the Specification requirements.

7. Factory testing organization certificates certifying that the organization meets the Specification requirements.
8. Certified copies of field tests including ground resistance tests.
9. Maintenance data for materials and products, for inclusion in operating and maintenance manual.
10. No load and full load losses.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. IEC 60751, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors.
2. IEEE 386, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV though 35 kV.
3. IEEE C2, National Electrical Safety Code (NESC).
4. IEEE C37.90, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
5. IEEE C37.91, IEEE Guide for Protecting Power Transformers.
6. IEEE C57.12.01, IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers.
7. IEEE C57.12.58, IEEE Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil.
8. IEEE C57.12.80, IEEE Standard Terminology for Power and Distribution Transformers.
9. IEEE C57.12.91, IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
10. IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.
11. IEEE C57.96, IEEE Guide for Loading Dry-Type Distribution and Power Transformers.
12. IEEE C57.98, IEEE Guide for Transformer Impulse Tests.
13. IEEE C57.124, IEEE Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers.
14. IEEE C62.11, IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuit (>1kV).
15. INETA, Acceptance Testing Specifications (ATS) for Electrical Power Distribution Equipment and Systems.
16. NFPA 70, National Electrical Code (NEC).
17. UL 486A-486B, Wire Connectors.
18. UL 1437, Electrical Analog Instruments - Panel Board Type.

PART 2 - PRODUCTS

2.01 Auxiliary Power Transformers

A. The Contractor shall furnish and install 3 phase, air cooled, auxiliary power transformers as shown on the Contract Drawings. Provide two (2) 13.2 kV/120-208 V auxiliary transformers at Broad TPSS, Park TPSS, and Loudon TPSS. Provide one (1) 13.2 kV/120-208 V auxiliary transformer at Castor TPSS. Provide one (1) 13.2 kV/4.8 kV lighting and power transformer at Broad TPSS, Park TPSS, and Loudon TPSS. The KVA rating shall be as shown on the Contract Drawings. The auxiliary power transformer shall be designed for operation from a 60 Hz power supply.

B. Each auxiliary power transformer shall be provided with two (2) 2 1/2 percent full capacity taps below normal and two (2) 2 1/2 percent full capacity taps above normal. Taps shall be set to provide a normal secondary voltage as indicated on the Contract Drawings.

C. The temperature rise, by resistance, shall not exceed 115°C in a 40°C ambient. Insulation system temperature class shall be 220°C.

D. Each auxiliary power transformer shall be dry type vacuum pressure encapsulated of continuous wound copper construction and be impregnated with non-hygroscopic, thermosetting varnish. Vacuum/pressure/baking process shall be a minimum of three (3) cycles.

E. The core of each auxiliary power transformer shall be built up of annealed, insulated laminations of a non-aging grain oriented silicon steel having both high and uniform magnetic characteristics. The core shall be adequately clamped to prevent excessive humming and chattering.

F. The core and coil assembly shall be mounted to its support structure by means of rubber vibration absorbing mounts.

G. Each auxiliary power transformer’s sound level shall be guaranteed by the manufacturer not to exceed 50dB.

PART 3 - EXECUTION

3.01 Tests for Auxiliary Power Transformers

A. Auxiliary power transformers shall be tested as per IEEE C57.12.91. Submit notarized, certified test data for each auxiliary power transformer supplied.

B. Refer to Section 16950 for additional testing requirements.

3.02 Tools

A. Furnish for each Traction Power Substation (TPSS) a complete set of tools required for adjusting, maintaining and dismantling the auxiliary power transformer. The tools shall be placed with the tools furnished for other items of the equipment.

3.03 Field Manuals

A. Refer to Section 01832 for operations and maintenance manual requirements.

3.04 Spare Parts

A. Refer to Section 01752 for spare parts and maintenance material requirements.

END OF SECTION

SECTION 16273

TRACTION POWER RECTIFIER TRANSFORMERS

PART 1 - GENERAL

1.01 Description

A. Furnish and install rectifier transformers complete with all connections. Each rectifier transformer shall furnish AC power at proper voltage and phase relation for operation of the associated rectifier. The rectifier transformer shall be designed for a best efforts design goal of at least forty (40) years of life, taking into consideration this Section as well as all conditions which may reasonably be expected in actual service.

B. Furnish and install indoor dry type air cooled rectifier transformers for Broad, Park, and Loudon Substations complete with all primary and secondary connections.

C. Furnish and install outdoor liquid filled air cooled rectifier transformer at Castor Substation. The Contractor to detail during final design.

D. Provide integral sensors for protective and measuring devices including wiring connections.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

C. Section 01810 – Commissioning of Systems

D. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

E. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following in accordance with Section 01300 and the requirements of this Section:

1. Product data for specified items.
2. Shop drawings for the rectifier transformer and accessory components. Include dimensional plans, sections, and elevations showing minimum clearances, installed devices, major features and materials lists.
3. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field installed wiring.
4. Manufacturer's certification signed by the manufacturer certifying that they meet the Specification requirements. Upon request submit evidence of experience.
5. Product certification signed by the manufacturer of equipment certifying that products meet the Specification requirements.
6. Installer’s certification signed by the installer certifying that they meet the

Specification requirements.

7. Factory testing organization certificates certifying that the organization meets the Specification requirements.
8. Certified copies of field tests including ground resistance tests.
9. Maintenance data for materials and products, for inclusion in operating and maintenance manual.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. IEC 60751, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors.
2. IEEE 386, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV though 35 kV.
3. IEEE 1653.1, IEEE Standard for Traction Power Rectifier Transformers for Substation Applications up to 1500 V DC Nominal Output.
4. IEEE 1653.2, IEEE Standard for Uncontrolled Traction Power Rectifiers for Substation Applications up to 1500 V DC Nominal Output.
5. IEEE C2, National Electrical Safety Code (NESC).
6. IEEE C37.90, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
7. IEEE C37.91, IEEE Guide for Protecting Power Transformers.
8. IEEE C57.12.01, IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers.
9. IEEE C57.12.00 - General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
10. IEEE C57.12.10 Standard Requirements for Liquid-Immersed Power Transformers.
11. IEEE C57.12.58, IEEE Guide for Conducting a Transient Voltage Analysis of a Dry-Type Transformer Coil.
12. IEEE C57.12.80, IEEE Standard Terminology for Power and Distribution Transformers.
13. IEEE C57.12.91, IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
14. IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.
15. IEEE C57.18.10, IEEE Standard Practices and Requirements for Semiconductor Power Rectifier Transformers.
16. IEEE C57.12.90 Test Code for Liquid Immersed Distribution Power and Regulating Transformers
17. IEEE C57.94, IEEE Recommended Practice for Installation, Application, Operation and Maintenance of Dry-Type Distribution and Power Transformers.

18. IEEE C57.96, IEEE Guide for Loading Dry-Type Distribution and PowerTransformers.
19. IEEE C57.98, IEEE Guide for Transformer Impulse Tests.
20. IEEE C57.110 Standard Test Procedure for Thermal Evaluation of Oil-Immersed Distribution Transformers.
21. IEEE C57.124, IEEE Recommended Practice for the Detection of Partial Discharge and the Measurement of Apparent Charge in Dry-Type Transformers.
22. IEEE C62.11, IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuit (>1kV).
23. INETA, Acceptance Testing Specifications (ATS) for Electrical Power Distribution Equipment and Systems.
24. National Electrical Manufacturers Association (NEMA).
25. NFPA 70, National Electrical Code (NEC).
26. UL 486A-486B, Wire Connectors.

1.05 Service Environment

A. Air cooled rectifier transformers shall be designed to operate at any environmental temperature from 32°F to 86°F continuously, at 99°F for periods of one (1) week, and at 104°F for periods of twenty-four (24) hours. The nominal average environmental temperature shall be 86°F.

1.06 Nominal Rating

A. Nominal KVA rating of each rectifier transformer shall be the KVA output necessary to supply AC power to its associated rectifier when the rectifier is delivering its nominal rated output. The rated high tension input voltage shall be 13,200 V and the rated low tension voltage shall correspond to rectifier's rated output of 700 V DC. Other nominal ratings shall be in accordance with IEEE 1653.2.

PART 2 - PRODUCTS

2.01 Rectifier Transformers

A. Dry Type Transformer

1. Rectifier transformers for **Broad, Park, and Loudon** substations shall be the indoor dry type, fire retardant, vacuum pressure encapsulated type as manufactured by the following:
2. Virginia Transformer Corporation.
3. Schaffner MTC.
4. Or Approved Equal.

B. Vacuum pressure impregnation type: the rectifier transformer coils shall be exposed to full vacuum to draw the insulating liquid into the coils. After at least three (3) hours of vacuum, four (4) or more atmospheres of pressure shall be applied to shrink any remaining bubbles and allow them to migrate out between turns. The pressure shall be

held at least three (3) hours. This air purging and impregnation process shall be repeated three (3) or four (4) times. The entire process shall take up to a minimum of ten (10) days when allowing for curing time of the insulating liquid.

2.02 Rectifier Transformer Phasing

A. Rectifier transformers with two (2) 3 phase low voltage windings; one (1) delta connected, the second wye connected as defined in IEEE 1653.1, to provide 12 phase, multiple delta- wye, double way supply.

2.03 Rectifier Transformer Windings

A. Both high voltage and low voltage windings shall be copper conductor.

B. For the vacuum pressure encapsulated rectifier transformer, both windings shall be vacuum pressure impregnated with high temperature varnish. The coils shall have a cast in place epoxy end ring to increase short circuit strength and prevent dust and moisture and other contaminants from entering the coil. The finished baked on varnish and sealing ring shall have thermal expansion characteristics that match that of the rectifier transformer core to minimize the possibility of cracking due to repeated high and low temperature cycles and thermal shock.

C. Windings shall not absorb moisture and shall be suitable for both storage and operation in adverse environments, including prolonged storage in 100 percent humidity at temperatures ranging from minus 58°F to plus 122°F, and shall be capable of being switched on immediately after such storage without pre-drying.

D. Basic Impulse Levels (BIL) for static discharge shall be as follows:

1. Insulator Class of 15 kV with a BIL of 95 kV.

E. Coils shall be thoroughly insulated from the core and from each other. Cooling ducts shall be interspersed between the coils, which shall maintain an even temperature throughout the coil structure. The coils shall be rigidly supported and braced in a manner that distortion or injury, due to specified overloads or short circuits of at least one (1) second, will be prevented.

F. All conductors interconnecting the coils within the rectifier transformer shall be copper. Interconnection conductors shall be insulated to the rated voltage of the coils.

2.04 Rectifier Transformer Core

A. Rectifier transformer core shall be constructed of high grade, grain oriented silicon steel laminations with high magnetic permeability. Magnetic flux density shall be kept well below the saturation point. The outside surfaces of the core shall be protected against corrosion by a resin coating.

B. Core of each rectifier transformer shall be built up of annealed, insulated laminations of non-aging grain oriented silicon steel having both high and uniform magnetic characteristics. The core shall be adequately clamped to prevent excessive humming and chattering.

C. Core and coil shall be mounted on vibration suppressors within the enclosure if necessary to keep the noise level of the transformer below 70 db.

D. Core of the rectifier transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable NEMA, IEEE and ANSI standards.

2.05 Overload Ratings

A. Each rectifier transformer shall have overload ratings corresponding to the overload ratings of its associated rectifier per the IEEE 1653.2 extra heavy duty traction standard. The overload rating of the rectifier transformer shall be the KVA output necessary to supply AC power to its associated rectifier when the rectifier is delivering its overload output immediately after the rectifier transformer has reached constant temperature at rated output.

2.06 Rectifier Transformer Insulation Ratings

A. Insulation system shall withstand the temperature conditions to which it will be subjected at the various ratings, without incurring any damage that would disqualify it for continuous service or reduce its life expectancy to less than the specified years. Insulation construction shall be such that shrinkage, coil distortion or displacement will not occur.

B. For the vacuum pressure encapsulated rectifier transformer, the insulation system for all windings shall be rated at 220°C and be capable of operating continuously at an average operating temperature of 150°C.

C. Life expectancy of each rectifier transformer shall be forty (40) years minimum based on IEEE 1653.2 extra heavy duty traction loading occurring twice a day.

2.07 Rectifier Transformer Voltage Taps

A. High voltage windings of each rectifier transformer shall be wound for their rated voltage and be equipped with a total of four (4) full capacity taps, at 2 1/2 percent and 5 percent below nominal and at 2 1/2 percent and 5 percent above nominal. These taps shall be connected to the high voltage coils so that unbalanced magnetic forces and short circuits will be reduced to a minimum. The tolerance on voltage difference between any pair of adjacent taps shall not exceed plus or minus 1/4 percent.

2.08 Tap Changer

A. Each rectifier transformer shall be provided with a re-connectable link tap changing device on the high voltage side of the rectifier transformer which will, when operated with the rectifier transformer de-energized, change the ratio of transformation. The rectifier transformer tap leads shall be marked and brought outside the coils, in such a manner that only a single metal link with the appropriate length may be used in changing all the taps. The links shall be clearly identifiable as to the tap selected. A removable panel (suitably interlocked to shut down the rectifier if the panel is inadvertently opened with the unit energized) on the rectifier transformer shall access the links.

2.09 Thermometer

A. A contact making thermometer shall be installed on the rectifier transformer which will

accurately within 1 percent indicate, in °C, the temperature therein. The device shall have a resettable red maximum temperature indicator. Thermometer shall have electrical contact elements capable of operating the control circuit and red maximum temperature indication. Thermometer shall be in addition to any non-replaceable thermo-sensitive elements which are buried in the rectifier transformer coil assembly which are for rapid temperature rise protection. Thermometer and associated control circuit power shall be taken from the 125 V DC stationary battery system.

2.10 Winding Temperature Sensor

A. Rectifier transformer shall have adequate solid state temperature sensors embedded in strategic places in the windings such as to be totally protected from any possibility of arc over to the sensors. Additional circuitry shall be provided by the rectifier transformer manufacturer to convert the output of the sensors to a relay logic. Output contacts of these relays shall interface with overall rectifier transformer protective logic. The sensor circuitry shall be adjustable from 10 percent above the maximum normal operating temperature up to the point where the insulation system may deteriorate at the worst case hot spot.

2.11 Temperature Telemetry

A. Equipment specified in this Section shall provide the telemetry interface with the Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU) to monitor rectifier transformer temperature. Provide temperature sensors and temperature transducers as described in this Section.

2.12 Temperature Sensors

A. The Resistance Temperature Detector (RTD) sensors for the rectifier transformer enclosure shall be manufactured by the following:

1. JMS Southeast, Inc.
2. Or Approved Equal.

B. The resistance of the RTD at 0°C shall hold less than a 0.05°C shift per year. The RTD shall withstand a vibration level of 30g over the frequency range 10 Hz to 1 kHz. It shall also be insensitive to large changes of pressure. When tested in accordance with the requirements of IEC 60751, the indicated temperature rise in the temperature detector, with a power of 10 mW dissipated in it, shall not exceed plus 0.3°C.

2.13 Rectifier Transformer Enclosure

A. Furnish each rectifier transformer mounted in a suitable, ventilated enclosure. Removable or hinged panels for access to the coils or their taps shall be equipped with handles for lifting or opening. The enclosures shall be constructed of minimum 12 gauge sheet steel and finished in gray enamel. All ventilating openings shall be in accordance with NEMA and the NEC standards for ventilated enclosures. Large enclosures shall have jacking pads designed to be flush with the enclosure. The base shall be constructed of structural steel members to permit skidding or rolling in any direction.

B. Lugs, eyes or other means shall be provided to permit lifting the complete rectifier transformer or coil assemblies. Maximum headroom for lifting shall be 15 feet clear.

Allowance shall be made for providing clearance for lifting or hoisting, especially if the coil assemblies are removable from the iron core.

C. Each rectifier transformer shall have a base suitable for attaching, by mutual resources, the rectifier transformer on the Traction Power Substation (TPSS) floor through tuned vibration dampers to mitigate transfer of noise by mutual resonances. It shall be equipped with jack boxes or other means whereby the unit may be raised. The steel structure making up the base shall be of sturdy construction which shall not be distorted in transportation. The rectifier transformer shall be mounted on noise reducing pads to reduce the transmission of core vibrations and noise to the building structure.

D. Due to the close proximity of each rectifier transformer to its associated rectifier, there shall be nothing to necessitate observation of access to or maintenance of the rectifier transformer on the side that faces its rectifier. All controls and gauges shall be easily readable and readily accessible and mounted on a single rectifier transformer side wherever feasible.

2.14 Rectifier Transformer Nameplate

A. An approved nameplate shall be permanently fastened to the low voltage side of each rectifier transformer enclosure. It shall show the manufacturer's name, serial number, type, number of phases, kVA ratings, voltage ratings, tap voltages, frequency, temperature rise, polarity, percent impedance, commutating reactance, type of material used for windings, insulation system class and materials, approximate weight, and a plan view giving the relative location of leads, arrangement of taps, and identification of taps and connections.

2.15 Rectifier Transformer Bushings and Terminals

A. All low voltage power terminal leads shall be brought out of the rectifier transformer enclosure through approved bushings, each of suitable size and voltage rating. The low voltage power terminals shall line up in phase and spacing with the AC input terminals of the associated rectifier. Low voltage bus connections between and from low voltage coils shall be solid copper detail. Flexible leads may be used between low voltage coils and low voltage AC bus within rectifier transformer; however, all connections shall be brazed not bolted. Flexible connections may not be used on outgoing AC buses. Buses within the rectifier transformer shall be solid copper bar. Detailed drawings showing bus interconnections within the rectifier transformer shall be provided to SEPTA for review and approval before the start of fabrication. Terminals for control and protective circuits shall be located at the top of the rectifier transformer.

B. The high voltage leads shall be brought out of the rectifier transformer cover through cable terminators. High voltage flexible leads from high voltage cable terminators to lightning arresters and high voltage coils shall be properly supported and secured. Cable terminators shall be single conductor type, for the termination of the high tension cable specified elsewhere.

C. Slip-on type terminations shall be as manufactured by the following:

1. G & W Electric Specialty Co.
2. Or Approved Equal.

D. Cold shrink type terminations shall be as manufactured by the

following: 1. 3M.

2. Or Approved Equal.

E. Cable terminators shall be installed in accordance with the manufacturer's recommendations. An approved torque wrench shall be used to tighten the assembly bolts.

2.16 Rectifier Transformer Surge Protection

A. Rectifier transformers shall be provided with surge arresters, installed at the incoming primary leads within the rectifier transformer enclosure. Arresters shall be heavy duty distribution class and shall have the following ratings:

1. Primary rating of rectifier transformer (kV RMS) to be 13.2 kV.
2. Arrester duty cycle rating (kV RMS) to be 15 kV.
3. Arrester MCOV (kV RMS) to be 12.7 kV.

B. Rectifier transformer secondary leads shall be provided with surge suppressors, as required, to protect against rectifier generated transients.

2.17 Liquid Filled Outdoor Rectifier Transformer

A. Rectifier transformer for Castor substation shall be self-cooled, oil-immersed, 60 Hertz transformers suitable for outdoor service, designed for extra heavy-duty traction service as specified, conforming to the applicable requirements of IEEE C57.12.00, IEEE C57.12.10, IEEE C57.12.90, IEEE C57.18.10, IEEE 1653.1.

B. Ratings: Rectifier transformers shall have the following minimum ratings:

1. Capacity: MVA rating as required to meet the specified ratings and performance requirements for the transformer-rectifier units.
2. Primary Winding Nominal Voltage: 13.2KV
3. Secondary Winding Nominal Voltage: As required to meet the specified performance requirements for the transformer-rectifier unit.
4. Primary winding is Delta and secondary is Delta/Wye for the twelve-phase, double-way rectifier in accordance with IEEE 1653.2, circuit number 31.
5. Cooling Class – KNAN
6. Average Winding Temperature Rise above 50 degrees Celsius Ambient after Stabilized Continuous Operation at 100 percent load: 55 degrees Celsius maximum.
7. Hottest-Spot Temperature Rise above 50 degrees Celsius Ambient after Stabilized Continuous Operation at 100 Percent Load: 65 degrees Celsius maximum.
8. Basic Insulation Level (BIL) 95KV.

C. Taps and Tap Changer:

1. Taps: The high voltage windings shall have four no-load, full capacity taps: two 2.5% above and two 2.5% below the rated line-to-line voltage of 13.2KV.

2. Changer: An Off-load tap changer shall be provided with an operating handle mounted on the exterior of the tank. A position indicator and provision for padlocking shall be provided in an accessible location. The padlock shall be interlocked with Rectifier-Transformer 13.2KV breaker – Device 52.

D. Alarm and Trip Devices: Transformer shall be equipped with the following:

1. Sudden pressure relay, device 63SP with alarm and trip contacts.
2. The sudden pressure device seal-in relay shall be equipped with an undervoltage relay with a closed auxiliary contact that shall activate the Device 286 lockout relay if control power is lost on the device 63SP seal-in relay.
3. Pressure relief device 63PR.
4. Liquid level gauge, device 71 with one low level alarm and low level trip contacts.
5. Pressure/vacuum gauge.
6. Hot-spot winding temperature indicator, device 49, minimum two stages, with alarm and trip contacts with adjustable temperature set.
7. Two stage top oil temperature indicator, device 26T with alarm and trip contacts with adjustable temperature set points.
8. Alarm and trip annunciations due to activation of any of the above protective devices including control power alarms shall be communicated via an I/O module located in the control cabinet through fiber optic cable to the station control panel.
9. The top of the transformer control panel shall not be more than 6.5 feet above the finish grade level where personnel accessing the control cabinet stand; the bottom of the transformer control panel shall be less than 3.5 feet from finish grade above the finish grade level where personnel accessing the control cabinet stand.

E. The main transformer control cabinet shall have thermostatically controlled anti-condensation heaters. Heater capacity shall be equally divided into two and located at the sides of the cabinet to maintain adequate clearances from entering cables.

F. Construction requirements

1. The rectifier transformers shall be designed for high voltage enclosed cable connections on the primary and secondary sides. The rectifier transformer shall be provided with incoming line section for terminating the 13.2 kV power cables entering from below as indicated. The section shall be large enough to accommodate built –up tape stress cones.
2. The incoming 13.2 kV incoming line section and the control cabinet shall be NEMA 4X with doors located on either side of the transformer tank and within reach of person standing on the transformer base level. Doors shall be hinged and provided with stops to hold the doors in open position. Door shall be provided with handle and three-point lockable latch.
3. The incoming 13.2 kV incoming line section shall be provided with compression lugs for terminating the 15 kV, # 2/0 AWG power cables entering from below as indicated.
4. Transformer shall be provided with lifting lugs located at the top of the unit in such a manner to allow the unit to be lifted by a boom-type crane or hoist without tilting of

the unit.

5. The transformer shall be designed for mounting on the concrete pad.
6. The transformer tank shall be a sealed tank liquid preservation system.

G. The transformer shall include the following:

1. Top filter press connection and sampling device.
2. Tank bottom drain valve and sampling device.
3. Gasketed, roof-mounted inspection covers to gain access to internal devices or connections.
4. Nameplate with connection diagram and transformer parameters as tested.
5. Warning signs as required.
6. Weatherproof, oversize connection box with provision for extension throat and access to end or side, removable for termination of low-voltage cables.
7. Primary and secondary bushings shall be side mounted.

H. Coating: Powder coat: Medium beige, Sherwin Williams number PLT6-1S4 or equal. Wet paint color: Medium beige, Sherwin Williams number F63RXN28022- 4337 POLANES or equal for touch up.

1. Weather, graffiti, and ultra-violet (UV) resistant.
2. Radiators may be painted or galvanized, as per manufacturer's recommendations.

I. Transformer Tank

1. A tank shall be mounted on a structural steel base that is adequate to provide support for the completely assembled transformer filled with oil and to prevent distortion during operation or relocation. Internal bracing shall not interfere with oil drainage. The structural steel base shall consist of at least two members parallel to the transformer major axis and at least two members parallel to the minor axis. The undersides of all members shall be in the same plane. The spacing of the base member shall be such as to permit the completely assembled transformer with or without oil to be safely tilted 15 degrees.
2. Transformer shall be of the sealed tank, welded steel plate and cover construction, outdoor type, liquid tight, with bolted and gasketed manhole(s) on top of tank. They shall be mounted on steel skid base, suitable for skidding in any direction. Use care to avoid tank or component distortion during welding operations. Assembled transformer base shall be sufficiently flat to be installed on a flat concrete foundation without supplemental shims. They shall be adequately designed and braced to allow full vacuum filling and vacuum drying operations in the field.
3. Provide jacking lugs and pulling eyes for lifting or moving along either axis when completely assembled and oil-filled. Lifting lugs are to be mounted near the top of the tank. Jacking lugs shall be installed with suitable clearance to the bottom of the base plate.
4. Provide two NEMA two-hole silver-plated copper ground pads at diagonal opposite corners of transformer tank near base, with two-bolt terminal connectors for 250

Kcmil copper conductors.

5. Maintain positive pressure continually to prevent ingress of moisture during shipping.
6. Provide an adequately braced domed or sloped top on major surfaces. Design tank and fittings to prevent water puddling on surfaces or in cavities.
7. Provide raised flanges with thru-bolts for removable cover penetrations, including bushings, manhole/handhole covers, and removable equipment. Welded studs are not acceptable.
8. Gasketed joints shall have machined surfaces on both sides and shall be provided with gasket retainers and metal-to-metal stops to assure even and effective pressure and to avoid over-stressing the gasket. Gaskets shall maintain oil-tight joints under service and fault conditions.

J. Core

1. Each core shall be fabricated from non-aging, cold-rolled, grain-oriented, stress-free, thin silicon steel laminations, with permeability and hysteresis loss characteristics necessary to satisfy design and performance requirements.
2. Provide each sheet with an insulated surface treatment that is impervious to hot transformer oil. Anneal properly with smooth surfaces at edges.
3. Core shall be rigidly clamped and blocked to prevent deteriorating vibrations, interference with oil circulation, objectionable noise conditions, and short circuit and shipment distortions.
4. Provide a core ground lead connected to an external bushing for each core. Provide a flexible ground strap to connect the terminal of the bushing to the transformer tank, thereby grounding the transformer core. Provide a suitable cover or deflector to protect the core ground bushing from damage from falling objects. Provide an engraved nameplate clearly indicating the function of the bushing. Provide a separate core ground bushing and ground strap for each separate core.
5. Serial number shall be stamped on core or core clamp in conspicuous place and shall be visible without the necessity for un-tanking or otherwise removing enclosure.

K. Windings

1. The windings shall be of copper and have insulation of high dielectric and mechanical strength and shall be arranged to permit free circulation of oil. Proper internal barriers shall be provided. Additional insulation shall be provided on end coils to protect against line disturbances.
2. The coils shall be fabricated and braced to provide for expansion and contraction due to temperature changes and to avoid abrasion of insulation. The coils shall be braced to prevent distortion due to any abnormal operating conditions and designed to withstand short circuit conditions in accordance with IEEE C57.12.90.
3. Each lead for connection to tap changers, bushings, etc. shall be permanently identified.

L. Instrument transformers

1. Instrument transformers shall conform to IEEE C57.13 and NEMA EL 21.2. The current

transformers (CTs) shall comply with the IEEE C57.13 relaying and metering accuracy standards, and shall have C200 accuracy class or better, under the burdens imposed by the connected services.

2. Instrument transformers shall be insulated for 1.0 kV voltage class and shall have basic impulse insulation (BIL) level of 20 kV full-wave.

M. Radiators

1. Radiators shall be detachable. The transformer cooling radiators shall be equipped with shut-off valves top and bottom and shall be bolted to the main tank to facilitate removal from the transformer main tank. The transformer shall be shipped with the radiators on at least one side removed to allow for the use of a standard size trailer, if necessary. The oil required to fill the removed radiators shall be shipped with the transformer or be provided by a local supplier.

2. Shut-off valves shall be equipped with a valve position indicator to indicate “valve open” or “valve closed”. The valves shall be lockable in the open and closed position. Steel blanking plates for openings shall be supplied.

3. Each radiator shall have a solid hex steel plug provided at the top and ball type drain valves at the bottom for drainage.

4. Each removable radiator shall be equipped with one lifting lug on top and one lifting lug on the bottom.

5. The design and construction of the radiators shall be such as to eliminate pockets where moisture can accumulate or which can prevent application of a continuous film of paint. Radiators shall be either hot dipped galvanized or painted in a fashion which ensures complete coverage of radiator surfaces. The radiators shall be provided with adequate bracing to prevent leakage from vibration.

6. Radiators are to have the same vacuum capability as the main tank.

N. Transformer oil

1. The transformer shall be provided with enough transformer oil for filling its tank and radiators to the proper level.

2. Transformer oil shall be biodegradable natural ester-based insulating fluid that provides for a low- vapor-pressure, low-viscosity, high-flash-point, stable insulating oil - EnviroTemp FR3 or approved equivalent.

3. Containment drain valve shall incorporate hardware that will allow for water to flow out of the containment pit at a flow rate equivalent or greater than a 1-1/2” diameter pipe. The same hardware shall cease all liquid flow from the containment pit if transformer oil is detected. The hardware shall detect oil using a passive system that does not require control power.

PART 3 - EXECUTION

3.01 General Requirements

A. All rectifier transformer tests, unless otherwise herein specified or as specified in Section 16953, shall be made in accordance with IEEE C57.12 Series and IEEE 1653.2. A complete

set of design tests will be required on one (1) rectifier transformer of each design and rating. The design tests shall also include a short circuit test to verify the integrity of the mechanical system. Routine tests as indicated in Article 3.02 in this Section are required for all rectifier transformers. For the routine tests submit notarized, certified test data for each rectifier transformer supplied. For the design tests indicated in Article 3.03 in this Section, submit notarized, certified test data for each rectifier transformer of the same design and rating. For the short circuit design test, test results on a rectifier transformer of the same design and rating, and of recent date, will be accepted. Submission and receipt of approval of the test reports are required before delivery of, or payment for, the rectifier transformers.

3.02 Routine Tests for Rectifier Transformers

A. Each rectifier transformer shall have routine tests performed as per IEEE C57.12.01, IEEE C57.12.91 and IEEE C57.18.10, plus the following additional tests shall be performed as routine tests. Impulse tests shall precede all low frequency tests as part of the test sequence:

1. Impulse tests consisting of the following, applied in the following order:
    a. One (1) reduced full wave, two (2) chopped waves and one (1) full wave. Details of impulse wave shapes shall be as per IEEE C57.98.
2. Partial discharge testing shall be performed and measurements taken for each high voltage coil of the rectifier transformer and for the complete rectifier transformer unit.

    Each high voltage coil and the complete unit shall have a minimum partial discharge extinction level of 120 percent of rated voltage. Test voltages shall be induced and not applied.
3. Each high voltage winding of every rectifier transformer shall withstand continuously for one (1) minute a potential applied between these windings and the grounded low voltage windings and iron core, the said potential to be not less 34,000 V AC for the 13,200 V rectifier transformers.
4. The low voltage windings shall withstand continuously for one (1) minute a potential of not less than 10,000 V AC applied between these windings and the grounded high voltage windings and iron core.
5. After the high potential test, all windings shall withstand continuously for seven thousand two hundred (7,200) cycles, at a suitable frequency, an induced potential between turns of twice their rated voltage per turn.
6. Audible sound level measurements shall be performed. Audible sound level shall be less than 70 dB.

3.03 Design Tests for Rectifier Transformers

A. Each rectifier transformer design shall have design tests performed as per IEEE C57.12.01, IEEE C57.12.91 and IEEE C57.18.10, plus the design tests indicated in this Section.

B. Each rectifier transformer design, with full sustained voltage applied to its high voltage terminals and with its low voltage terminals short circuited, shall withstand

for four (4) seconds the resultant mechanical and electrical stresses without mechanical damage or deterioration of the insulation.

C. Temperature Rise Tests:

1. In a 40°C ambient environment, for every winding, the average solid cast resin rectifier transformer winding temperature shall be less than 90°C (50°C rise) at full load and the hottest spot temperature less than 120°C.

2. Each vacuum pressure encapsulated rectifier transformer shall carry its overload rating, when operating on the lowest voltage taps of the high voltage winding, with a corrected temperature rise of less than 115°C at all times, during and following the test, for the average winding temperature as measured by resistance measurement. Similarly, the corrected hottest spot temperature rise shall remain less than 145°C in every case.

3. In a 40°C ambient environment, for every winding, the average vacuum pressure encapsulated rectifier transformer winding temperature shall be less than 105°C (65°C rise) at full load and the hottest spot temperature less than 135°C.

4. The corrected temperature rise shall be the greatest temperature rise obtained after correction to the specified nominal environmental temperatures and after making

allowances for tolerances and variations of manufacture and of the heat runs, including the thermal time constants, sufficient to include a very large percentage of such units. The tests shall be conducted as close as practicable to the nominal environmental temperature.

D. The overload rating shall be two (2) hours at a constant load of 160.3 percent. The rectifier transformer shall be mechanically, electrically and thermally capable of this loading cycle on a twice daily basis.

E. When operating at unity power factor on a 60 Hz, 3 phase, sine wave circuit at rated voltage on the high voltage winding, the conventional rectifier transformer efficiencies at loads corresponding to various rectifier outputs shall be not less than the values listed in Table 16273-1.

Table 16273-1 Conventional Transformer Efficiencies

Percent of Rated Rectifier Output Current	Percent Rectifier Transformer Efficiency
25	98.4
50	99.0
75	99.0
100	99.0
125	98.9
150	98.7

F. The efficiencies listed in Table 16273-1 shall be computed from the conventional losses of the rectifier transformer, corrected to a temperature of 80°C.

3.04 Field Tests

A. The primary and secondary of each rectifier transformer supplied and installed shall have dielectric tests performed as indicated in Article 3.02 in this Section. The voltage shall be 75 percent of the values indicated in Article 3.02 in this Section.

B. At any service temperature, while in or out of service, each rectifier transformer shall be capable of withstanding a five (5) minute dielectric test voltage applied between the high voltage windings and grounded low voltage windings and iron core. The voltage for the said dielectric test is to be 30,000 V DC or 20,000 V AC for the 13,200 V rectifier transformers as required by PECO.

C. The rectifier transformer shall be able to withstand any high frequency oscillatory voltage transients produced during the opening of the high tension vacuum circuit breaker. Prior to rectifier transformer energization a “Ping” test shall be performed by a qualified testing agency.

3.05 Tools

A. Refer to Section 01752 for spare parts and maintenance material requirements.

3.06 Field Manuals

A. Refer to Section 01832 for operations and maintenance manual requirements.

3.07 Spare Parts

A. Refer to Section 01752 for spare parts and maintenance material requirements.

END OF SECTION

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SECTION 16274

TRANSFORMER AND RECTIFIER UNIT

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for the installation, connection, interconnection and testing of the rectifier transformer and rectifier.

B. The work under this Section shall include the furnishing of all materials, equipment, labor, transportation, permits, construction equipment, machinery, tools, appliances, and all other facilities and incidentals necessary for the execution, testing, connection, interconnection, insulation or grounding, initial operation, and completion of the specified work.

C. The Contractor shall purchase and install traction power equipment and accessories as described in the related Sections and in accordance with the configurations shown on the Contract Drawings.

1.02 Related Sections

A. The General Provisions of the Agreement.

B. Section 01300 – Submittals

C. Section 01810 – Commissioning of Systems

D. Section 09662 – Electrically Insulated Floor Covering

E. Section 16260 – Traction Power Rectifier

F. Section 16273 – Traction Power Rectifier Transformers

G. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Refer to Sections 01300, 16260 and 16273 for submittal requirements.

B. Documentation and calculations to substantiate the design and performance requirements as described in Article 1.05 in this Section.

1.04 Quality Assurance

A. The rectifier transformer and rectifier unit shall be designed in accordance with the appropriate codes and standards and to meet the harmonic requirements of IEEE 519.

B. Meet the applicable provisions of the most recent issues of the following references:

1. IEEE 519, IEEE Recommended Practice and Requirements for Harmonic Control in Electric Power Systems.

2. IEEE 1653.1, IEEE Standard for Traction Power Rectifier Transformers for Substation Applications up to 1500 V DC Nominal Output.

3. IEEE 1653.2, IEEE Standard for Uncontrolled Traction Power Rectifiers for Substation Applications up to 1500 V DC Nominal Output.
4. NFPA 70, National Electrical Code (NEC).
5. IEEE C37.91, IEEE Guide for Protecting Power Transformers.
6. IEEE C57.12.01, IEEE Standard for General Requirements for Dry-Type Distribution and Power Transformers.
7. IEEE C2, National Electrical Safety Code (NESC).

1.05 Design and Performance Requirements

A. Rectifier Transformer and Rectifier Unit:

1. The rectifier transformer and rectifier unit shall include all equipment at the Traction Power Substation (TPSS) from the high voltage connections on the rectifier transformer to the DC connection at the rectifier. The unit shall consist of a rectifier transformer and a rectifier complete with all standard and specified accessories, auxiliaries, controls and all necessary hardware, interconnecting buses, wiring and devices.
2. Voltage Regulation:
   a. The DC output voltage of the rectifier transformer and rectifier unit at 100 percent load shall be 700 V DC plus or minus 0.5 percent. The rectifier transformer and rectifier shall have linear direct current voltage regulation not exceeding 6 percent plus or minus 0.5 percent, between 1 percent and 100 percent of rated load, when rated primary voltage is applied to the AC line terminals of the rectifier transformer. At 450 percent of rated kilowatt load, the voltage at the rectifier load terminals shall not be less than 535 V DC.
   b. A base load resistor, with means of manual disconnection, shall be furnished with the rectifier unit, to limit the no load (1 percent full load) terminal voltage to a maximum of 750 V DC.
   c. With wayside energy storage system enabled the load resistor shall limit the terminal voltage to 800 V DC.
3. The overall efficiency of the rectifier transformer and rectifier unit shall be greater than 98 percent at 100 percent rated kilowatts.
4. The total power factor, including harmonics, of the rectifier transformer and rectifier unit shall be greater than 0.95 from 25 percent to 100 percent full load at rated AC voltage.
5. The rectifier transformer and rectifier combination shall be connected for 12 pulse, double-way operation.
6. The rectifier transformer and rectifier unit N-1 mode shall be capable of withstanding 100 percent of the theoretical short circuit current, with short circuit applied at the rectifier terminals, without damage to any component, including diodes and diode fuses, until cleared. The Contractor shall provide calculations and supporting data for protection coordination for an internal and external fault on the rectifier.
7. The rectifier transformer and rectifier unit shall minimize generation of harmonics, consistent with the design and construction requirements. Refer to IEEE 519 for recommended maximum harmonic current and voltage distortion limits as measured at

the service point. The Contractor shall provide necessary documentation, calculations and test results to demonstrate compliance with IEEE 519.

8. Protection against transient surges shall be provided.
9. Base load resistors for the rectifier transformer and rectifier unit shall be mounted in a ventilated perforated steel metal enclosure mounted on the rectifier roof.
10. Provide hardwired connections for monitoring the status, protection and analogs of the rectifier units.

1.06 Inspection

A. Inspection of the material/equipment will be made at the point of delivery. However, the SEPTA Project Manager reserves the right to make any tests or inspection that it may deem necessary at the manufacturer's plant. In the event inspection is made at the plant, the Contractor shall grant the SEPTA Project Manager free entry at all times while work under this Section is being performed, to all parts of the plant which concern the manufacture of the concerned material/equipment. The Contractor shall render all facilities to satisfy the SEPTA Project Manager that the material/equipment is being furnished in accordance with this Section. In all cases, the Contractor shall notify the SEPTA Project Manager when the finished material/equipment is ready for shipment in order that plant inspection of the material/equipment may be made if desired.

1.07 Warranty

A. Provide a two (2) year warranty against defective materials and workmanship, from the date of final acceptance.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Refer to Sections 16260 and 16273.

PART 3 - EXECUTION

3.01 Preparation

A. The Contractor shall thoroughly review the Contract Drawings and Specifications in preparation for the development of detailed installation plans and procurement of the materials and equipment. Materials shall be procured, stored, and planned for use which minimizes waste, and substitutions, and maximizes installation efficiency and quality of the end product. The Contractor shall be responsible for developing all site details, including foundations details as applicable and equipment interconnections for complete installation of the equipment supplied. All installation details shall be subject to approval of the SEPTA Project Manager.

B. The Contractor shall examine all approved and reference drawings, to verify and properly coordinate the work; check all relevant drawings including shop drawings.

3.02 Installation and Execution

A. General:

1. Install rectifier transformer, rectifier and associated connections as per the manufacturer's recommendations and standard industry practice.
2. Silver plate surfaces of any bus connections and bolt the connections.
3. The completed installation shall be checked out and tested in accordance with the applicable portions of Section 16953.

B. Rectifier Transformer:

1. Furnish, install and connect the 13.2 kV power circuit conductors and control cables necessary for operation of the rectifier transformer, in accordance with applicable requirements.
2. The low voltage terminals of the rectifier transformer shall be connected to the AC cables that then connect to the rectifier.

C. Rectifier:

1. The rectifier unit shall be completely assembled and installed.
2. The floor area at the rectifier unit shall be covered with a layer of insulating material. Care shall be taken that the insulated floor area is not scraped or otherwise damaged during installation. Bolt the rectifiers to the floor using insulated mounting bolt assemblies. The dielectric floor shall have an insulation resistance as per Section 09662.
3. Grouting shall not be allowed after installation of the insulating floor topping.
4. Furnish, install and connect the control supply, auxiliary power supply cables, control and interlocking circuit cables necessary for intended operation of the rectifier and its auxiliary circuits in accordance with all applicable requirements.
5. The rectifier unit shall be connected to the rectifier transformer and to the cathode circuit breaker. Rectifier negative terminal shall be connected to the negative and drainage switchboard.

3.03 Testing

A. Test the rectifier transformer and rectifier unit as specified in this section, as per the required IEEE Standards and as specified in Section 16953.

END OF SECTION

SECTION 16290

PROTECTIVE DEVICES AND INSTRUMENT TRANSFORMERS

PART 1 - GENERAL

1.01 Description

A. This Section specifies general requirements for application of protective relays, instrumentation and associated devices.

B. Detailed requirements are specified in the relevant individual equipment sections. The equipment sections and the Contract Drawings describe the minimum protective scheme required and are intended to serve as an aid to the functional requirements. Components such as auxiliary relays, isolating diodes, fuses and other similar devices required for a complete installation are not individually specified but shall be provided by the Contractor.

C. Perform all final design details including selection of device models, styles, ranges, connections, and settings to ensure satisfactory coordination of all protective devices and a fast fault clearance.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control - Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling - Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials - Traction Power Equipment

E. Section 01822 – Demonstration and Training - Traction Power Equipment

F. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment

G. Section 05090 – Metal Fasteners, Joining and Welding

H. Section 09910 – Paints and Coatings

I. Section 16060 – Grounding and Bonding

J. Section 16075 – Electrical Identification

K. Section 16335 – Surge Protection

L. Section 16344 – DC Traction Power Switchgear Assemblies

M. Section 16910 – Electrical Systems Control SCADA, Remote Terminal Unit – Including HMI

N. Section 16953 – Electrical Testing - Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following documents and samples for SEPTA's review and approval:

1. Provide technical product data sheets for all system equipment. Including the following equipment:

a. Current transformers.
b. Potential transformers.
c. Protective devices.
d. Auxiliary relays.
e. Measuring instruments.
f. Indicating devices.
g. Cables and wires.
h. Equipment enclosure.
i. Terminal blocks and connectors.

2. Submit product samples:
   a. The Contractor shall submit samples of the following products for approval:
      1) Cables and wires.
      2) Terminal blocks and connectors.
3. Submit relay setting software for each relay.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following standards:

1. ASCII, American Standard Code for Information Interchange.
2. IEEE 242, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
3. IEEE C2, National Electrical Safety Code (NESC).
4. IEEE C37.1, IEEE Standard for SCADA and Automation Systems.
5. IEEE C37.2, IEEE Standard Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.
6. IEEE C37.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
7. IEEE C37.90.1, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
8. IEEE C37.97, IEEE Guide for Protective Relay Applications to Power System Buses.
9. IEEE C37.112, IEEE Standard Inverse-Time Characteristic Equations for Overcurrent Relays.
10. IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.
11. IEEE C62.11, IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV).
12. NEMA FB 1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
13. NEMA ICS 4, Application Guideline for Terminal Blocks.
14. NEMA ICS 6, Industrial Control and Systems: Enclosures.

15. NEMA PB 1, Panelboards.
16. UL 486A-486A, Wire Connectors.
17. UL 508, Industrial Control Equipment.
18. UL 1437, Electrical Analog Instruments, Panel Board Type.

PART 2 - PRODUCTS

2.01 Protective Devices

A. Design and provide a comprehensive protective relay scheme to protect the Traction Power Substation (TPSS) equipment and the overhead distribution system, as well as to provide back-up protection to the vehicle protective devices.

1. Base the protective scheme design on the load, overload and short circuit currents.
2. Select the characteristics and ranges of all protective devices to ensure satisfactory coordination of all devices and a fast fault clearance.
3. The Contractor is required to review other “existing TPSS location” relay protection schemes and present a standardized list of common parameter settings for SEPTA’s review.
4. All devices (relays, panels, etc.) that are considered long lead items must be submitted by the Contractor within the first ninety (90) days of the Contractor's Notice to Proceed.

B. Provide sufficient hard wire connections for all protective functions to allow for all TPSS equipment including the switchgear, high voltage circuit breakers and transformers, to continue to be functional, via local control, in the event of failure of the local area network, the Remote Terminal Unit (RTU), or any part of the Supervisory Control and Data Acquisition (SCADA) or communications equipment.

C. Select solid state, microprocessor based, multi-function, self-reset protective relays. All main functions of the relays shall be individually configurable on a computer and shall be enabled or disabled by the user by means of straightforward configuration procedure.

D. Provide high quality, utility type, protective relays of modular design enclosed in rustproof, dust-proof, metal or high impact plastic cases suitable for flush mounting on equipment cabinets.

E. Provide relays with provisions for relay setting, adjustments and testing from the front of the relay. Provide each protective relay with readily visible and accessible LCD control panel integrated with the relay. The control panel shall enable entry of all data required for operation of the relay, including the following:

1. Readout and modifications of settings.
2. Readout of measured data.
3. Readout of operating data logs and of monitored signal logs.
4. Readout of event logs, at least last ten (10) events.
5. Support relay testing and commissioning tasks.

F. Design, provide, install and program the protective relays with a dual redundant (self-healing) path communication network to communicate traction power equipment information (reference 16910) amongst all of the relays installed in the TPSS back to the SCADA/RTU network.

G. Provide a non-proprietary data concentrator to communicate the relay control and information protocols to the SCADA/RTU. The data concentrator shall have dual processors that run simultaneously, and each shall contain the most current software and data files used to operate and monitor the relay control system at all times. In the event of a failure of the concentrator processor currently in service, there shall be a non-detectable automatic switch from the failed processor to the operable second processor. The data concentrator shall provide an alarm/indication of the failure of any processor to the SCADA/RTU.

H. Provide a “watchdog” alarm for all traction power equipment to annunciate to the SCADA/RTU system when a relay has failed and/or lost communication on the network. This alarm shall not activate any trip for any medium voltage circuit breaker.

I. The design and/or installation of additional auxiliary or interposing relay(s) between the relay circuit breaker trip output contacts and its associated rectifier transformer circuit breaker trip circuit is not permitted.

J. Design, provide and install a non-proprietary communication device for the relay communication network to communicate back to the SCAD/RTU unit in a suitable protocol.

K. Provide, install and program any/all hardware (including all communication cabling to SEPTA’s Communication Plant/System) and software required to allow SEPTA the complete ability to remotely (without having to physically go to the TPSS) extract relay event files and parameters.

L. Coordinate with the SEPTA Project Manager and SEPTA C&S department for relay network individual addresses.

M. All components design and implementation in this design (in its entirety) must be non-proprietary and able to be troubleshooted by SEPTA maintenance personnel.

N. Provide each relay with comprehensive and continuous self-monitoring capability ensuring that hardware and software errors are detected and will not cause malfunction of the protective device. Depending upon the fault diagnosis, the self-monitoring system shall issue alarm or block the relay operation. Provide all relays with provision to annunciate operation and failure on the relay as follows:

    1. Locally, the relay operation, alarm and failure shall be indicated by light emitting diodes (LEDs).

    2. Remotely, provide each relay with a sufficient number of contacts and outputs to enable operation, alarm and failure of the relay to be indicated on the SCADA system.

O. All protective relays shall be arranged to be conveniently accessible, easily visible and logically grouped. Devices of related functions shall be located in proximity to each other. The protective relays shall be installed on the cubicle door and shall be semi-flush mounted.

P. Provide test switches to disable all tripping circuits of the relay in the event that it is necessary to remove the relay for service or replacement or for testing the relay functions. Provide test switches so that current transformer circuits shall be short circuited and potential transformer circuits shall be open circuited prior to the relay removal from its case or its rack or for testing the relay functions.

Q. Provide the protective relays with the following other features:

1. Internal clock for event logging capable of being synchronized to the communications protocol.

2. Silver or silver/copper alloy non-bonding contacts.

R. Manufacturers:

1. Schweitzer Engineering Laboratories (SEL).

2. Or Approved Equal.

2.02 Protective Relay Philosophy

A. Transformer Faults:

1. Transformer protection shall include overcurrent relays, as well as pressure relief, temperature and low oil devices. The relays shall trip the respective transformer circuit breaker via hand reset and electrical/hand reset lockout relays.

B. Feeder-to-Ground Faults:

1. Feeder-to-ground faults shall be detected by instantaneous and time overcurrent relay (Device 50/51).

C. High Voltage Circuit Breaker Failure Relaying:

1. The Contractor to provide final design for failure of high voltage circuit breakers to interrupt fault current shall be detected and cleared by circuit breaker failure relays (Device 52BF).

2. If at the end of a pre-selected time, the current remains above the current setting, all high voltage circuit breakers on the bus shall be tripped via a lockout relay.

D. Automatic Reclosure:

1. Each DC feeder circuit breaker shall have automatic reclosure capability including a load measuring network consisting of a feeder current measuring relay (Device 182), voltage measuring transfer relay (Device 183), load measuring contactors (Device 129), load measuring resistors, adjustable time delay re-closing relays, counters, and other associated devices as required.

E. Protective Devices Wiring:

1. Use copper cables for the wiring related with the protection circuits including wiring from current transformers and potential transformers and the wiring for the trip circuits between various cubicles. All wiring must be low smoke, zero halogen type as specified in other Section of the Project.

2.03 Auxiliary, Tripping and Control Relays

A. Provide compact, highly reliable, mechanically stable, voltage operated, self-reset, hand-reset and electrically/hand-reset auxiliary, tripping and control relays, as required for the particular application.

B. Provide each relay with a flag to indicate relay operation.

2.04 Current Transformers

A. Provide current transformers to accurately transform the system currents for metering and relaying. Select the current transformers to satisfy ANSI and IEEE requirements for metering and relaying accuracy classification under the burdens imposed by the metering and protective devices.

B. Select ring core type current transformers with toroidally wound and fully distributed secondary windings.

C. Select current transformers insulated with structural grade thermoplastic to withstand dielectric test levels of the equipment and to carry the currents occurring during rated load, overload, and short circuit currents without excessive heating or injury.

D. Provide each current transformer with a mounting frame which bolts securely to the mounting beam. Run secondary wiring from the current transformer terminal studs to terminal blocks. Provide the current transformer terminal blocks with covers having integral shorting bars.

E. Ensure that all unused current transformer connections are properly shorted to prevent the possibility of the current transformer developing very high voltage across its secondary which may damage the current transformer insulation and/or pose a personal safety hazard.

2.05 Potential Transformers

A. Provide potential transformers to accurately transform the system voltages for metering and relaying. Select the potential transformers to satisfy ANSI and IEEE requirements for metering and relaying accuracy classification under the loads imposed by the metering and protective devices.

B. Potential transformers shall be suitable for the installed environment.

C. Select dry type potential transformers with physically strong protective cases and with superior insulating properties.

D. Select potential transformers with adequate insulation to withstand the dielectric test levels of the equipment and to carry their load continuously without excessive heating or injury.

E. Select the potential transformers with high resistance primary windings and with high knee point (not less than 1.2 p.u.).

F. Rating:

1. Potential Transformer Circuit:
    a. Frequency to be 60 Hz.

b. Primary voltage rating to be 13.8 kV (meet PECO requirements).
c. Secondary voltage rating to be 120 V.
d. Basic Insulation Level (BIL) to be 150 kV.
e. Power frequency withstand to be 95 kV.

2. Burden and accuracy to be consistent with relay requirements.

G. Protect the primary circuits of all potential transformers by means of non-renewable cartridge type fuses. Provide fuses with blown fuse indication. Protect secondary circuits of all potential transformers by molded case circuit breakers mounted in the cubicle control compartment.

2.06 Transducers and Converters

A. Select transducers and converters as required for the applications specified.

B. Choose transducers and converters with inputs compatible with outputs from current transformers, potential transformers, and other measuring devices and outputs.

C. Provide compact transducers and converters to convert input variables into proportional output signals with accuracy of 0.1 percent or better.

D. The transducers and converters may be stand-alone devices or may be an integral part of relays or measuring devices.

E. Install the transducers and converters in a suitable enclosure.

F. SEPTA SCADA analog boards are rated for 0-1 mA. Transducer output rating must match SEPTA SCADA analog board rating.

2.07 Instrumentation

A. Provide high quality, metal case, semi-flush, 4 1/2 inch square, switchboard type digital meters with accuracy of 1 percent of full scale value.

B. Select all instruments to match the input signals, including fault currents.

2.08 Indication

A. Provide illuminated and non-illuminated indication for all key functions of the equipment as specified herein.

B. All illuminated indication shall be by Light Emitting Diodes (LEDs) located on cubicle doors. The indicators may consist of individual LEDs or clusters of LEDs, depending on the required brightness. In order to identify LED failures, each LED or group of LEDs shall have a push-to-test switch located conveniently near the LED or group of LEDs. When depressed, the test switch shall disconnect the normal circuit feed and cause the LEDs to illuminate. The LED color shall be selected by SEPTA during shop drawing review.

2.09 Test Blocks/Test Switches

A. Provide test blocks in semi-flush cases of uniform sizes suitable for panel mounting.

B. Wire the test blocks to provide a direct access to the system protection and measurement. Include the following monitoring and testing functions:

1. Recording of all instrument measured functions.
2. Monitoring of current transformer currents and potential transformer voltages.
3. Current transformer short circuiting.
4. Current transformer secondary injection testing.
5. Operation of circuit breakers.
6. DC auxiliary power monitoring.

C. Provide a dull black dust cover permitting covering of the test blocks when not in use.

D. Ensure that all unused current transformer connections are properly shorted to prevent the possibility of the current transformer developing very high voltage across its secondary which may damage the current transformer insulation and/or pose a personal safety hazard.

2.10 Annunciation

A. All control, status and alarm functions which are transmitted to the SEPTA Power Department Control Center shall be annunciated locally at the touch screen Human Machine Interface (HMI) installed on the door of the proposed RTU. The HMI screen shall be subject to SEPTA pre-approval and shall replicate the display at the SEPTA Power Department Control Center. The high voltage circuit breaker control functions, circuit breaker status and voltage shall also be annunciated on the RTU. Include test, silence, acknowledge and reset switches, as well as other associated equipment. The Contractor may propose an alternative location of the HMI for review and approval SEPTA.

B. Design the audible alarm to operate only when the annunciator control switch is in "Local" position.

PART 3 - EXECUTION

3.01 Testing

A. Perform tests specified in section 16953 and include all applicable tests from:

1. Test indicating instruments in accordance with UL 1437.
2. Test relays and transducers in accordance with IEEE C37.90 and IEEE C37.90.1.
3. Test instrument transformers in accordance with IEEE C57.13
4. Test annunciator in accordance with IEEE C37.90.

B. Field testing will be performed at rated frequency.

C. It will be required by the Contractor and SEPTA that the relay manufacturers' programmer(s) be on each of the sites ready for any startup activities and all other programming exercises, and the Contractor will be required to provide payment for these programmers' services as part of his Step Two Price Proposal. Additionally, these programmers are to be compensated by the Contractor to remain on site; or exclusively accessible; for a period of one (1) week after commissioning/startup to make any SEPTA authorized setting adjustments during this time.

3.02 Technical Support

A. SEPTA will require that both the SCADA and relay vendors provide (at no additional cost to SEPTA) one hundred and eight-two (182) days of technical support from the date that the entire TPSS is placed back into “revenue service”. Support is defined as immediate dedicated phone support available twenty-four (24) hours per day every day per week (not excluding holidays). If a resolution cannot be attained via the phone support, then the vendor will need to send on-site trouble shooting personnel with a response time of no greater then twelve (12) hours from the time of the initial phone call to the vendor. Provide experienced and competent technical support personnel who have a direct and complete knowledge of the equipment and systems supplied and are capable of providing detailed explanations of the operation, trouble shooting and maintenance of all equipment and systems.

B. Provide technical support personnel with a minimum of ten (10) years of experience in the design, manufacture, installation, trouble shooting and maintenance of the equipment.

C. The technical support personnel shall be subject to approval by SEPTA. SEPTA reserves the right to request personnel replacement for any reason and have the technical support activity repeated at no additional cost to SEPTA.

END OF SECTION

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SECTION 16300

DC REMOTE CONTROL BOARD

PART 1 - GENERAL

1.01 Summary

A. This Section includes:

1. Furnishing, installing, and testing of DC remote control boards associated with remote control of existing wayside DC circuit breakers.
2. The Contractor to determine the final physical layout and control circuit topology for the new DC remote control boards.

1.02 Related Sections

A. Section 01010 - Summary of Work

B. Section 01300 - Submittals

C. Section 01810 - Commissioning of Systems

D. Section 01832 - Operations and Maintenance Manuals – Traction Power Equipment

E. Section 16130 - Raceways and Boxes

F. Section 16290 - Protective Devices and Instrument Transformers

G. Section 16953 - Electrical Testing - Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following for approval:

1. Shop drawings; including but not limited to; schematics and interconnecting drawings; connection diagrams and outline drawings; assembly erection and installation drawings.
2. Product data for all components including manufacturer’s catalog cuts, materials specifications, installation instructions and other data pertinent for DC remote control board.
3. Manufacturer’s product and performance data.
4. Certificate of compliance.
5. Parts and special tools list.
6. Operations and maintenance manual.
7. Test reports.
8. Test plans and procedures. No test results will be accepted prior to receipt and approval of test plans and procedures.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following standards:

1. ANSI Z535, Safety Alerting Standards.
2. ASCII, American Standard Code for Information Interchange.
3. Codes and regulations of Authority Having Jurisdiction (AHJ).
4. IEEE 242, IEEE Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
5. IEEE C37.1, IEEE Standard for SCADA and Automation Systems.
6. IEEE C37.2, IEEE Standard Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.
7. IEEE C37.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
8. IEEE C37.90.1, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
9. IEEE C37.97, IEEE Guide for Protective Relay Applications to Power System Buses.
10. NEMA FB 1, Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing, and Cable.
11. NEMA ICS 4, Application Guideline for Terminal Blocks.
12. NEMA ICS 6, Industrial Control and Systems: Enclosures.
13. NEMA PB 1, Panelboards.
14. UL 486A-486A, Wire Connectors.
15. UL 508, Industrial Control Equipment.

B. Qualifications:

1. Select a manufacturer who is regularly engaged in the production of similar equipment and has demonstrated a successful record of providing equipment of similar type and rating for control of existing wayside DC circuit breakers.

1.05 Delivery, Storage and Handling

A. Equipment for each Traction Power Substation (TPSS) shall be delivered in accordance with the specified or agreed schedule.

B. Ship each unit securely packaged and labeled for safe handling.

C. Properly receive, handle, and store all materials and equipment in conformance to the manufacturer’s requirements.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. DC Remote Control Board:

1. Free standing, metal enclosed, suitable for installation inside each TPSS. The following equipment shall be included in the DC remote control board cabinet:
   a. Control circuits for the remote control of existing wayside DC circuit breakers as shown on Contract Drawings TP142, TP242, TP243, and TP342.
2. Enclosure:
   a. Metal-enclosed, rigid, self-supporting, self-contained, assembled as one (1) unit. Minimum 12 gauge sheet steel to be used for enclosure construction.
   b. Designed and arranged to provide convenient access to all components for normal operation and maintenance.
   c. Finish:
      1) Metallic surfaces degreased, primed and finished with standard light gray enamel color 61, ANSI Z535; 2 mils minimum dry film thickness.
   d. Enclosure shall be constructed to be fastened to an existing TPSS floor by means of expansion type concrete anchors.
3. Name Plates:
   a. Three (3) ply, laminated phenolic plates engraved through black face to white core and attached by means of stainless steel rivets or screws. Vertical gothic lettering using a round or square cutter.
   b. Provide additional functional nameplates for each component.
   c. Each enclosure labeled, in front with nameplate 2 1/2 inches by 6 1/2 inches, inscribed in letters 1/2 inch high: “DC REMOTE CONTROL BOARD”.

PART 3 - EXECUTION

3.01 Installation

A. Install DC remote control board in accordance with the approved shop drawings.

B. Install conduit and raceway in accordance with the approved shop drawings.

C. Make cable connections in accordance with the approved shop drawings.

3.02 Testing

A. Products shall all be factory tested prior to delivery.

B. Field test per approved test plan submittal.

END OF SECTION

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SECTION 16315

DEAD BREAK JUNCTION EQUIPMENT

PART 1 - GENERAL

1.01

A. This Section includes:

1. Furnishing, installing, and testing of load break junction equipment associated with rehabilitation of the 4.8 kV AC power and lighting cable system.
2. Refer to reference drawing 7E – 16563, latest revision, 4.8 kV AC Power & Lighting Cable Loading Single Line Diagram Electrical which is included in the Reference Documents. Refer to Article 1.02/L/1, Table 01010-1 of Section 01010 for the Reference Documents.
3. Install new 600 amp dead break elbows on the new MV cable installed between the 4.8 kV system circuit breakers and the existing 3-way 600 amp dead break junctions in the manholes outside the substation. Upon successful commissioning and acceptance, SEPTA's Underground Power personnel will terminate the elbows at the existing 3-way junction.

1.02 Related Sections

A. Section 01010 - Summary of Work

B. Section 01300 - Submittals

C. Section 01832 - Operations and Maintenance Manuals – Traction Power Equipment

D. Section 16130 - Raceways and Boxes

E. Section 16138 - Ductwork and Electrical Manholes and Handholes

1.03 Submittals

A. Submit the following for approval:

1. Shop drawings; including but not limited to; schematics and interconnecting drawings; connection diagrams and outline drawings; assembly erection and installation drawings.
2. Product data for all components including manufacturer’s catalog cuts, materials specifications, installation instructions and other data pertinent for dead break junction assembly.
3. Manufacturer’s product and performance data.
4. Certificate of compliance.
5. Parts and special tools list.
6. Operations and maintenance manual.
7. Test reports.
8. Test plans and procedures. No test results will be accepted prior to receipt and approval of test plans and procedures.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following standards:

1. Codes and regulations of Authority Having Jurisdiction (AHJ).
2. ANSI Z535, Safety Alerting Standards.
3. IEEE 386, IEEE Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
4. NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems.

B. Qualifications:

1. Select a manufacturer who is regularly engaged in the production of similar equipment and has demonstrated a successful record of providing equipment of similar type and rating for medium voltage underground distribution.

C. Factory testing:

1. Factory test requirements are as follows:
   a. Equipment dielectric withstand test:
      1) Test all live parts of the equipment, completely assembled, at a voltage level of 28000 V AC RMS, 60 Hertz or 34000 V DC for sixty (60) seconds.

D. Field Testing:

1. Perform dielectric withstand test in the field after equipment has been installed and properly grounded. Test points from junction shall be between bushing inset conductor and equipment ground point. All cables shall be tested individually after termination but before installation. Follow hi-pot test set manufacturer's procedure (or recommendations) for test voltage level and time duration.

1.05 Delivery, Storage and Handling

A. Equipment for each TPSS shall be delivered in accordance with the specified or agreed schedule.

B. Ship each unit securely packaged and labeled for safe handling. Where necessary, brace for hoisting, lowering and skidding into manholes.

C. Properly receive, handle, and store all materials and equipment in conformance to the manufacturer's requirements.

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Dead Break Junction Equipment:

1. Free standing, enclosed, suitable for installation in manholes, underground vaults and on outdoor concrete pads as for typical underground distribution service equipment. The following equipment shall be included in the cabinet:
   a. 600 A 15 kV dead break elbows and junctions for connecting equipment and cable on primary feeder and network circuits:

1) 600 A 15 kV Class dead break Junction with three (3), 8.3/14.4 kV dead break interfaces (bushings) that are internally bused together.
2) Suitable for use in pad-mounted apparatus, underground vaults, and other apparatus to sectionalize, establish loops, taps, or splices, and to facilitate apparatus change-outs when mated with comparably rated products.
3) Shall provide a fully shielded, submersible, separable connection for dead break operation.
4) Minimum voltage ratings of the junction shall be as follows:
    a) Standard voltage class to be 15 kV.
    b) Maximum rating phase-to-phase to be 14.4 kV.
    c) Maximum rating phase-to-ground to be 8.3 kV.
    d) AC 60 hertz one (1) minute withstand to be 34 kV.
    e) DC fifteen (15) minute withstand to be 53 kV.
    f) BIL and full wave crest to be 95 kV.
    g) Minimum corona voltage level to be 11 kV.
5) Shall have a continuous solid current path of all copper alloy. No aluminum components shall be used.
6) It shall have an arc interrupter with highly effective deionizing properties.
7) The body shall be molded of high quality peroxide-cured EPDM insulation and shall have a molded on peroxide-cured semi-conductive EPDM shield.
8) The dead break interface (bushings) shall have latch indicator rings, located on the circumference of the collar, to indicate when the elbow is fully latched.
9) The dead break junction shall have an adjustable stainless steel bracket for mounting at various operating angles on flat or curved surfaces, with up to 90° tilt in 10° increments.
10) The dead break junction shall be supported by a solid back plate channel that will provide rigid support for the junction as will be required during load break operation.
11) Parking stands to accommodate insulated standoff bushings or portable feed-through inserts.
12) Two (2) drain wire clamps, each to accommodate two (2) wires up to No. 1/0 AWG stranded (3/8 inch diameter) or stainless steel “U” straps for direct wall mounting.

b. 600 A 15 kV dead break elbows with the following features and ratings:
    1) Shall be fully shielded and insulated plug-in termination for connecting insulated cables to transformers, switching cabinets and junctions equipped with dead break bushings (interfaces).
    2) Voltage rating to match the rating of the junction as shown in this Section.
    3) Shall be molded using high quality peroxide-cured insulating and semi-conducting EPDM rubber.
    4) Shall have coppertop connector to transition from the cable to the load break probe.
    5) Tin-plated copper load break probe with an ablative arc follower tip.
    6) Stainless steel reinforced pulling eye.
    7) Shall have a capacitive test point, made of corrosion resistant plastic, for use with fault indicators.
    8) Copper cable lug with each elbow.
c. 15 kV bushing well insulated plug:

1) Provide one (1) 600 A 15 and 25 kV class bushing well insulated plug with each junction. The plug shall have the following properties:
    a) Shall provide an insulated, fully shielded, submersible cover for an unused 15 kV Class bushing well in dead front equipment.
    b) Shall be molded of high quality EPDM insulation and have a molded semi-conductive EPDM shield.
    c) A molded ground tab on the shield shall allow attachment of a ground wire to ensure dead front construction.
    d) Shall have a stainless steel reinforced pulling eye that allows hot stick installation and removal.

d. Ground bus:
    1) Provide one (1) copper ground bus, in each junction assembly, with the following properties:
        a) Copper bus shall be sized to carry the available short circuit current at the location.
        b) OSHA ground stud attached to ground bus.

2. Assembly:
    a. Designed and arranged to provide convenient access to all components for normal operation and maintenance.
    b. Finish:
        1) Metallic surfaces degreased, primed and finished with standard light gray enamel color 61, ANSI Z535; 2 mils minimum dry film thickness.

PART 3 - EXECUTION

3.01 Preparation

A. Pump out manholes and underground vaults and maintain that condition while installing the dead break junction equipment.

B. Enter manholes and vaults as part of a confined space entry program.

3.02 Installation

A. Install dead break junction in accordance with the approved shop drawings.

B. Install conduit and raceway in accordance with the approved shop drawings.

C. Make cable connections in accordance with the approved shop drawings.

3.03 Testing

A. Products shall all be factory tested prior to delivery.

B. Field test per approved test plan submittal.

END OF SECTION

SECTION 16335

SURGE PROTECTION

PART 1 - GENERAL

1.01 Description

A. Furnish suitable surge arresters and transient voltage surge suppression devices to protect Traction Power Substation (TPSS) equipment against overvoltages. Replace the existing surge arresters on the AC utility feeder circuits, as a minimum, as shown on the Contract Drawings.

B. Provide surge protection on main auxiliary transformers and power panels.

C. The Contractor to provide surge arresters inside the new 1000 V DC switchgear as shown on the Contract Drawings. The voltage rating of the existing surge arresters on the SEPTA system is 970 V DC.

1.02 Related Sections

A. All requirements that are described in Division 1.

B. Section 01452 – Contractor Quality Control - Traction Power Equipment

C. Section 01612 – Delivery, Storage and Handling - Traction Power Equipment

D. Section 01752 – Spare Parts and Maintenance Materials - Traction Power Equipment

E. Section 01832 – Operations and Maintenance Manuals - Traction Power Equipment

F. Section 05610 – Miscellaneous Metals

G. Section 09910 – Paints and Coatings

H. Section 16050 – Basic Electrical Materials and Methods

I. Section 16060 – Grounding and Bonding

J. Section 16075 – Electrical Identification

K. Section 16290 – Protective Devices and Instrument Transformers

L. Section 16953 – Electrical Testing - Traction Power Equipment (CTD)

1.03 Submittals

A. Submit the following documents for SEPTA's review and approval:

1. Technical product data for the following equipment:
    a. Surge arresters.
    b. Transient voltage surge suppressors.
    c. Connecting wires and cables.
2. Submit the manufacturer's certified test data including evidence that the arresters and transient voltage surge suppressors that meet the specified standards.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
2. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
3. IEEE C2, National Electrical Safety Code (NESC).
4. IEEE C62.11, IEEE Standard for Metal-Oxide Surge Arresters for AC Power Circuits (>1 kV).
5. IEEE C62.22, IEEE Guide for the Application of Metal-Oxide Surge Arresters for Alternating-Current Systems.
6. UL 1449, Surge Protection Devices (SPD).

PART 2 - PRODUCTS

2.01 Equipment to be Protected

A. Protect all power and electronic equipment outside and within the TPSS as appropriate, including the following equipment:

1. AC switchgear, DC switchgear, rectifier transformers, auxiliary transformers, and power panels.
2. Electronic equipment, including, but not limited to:
   a. Power supplies.
   b. Electronic equipment.
   c. Remote terminal unit.
   d. Data communication lines.

B. Select the protective equipment voltage rating, energy dissipation rating and other characteristics compatible with the equipment to be protected.

2.02 Overvoltage Protection

A. Protect all electrical and electronics equipment taking into account the following:

1. Possible Sources of Overvoltages:
   a. Lightning strikes in the project locale.
   b. Circuit breaker switching surges.
2. Location of Equipment:
   a. Take into account the equipment distance from the service entrance for indoor equipment.
3. Equipment Type:
   a. Voltage level of equipment input and output.
   b. AC or DC power input and output.
   c. Analog or digital signal input and output.

d. Voice or data signal input and output.

4. Ground grid resistivity at the TPSS location.

5. In accordance with the existing TPSS design and the Contract Drawings. Design and coordinate equipment insulation and protection at three (3) levels:

a. Primary level shall prevent surges from lightning and other power sources from entering the TPSS. Surge arrester devices shall be placed at these interfaces to divert any damaging surges from reaching main equipment.

b. Use secondary level of protection directly in front of the protected equipment. Design the units to allow for protection against surges that pass the primary level protection. Ensure that primary level of protection that exists is adequate.

c. Use tertiary level of protection, also called equipment withstand capability, to protect against all remaining overvoltages.

d. Coordinate all three (3) levels of protection to ensure that, following a lightning strike, switching surge, or increase in noise energy, the protective devices clamp the voltage at the terminal of each item of equipment to a safe level.

B. Provide the following:

1. A sufficient number, as shown on the Contract Drawings or described in this Section, of appropriately rated protective devices suitable for the protected circuit voltage level and functional requirement. Protect circuits using the following equipment:

a. Surge arresters.

b. Surge protective devices.

2. An adequate bonding of equipment to reduce potential differences between equipment and limit circulating currents.

3. A low resistance grounding system for the protected and protective equipment to safely shunt overvoltages to the ground grid.

2.03 Surge Arresters

A. Provide at locations shown on the Contract Drawings.

1. AC Utility Feeder Circuits and AC Switchgear:

a. Provide one (1) surge arrester on each phase of the line side of each AC utility feeder circuit.

2. DC Feeder Circuits and DC Switchgear:

a. Provide one (1) surge arrester on the load side of each DC feeder circuit breaker.

B. Ratings:

1. Provide porcelain body surge arresters for AC utility feeder circuits with characteristics as shown in Table 16335-1.

Table 16335-1 AC Surge Arrester Ratings

Surge Arrester Characteristic	15 kV Circuits, 150 kV BIL
Class	Station Class
Type	Gapless Metal-oxide
Rating	18 kV
Maximum Continuous Operating Voltage (MCOV)	15.3 kV

2. Provide porcelain body surge arresters for DC feeder circuits with characteristics as shown in Table 16335-2.

Table 16335-2 DC Surge Arrester Ratings

Surge Arrester Characteristic	1000 V DC Circuits
Class	DC-A
Type	Gapless Metal-oxide
Rating	3 kV
Maximum Continuous Operating Voltage (MCOV)	1 kV

3. Manufacturers:
   a. GE Tranquell Station Class.
   b. ABB.
   c. Or Approved Equal.
4. The surge arresters shall be designed, tested and manufactured in accordance with IEEE C62.11 and IEEE C62.22. Surge protective devices shall meet the requirements of UL 1449.
5. Nameplates:
   a. Each surge arrester shall be provided with an aluminum nameplate which shall be riveted to the exterior of the surge arrester, easily readable and contain the following information:
      1) Arrester classification.
      2) Manufacturer's name.
      3) Manufacturer's type and identification number.
      4) Duty cycle voltage rating of the arrester in kV.
      5) MCOV rating of the arrester in kV.
      6) Electrical connection of arrester and/or instruction manual number.
      7) Year of manufacture.
      8) Pressure relief rating in amperes.

2.04 Transient Voltage Surge Suppressors

A. Locate the surge protective devices in close proximity of the protected devices.

B. Consult the protected device/equipment manufacturer about the type and rating of the most suitable surge protective device for protection of the device/equipment. Meet the device/equipment manufacturer recommendation.

PART 3 - EXECUTION

3.01 Installation

A. Use only UL listed materials.

1. Surge Arresters:
   a. Install surge arresters associated with the AC utility feeder circuits and DC feeder circuits.

2. Transient Voltage Surge Suppressors:
    a. Install the transient voltage surge suppressors in accordance with the suppressor and the protected device/equipment manufacturers' recommendations.

3.02 Grounding

A. General:

1. Install each grounding connection via the shortest possible route without unnecessary bends and kinks in the grounding conductor.
2. Use only copper conductors.
3. Splices are not allowed in the grounding connections.

B. Surge Arresters:

1. Ground each AC surge arrester to the TPSS perimeter ground bus.
2. Ground each DC surge arrester to a ground rod that is separate from the TPSS AC grounding system.

C. Transient Voltage Surge Suppressors:

1. Use stranded copper wires for connections between surge arresters and grounding busbar or equipment grounding lug.
2. Use conductors and grounding techniques as recommended by the transient voltage surge suppressor manufacturers.

3.03 Testing

A. Test surge arresters in accordance with IEEE C62.11.

B. Submit design test reports to SEPTA for review and approval.

C. Submit routine test reports per IEEE C62.11, with the serial numbers of the models tested, to SEPTA for review and approval before installation.

D. Perform power frequency and partial discharge test per IEEE C62.11 after installation. Record leakage current and measured partial discharge in the installation report.

END OF SECTION

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SECTION 16340

MEDIUM VOLTAGE SWITCHGEAR ASSEMBLIES (60 HZ)

PART 1 - GENERAL

1.01 Description

A. This Section specifies furnishing, installing, and testing of 15 kV class AC medium voltage switchgear, for use at 13.2 kV and 4.8 kV as shown on the Contract Drawings.

1. Provide all accessories and terminations.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 01300 – Submittals

C. Section 01810 – Commissioning of Systems

D. Section 16121 – Medium Voltage Cable

E. Section 16274 – Transformer and Rectifier Unit

F. Section 16290 – Protective Devices and Instrument Transformers

G. Section 16335 – Surge Protection

1.03 Submittals

A. The Contractor shall submit the following shop drawings and data for the SEPTA Project Manager's review in accordance with Section 01300:

1. Certified outline drawings of all major equipment, indicating overall dimensions, space requirements, location of control and protective devices on panels and reference tables to other drawings furnished. The submittal shall include the front and rear view of the switchgear showing all door and panel mounted devices, equipment and device nameplates and door swings.

2. Certified floor plans of equipment, showing dimensions necessary for installing equipment, clearances from building structure, equipment base details; dimensions and weights of shipping sections.

3. Certified top and bottom views of equipment, showing available space for entrance of power and control circuit wiring from the top or bottom, as specified, and entry of bus ducts.

4. Certified section views of each non-identical unit showing buses and bus supports, location of circuit breakers in withdrawn, test and fully connected positions and the location of outgoing power and control terminals. Drawings must be in sufficient detail to illustrate accessibility for maintenance and for adjustments while energized.

5. Certified front view and side panel views of each non-identical control compartment unit, with control compartment door(s) open, showing internally mounted control

devices. All devices shall be shown in their respective locations with identifying nameplates.

6. One line diagram of equipment supplied, showing all power and auxiliary circuits, protective devices, and the location of all current, potential and auxiliary transformers and shunts with the devices energized by them. This shall be inclusive of equipment interlocking requirements (electrical and mechanical).
7. Block diagrams for the Traction Power Substation (TPSS) communications system and automation, function diagrams and logic diagrams, product data and equipment dimensions and housings.
8. Schematic Diagrams:
    a. These shall be self-explanatory and shall be specifically prepared for this Contract and shall include AC schematic (three line) and DC elementary diagrams for all circuits.
9. Wire numbers shall be assigned to each schematic and elementary diagram so that each segment of all circuits can be identified on internal wiring diagrams of the equipment and on the interconnection diagrams. Wire sizes shall also be identified.
10. Wire numbers of similar schematics of different circuits shall be prefixed or suffixed to differentiate between the wires of separate pieces of equipment.
11. Terminal blocks in all equipment shall be assigned unique labels.
12. Circuits and portions of circuits which will be routed external to the originating cubicle shall be clearly indicated as external wiring. Interconnection wire sizes shall also be identified.
13. Schematic diagrams shall show originating and terminating terminal block numbers for all wiring which enters or leaves an equipment compartment (“external wiring”). These terminal block numbers shall match the terminal block numbers shown on subsequent wiring diagrams.
14. Internal connection diagrams of devices, including relays and meters. Contact development of control, selector and instrument transfer switches, test switches and lockout relays.
15. Equipment trip and lockout schedule, in tabulated form.
16. Calculations of 136 V DC control power requirements and for sizing of station battery, charger, and DC panel.
17. Supervisory Control and Data Acquisition (SCADA) points list.
18. Composite one line diagram of the TPSS power systems.
19. Internal Wiring Diagrams:
    a. Schematic or figurative type wiring diagrams which do not portray the physical wiring of the panels will not be accepted.
    b. Wiring diagrams shall provide sufficient empty space next to terminal blocks for interconnecting wiring cable bundle numbers and individual wire color designations.
    c. Circuit purpose/description shall be noted adjacent to the terminal blocks to which the circuits are connected.

d. Wiring diagrams shall be orderly, legible and neat in appearance. Line crossings and drawing call-outs, if used, shall make use of different line widths or CAD line screening techniques to improve readability. Wiring diagrams that, in the opinion of the SEPTA Project Manager, do not meet this requirement, will be rejected.

e. Circuit breaker reference position for all contacts shown on the diagrams shall be circuit breaker racked-in and open (tripped).

f. TPSS automation functional and wiring diagrams showing communications ports, equipment location, cable numbering and logic diagrams with points list, programming, and software.

20. Submit installation and test instructions.

21. Submit special storage instructions, if applicable.

22. Submit recommended termination materials and procedures.

23. The Contractor shall submit five (5) certified copies of test reports of all the tests conducted at the factory and in the field for the SEPTA Project Manager's approval. Test reports shall be submitted to SEPTA within two (2) weeks after completion of tests. In case of "Factory Tests", test reports shall include original data, detailed calculation of test data to arrive at the results and interpretation of results. Test reports shall contain the characteristics, curves, etc. where required for interpretation of results. Authorization to ship will not in any way relieve the Contractor of this responsibility under this Contract.

24. Submit certificate certifying that the switchgear meets the requirements specified herein, meets the standards designated herein and that the switchgear has been tested as specified herein.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. ASTM A 153/A 153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

2. ASTM E 662, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.

3. IEEE C2, National Electrical Safety Code (NESC).

4. IEEE C37.2, IEEE Standard Electrical Power System Device Function Numbers, Acronyms, and Contact Designations.

5. IEEE C37.20.2, IEEE Standard for Metal-Clad Switchgear.

6. IEEE C37.20.6, IEEE Standard for 4.76 kV to 38 kV Rated Ground and Test Devices Used in Enclosures.

7. IEEE C37.06, IEEE Standard for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis – Preferred Ratings and Related Required Capabilities for Voltages Above 1000 V.

8. IEEE C37.09, IEEE Standard Test Procedures for AC High-Voltage Circuit Breakers with Rated Maximum Voltage Above 1000V.

9. IEEE C37.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
10. IEEE C37.90.1, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
11. IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.
12. NEMA SG 4, AC High-Voltage Circuit Breakers.
13. NFPA 70, National Electrical Code (NEC).
14. UL 44, Thermoset-Insulated Wires and Cables.
15. UL 1072, Medium-Voltage Power Cables.
16. UL 1581, Electrical Wires, Cables, and Flexible Cords.

B. Furnish and install the switchgear having a performance record demonstrating a minimum of twenty (20) years successful operating experience in utility and industrial power applications.

1.05 Delivery, Storage and Handling

A. Ship the switchgear suitably covered to protect the switchgear from injury during shipment.

B. Seal, secure and protect the switchgear from damage.

C. Suitably store the switchgear to protect it from damage, corrosion, and condensation.

PART 2 - PRODUCTS

2.01 General

A. The switchgear assembly shall consist of indoor, metal-clad, single height, self-supporting units rated for operation on nominal 13.8 kV, 3 phase, 3 wire, 60 Hz grounded neutral service. The switchgear shall be arranged for future extensions to the switchgear at either end.

B. The Contractor shall submit for the SEPTA Project Manager's approval, design calculations or test data defining the amplitudes of transient overvoltages produced by the proposed vacuum circuit breakers during switching operations. The data submitted shall address switching transients caused by pre-striking, current chopping, virtual chopping, and repetitive re-ignition phenomena for the following switching operations:

1. On- and off-switching of the rectifier transformer and rectifier package at no load, rated load, and 150 percent of rated load. Circuit from the circuit breaker to rectifier transformer high voltage terminals shall be bus duct per the Contract Drawings.

C. Surge arresters shall be installed per Section 16335.

2.02 Ratings

A. The switchgear assemblies shall be rated as follows, in accordance with IEEE C37.20.2:

1. Nominal voltage to be 13.8 kV.
2. Rated maximum voltage to be 15 kV.

3. Rated power frequency to be 60 Hz.
4. Power frequency withstand voltage to be 36 kV.
5. Lightning impulse withstand voltage to be 95 kV.
6. Main bus continuous (rated) current to be 1200 A.
7. Rated short-time withstand current, minimum to be 36 kA.
8. Rated momentary withstand current, kA crest to be 97 kA.
9. Nominal MVA class to be 750 MVA.

2.03 Switchgear Assembly

A. The switchgear assembly shall be metal-clad and consist of rigid, self-supporting, and self-contained, electrically welded steel structure units. Individual units shall be enclosed with not less than 11 gauge formed steel sheets on all exterior surfaces and minimum of 12 gauge on other surfaces. Each unit shall be bolted to each other to form a continuous, free standing switchgear assembly.

B. The switchgear dimensions shall be of sufficient depth and height to allow the racking-in of the ground and test device with the front door of the circuit breaker compartment closed, as specified in elsewhere in this Section. The depth and height of the switchgear shall be increased, as required, if the manufacturer's standard switchgear does not allow the specified operation of the ground and test device. Ground and test device clearances shall not be compromised due to switchgear cubicle size. All required modifications and additional equipment necessary for each circuit breaker cell to maintain the original functionality of the standard arrangement shall be provided in each cell at no extra cost to SEPTA. Modified operating tools necessary for the proper operation of the equipment shall also be included at no extra cost.

C. Hinged doors shall be provided with each unit, located both on the rear and on the front of the switchgear assembly, for access to circuit breakers, instruments and terminal blocks, relays, meters, control devices, and buses. Instruments and relays mounted on the front door and not barriered or compartmented from the circuit breakers are acceptable with the exception of the incoming line (52-L) circuit breakers supplied directly by PECO, where controls shall be located on the adjacent metering cubicle. Doors shall be formed of sheet steel and shall be properly reinforced against distortions by suitable flanges and stiffening members. Hinges shall be heavy duty of a type approved by the SEPTA Project Manager. Full height doors shall be securely fastened in the closed position with a minimum of three (3) latches easily opened without the use of tools. For doors less than the full height of the switchgear, a minimum of two (2) latches will be acceptable.

D. Front doors shall be provided with two (2) position automatic self-stopping mechanism with the first automatic stop at 90 degrees and the second at 120 degrees. Manual defeating feature of the mechanism shall be provided for moving the door from one (1) position to the other. At each stop, the door shall be held securely in the open position. With the front door of any compartment open at 90 degree position, it shall not prevent the adjacent compartment door from being opened and its circuit breaker completely removed from its housing. Rear doors shall be provided with stops to hold them securely open at 90 degrees in a manner to allow the opening of the doors of adjacent cubicles.

E. The circuit breakers, buses, instrument transformers, incoming and outgoing cables, instruments, and control devices in each switchgear unit shall be isolated within separate grounded compartments formed by sheet steel barriers. All compartments shall be sufficiently gas tight to assure that no ionized gas will pass from one (1) compartment to another. Each compartment shall be provided with a separate hinged door or a removable bolted-on cover with handles for gripping for servicing, without exposing circuits in adjacent compartments. All unused holes and openings between compartments shall be sealed.

F. Vent openings on top of the switchgear shall be installed through vertical surfaces to prevent the entry of foreign objects. Openings shall be arranged so that hot gases or other materials cannot be discharged through them in a manner which might be injurious to operating personnel. Grills located on top of switchgear shall be reinforced so that they will not be damaged if stepped on.

G. Each circuit breaker unit shall be provided with protective shutters which are forced to close and cover live high voltage terminals as the removable element of circuit breaker is racked out of the cubicle. If the shutters are made of steel, the clear distance from the shutter plate to any un-insulated primary circuit component on the circuit breaker shall not be less than 7 inches at any point during the circuit breaker and the ground and test devices racked-in and withdrawal operation.

H. Primary circuit portholes shall be identified with permanently attached nameplates engraved "BUS" and "CABLE" at each circuit breaker housing, and phases “A”, “B”, “C”.

I. Finish of inside and outside of the switchgear assembly shall be of a high standard.

J. The front door of each circuit breaker housing shall be provided with a properly sized opening covered with a sliding door, for the passage of the push button station and the control cable of the ground and test device.

2.04 Buses

A. Main buses and bus taps shall as be follows:

1. Main buses and bus taps shall be fully insulated with flame retardant, track resistant molded insulation rated for 15 kV in accordance with IEEE C37.20.2. Bus conductors shall be supported and braced to withstand short circuit stresses at least as great as those for which the circuit breakers are rated. Insulated supports of main bus shall be arranged to form a gas tight barrier which shall isolate each unit from the adjacent unit.

B. Ground bus shall be provided in the switchgear assembly in accordance with the following:

1. A continuous copper “equipment” ground bus, minimum 2 inches by 1/4 inch, shall extend throughout the entire length of the switchgear assembly. Each switchgear unit shall be grounded directly to this bus. The frame of each circuit breaker shall be grounded through a rugged contact shoe at all times, except when the primary disconnecting devices are separated by a safe distance. A bolted-type terminal lug, with a NEMA two (2) bolt tongue, shall be provided at each end of ground bus for field connection to the station ground. The lugs shall be suitable for stranded copper ground cable within the range of No. 4/0 AWG through 500 kcmil.

2. Ground bus splices shall be made with a minimum of four (4) bolts, two (2) bolts on each side of the splice plate.

2.05 Power Circuit Breakers

A. Power circuit breakers shall be draw-out type, 15 kV class, 3 pole, employing vacuum interrupters, designed for 60 Hz operation, and rated on a symmetrical current basis in accordance with IEEE C37.06 as follows:

1. Rated continuous current to be 1200 A.
2. Rated maximum voltage to be 15 kV.
3. Nominal voltage to be 13.8 kV.
4. Rated voltage range factor (K) to be 1.3.
5. Rated Withstand Test Voltage:
   a. Low frequency (RMS) to be 36 kV.
   b. Impulse, crest to be 95 kV.
6. Nominal MVA class to be 750 MVA.
7. Rated short circuit current at maximum voltage (RMS) to be 28 kA.
8. Maximum symmetrical interrupting capability (RMS) to be 36 kA.
9. Rated short time current (three (3) seconds) to be 36 kA.
10. Closing and latching capability, crest to be 97 kA.
11. Rated interrupting time to be 5 cycles.

B. Operating mechanisms shall be of the stored energy type, suitable for operation from a 136 V DC supply, and electrically and mechanically trip free. Operating circuits shall successfully close the circuit breaker over a voltage range of 90 to 140 V and trip the circuit breaker over a voltage range of 70 to 140 V. The circuit breakers shall be designed so that they may be tripped manually in an emergency. A removable handle shall be provided for manual closing of the circuit breaker for maintenance and adjustment. Circuit breakers shall have a means of manually closing during loss of control power. An operating mechanism shall be provided with a mechanism charging motor cut-off switch mounted on the circuit breaker removable element and a mechanical circuit breaker contact position indicator visible from the front when the circuit breaker is inserted in its housing.

C. The stabs of the movable element and the bus will be insulated to the same requirement as the main buses, in so far as practically possible.

D. In addition to auxiliary switches required for control, interlock, indication, and alarm circuits, provide each circuit breaker with a minimum of four (4) "a" and four (4) "b" spare auxiliary switch contacts wired to outgoing wiring terminal block for SEPTA's use. Auxiliary switches mounted on stationary structures are acceptable.

E. Auxiliary switches and circuit breaker control circuit wiring connected through the secondary disconnecting devices shall be operable when the circuit breaker is racked to the test position so that the circuit breaker can be closed and tripped, electrically or mechanically, with primary disconnecting devices open.

F. Normally closed auxiliary switches mounted on the removable element and used for interlocking shall be shunted with truck operated cell switches to permit operation of interlocked equipment when the circuit breaker is in the withdrawn position. A minimum of

two (2) "a" and two (2) "b" spare cell switch contracts shall be provided, wired to outgoing wiring terminal block for SEPTA's use.

G. Each circuit breaker shall be mounted on a mobile steel frame equipped with main and secondary circuit disconnecting devices. The frame shall be permanently attached to the circuit breaker and shall be equipped with wheels for rolling the circuit breaker on the floor of the TPSS. All circuit breakers are required to be a direct roll-in design which allows moving the circuit breaker over the concrete TPSS floor into the switchgear unit without the need for portable ramps or wedges or cradles. A four (4) digit register type operations counter shall be mounted on the removable element of each circuit breaker.

H. Circuit breakers of same rating shall be mechanically and electrically interchangeable.

I. The primary disconnecting devices shall consist of self-aligned assemblies. The female contacts shall be constructed of bridging segments of fatigue resistant zirconium copper alloy with silver tungsten arching tips or similar approved high quality material, designed to ensure high pressure contact and guaranteed not to distort or fail under the mechanical stresses and heating due to duties specified for circuit breakers. All contact surfaces shall be heavily silver plated.

J. Secondary disconnecting devices shall provide connections for the control circuits and interlocks between the removable element and the housing. The devices shall be accurately located and securely mounted to maintain alignment.

K. Each switchgear unit housing a circuit breaker shall be equipped with a cranking device for moving the removable circuit breaker element to and from its operating position. The cranking device shall be permanently attached to either the stationary housing or to the removable circuit breaker unit. Suitable guide rails which prevent misalignment shall be provided for centering the circuit breaker in proper position when inserting or withdrawing the removable element. A positive stop shall be provided for the test position and fully disconnected position. Provisions shall be made for padlocking the removable element in the operating and fully disconnected positions. Provisions shall be made to the front of the cubicle's hinged door to provide a sliding shutter to cover the aperture utilized for the cranking device. The circuit breaker shall be able to be racked or cranked from the "test" position to the "operating" position with the circuit breaker compartment door closed. The doors of each cubicle shall have provisions for padlocking.

L. Front ends of guide rails shall be flared and the bottom plate of the enclosure within the guide rails beveled to facilitate the lining-up and insertion of the circuit breaker removable element.

M. Mechanical interlocks shall be provided on each circuit breaker to prevent the withdrawal of the removable element when the circuit breaker is in the closed position and to prevent the insertion of a closed circuit breaker from the test to the operating position. The interlocks shall also discharge the spring of the stored energy operating mechanism before the circuit breaker removable element can be fully withdrawn from its housing.

N. The racking-in mechanism shall be manually operated, threaded shaft type, employing a removable crank. A portable electric racking in device with time delay shall be provided to supplement the manual racking operation. Lever type rack-in mechanism will not be acceptable.

2.06 Ground and Test Device (GTD)

A. A GTD shall be provided at each TPSS. The requirements for the GTD are as follows:

1. A GTD shall be provided for the grounding of primary switchgear circuits during maintenance work, and to provide access to high voltage circuits for high potential (hi-pot) testing and phase checking. The GTD shall be a mobile draw-out element that can be inserted into a switchgear cubicle in place of a circuit breaker. The GTD shall be constructed in compliance with all mechanical features and applicable electrical ratings specified for the 15 kV class circuit breaker removable element, in accordance with IEEE C37.20.6 and this Section. The GTD is required to be a direct roll-in design which allows moving the GTD over the concrete TPSS floor into the switchgear unit without the need for portable ramps or wedges or cradles.
2. The GTD shall be designed so that it can be racked from the "test" to "operating" position with the circuit breaker compartment door closed. Clearly indexed positive stops shall be provided for the operating, test and disconnected positions.
3. The GTD shall be provided with three (3) primary disconnecting devices for connection to the feeder cable terminals and with three (3) uninstalled primary disconnecting devices for connection to the switchgear bus. The GTD will be accepted with all six (6) primary disconnecting devices installed, provided that those for connection to the switchgear bus can be readily removable in the field. The GTD shall be provided with a sliding contact assembly, of appropriate ampacity, for connecting to switchgear ground bus; a 15 kV, 3 pole, two (2) position, manually operated air break primary selector switch; and a stored energy operated air break ground switch capable of closing and latching against a live circuit. Windows of non-shatterable material shall be provided for observation of ground switch contact position when the GTD is racked into the switchgear. Windows on the top and side panels of transparent insulating, non-shatterable material shall also be provided for viewing the position of the selector switch, the ground switch, the bus work and the primary circuit cable from the buses at the primary circuit disconnect devices to the test ports. Viewing mirrors may be added to facilitate easy viewing of the switch position. The mirrors, if used, shall be secured such that once in the necessary position they cannot be easily dislodged or adjusted.
4. GTDs employing a vacuum interrupter as the ground switch will not be acceptable.
5. Test port cables shall be firmly supported and installed with phase-to-phase distances based on in-air clearances without the benefit of the cable insulation unless barriers of insulating material are installed to separate the phases.
6. The stabs of the movable element and the bus will be insulated to the same requirements as the main buses.
7. Interlocks shall be provided so the primary circuit selector switch can be operated only while the GTD is outside the switchgear. Mechanical interlocks shall be provided to permit the insertion and removal of the GTD only when the ground switch is open. A mechanical interlock shall be bolted to the selector switch operator to prevent positioning of the ground switch from cable side to bus side unless the interlock is removed. Means for padlocking the ground switch in open and closed positions shall be provided.

8. The GTD shall have the same voltage, three (3) second current carrying capability, and closing and latching capability as specified in this Section, for the circuit breakers. The ground switch control circuit shall be rated for operation on 136 V DC. The control circuit shall be wired to the secondary disconnecting devices matching those furnished with the circuit breaker removable elements. A 20 foot long control cable, with a pushbutton station at one (1) end and quick-type disconnecting plug on the opposite end, shall be provided for electrically closing and tripping the ground switch. A timing relay, adjustable between five (5) and fifty (50) seconds, shall be provided for the ground switch closing circuit. Interlocks shall be provided to permit the closure of the ground switch only when the GTD is racked into the "operating" position. A manual handle shall be provided for closing the ground switch when the GTD is inserted in the circuit breaker housing and the cubicle door is closed.
9. The GTD will normally be operated with the circuit breaker cubicle door closed. Provide shuttered openings in the circuit breaker cubicle doors to accommodate the GTD control cable. The cubicle door openings for the GTD control cable shall be provided with means of securely fastening them in the closed position when GTD is not in use.
10. Arrangements shall be made to prevent the operation of the structure mounted circuit breaker auxiliary switches during the racking-in and withdrawal operation of the GTD.
11. Opening and closing of the GTD grounding switch shall occur only as a separate operation independent of the charging of the ground switch mechanism. A ground switch mechanism that charges and then automatically closes or opens will not be acceptable.
12. Mechanical means of charging the ground switch mechanism shall be provided, enabling the GTD to be opened in the event the charging motor fails.
13. Primary circuit test terminals shall be recessed, and the access ports furnished with automatic shutters. The Contractor shall provide the GTD with two (2) sets of high voltage test probes for applying an external test voltage (hi-pot) to the incoming feeder cable or the switchgear bus. These test probes shall be self-powered, requiring no auxiliary supply for operation.
14. The primary disconnect devices, test port openings and the selector switch positions shall be identified with permanently attached nameplates engraved "BUS" and "CABLE". Similarly, all references to the primary circuit positions on the schematic and wiring diagrams and in the operating instructions shall be "BUS and "CABLE".
15. A nameplate, depicting the primary circuit in single line from shall be permanently attached to the front or side of the GTD.
16. The GTD will be used for hi-pot testing of TPSS 15 kV cable circuits. A DC test source up to 45 kV will be applied to the cable through the GTD for five (5) minutes while the ground switch is open.
17. Provide a charging motor cut-off switch mounted on the front of the GTD similar to that provided for the TPSS 15 kV class circuit breakers.
18. Provide a white Light Emitting Diode (LED) lamp as well as a mechanical flag to indicate “mechanism fully charged” status.
19. Provide a mechanical flag to indicate ground switch open and closed status.

20. The diameter of the GTD test ports shall accommodate a “shotgun” telescopic high voltage detector stick, Biddle Instruments DETEX Neon Voltage Detector Catalog No. 51440-1 or 51440-2; Or Approved Equal. The Contractor to provide “shotgun” telescopic high voltage detector stick, one (1) for each TPSS. Provisions shall be made to allow verification of cable de-energized status using the detector stick when the GTD is racked into position and open, in accordance with SEPTA standard operating procedures. A detector shall be present at the time of factory testing for use in the testing of the equipment.
21. The construction details, list of components, single line and schematic diagrams and operating procedure of the GTD shall be submitted to the SEPTA Project Manager for approval. Construction details shall include dimensioned front, side and section views illustrating dimensions of internal and external features. Demonstration of the approved GTD operating procedure shall be considered part of the factory witness testing requirements.
22. The GTD shall be tested in accordance with IEEE C37.20.6, with certified test reports provided for the SEPTA Project Manager’s approval.

2.07 PECO Revenue Metering

A. The following are the requirements for primary metering equipment that will be installed in separate metal enclosed bays. The Contractor shall furnish and install the metal clad bay for approved metering current and potential transformers. This will include cubicle heaters and interior connections. The metering transformers will be furnished and installed by the Contractor’s switchgear manufacturer. The metering transformers will be become the property of PECO.

B. No instruments, meters, or devices other than the aforementioned current and potential transformers shall be mounted on or inside the metering bay unless specified herein.

C. All ground connections shall be copper to copper connection.

D. The metallic metering instrument transformer bases shall be grounded to their supporting structures by serrated metal mounting washers with screws that penetrate the painted surface, and by No. 6 AWG bare copper ground connections to the switchgear ground bus. The bases of each of the metering transformers are to be grounded individually to the ground bus. Daisy chain grounding arrangements are not acceptable.

E. Metering Current Transformers:

1. Comply with Section 16290 and the following requirements:
    a. A separate section, isolated with a solid barrier, shall be provided for the installation of two (2) metering current transformers. Compartment design shall be such that after proper electrical isolation, the transformers can be readily replaced.
    b. The approved current transformers will be mounted in phases 1 and 3, and the area of the primary connections to the bus shall be treated to inhibit corrosion and oxidation. Current transformers will be mounted on phase 1 and 3 when connected to a delta connected transformer. These current transformers shall be the following; Or Approved Equal:
        1) Manufacturer to be General Electric.
        2) Type to be JKM-5 / #755X142043.
        3) Ratio to be 200/400:5.

4) Accuracy to be 0.3.
5) Burden to be B-0.1 to B-1.8.

c. Current transformers shall not be ordered until consultation with PECO has occurred.
d. The current transformers shall be located in the top section of the metering bay.

F. Metering Potential Transformers:

1. Comply with Section 16290 and the following requirements:

a. The potential transformers and fuses shall be mounted on a draw-out carriage located in the bottom half of the metering bay and shall be completely isolated from the high voltage bus or connections. Phasing shall be 3-2-1 (C-B-A) left to right facing the draw-out carriage. SEPTA phasing at the front to the switchgear is 1-2-3 or A-B-C. These potential transformers shall be the following; Or Approved Equal:
1) Manufacturer to be General Electric.
2) Type to be JVM #765X023026.
3) Primary voltage to be 14,400.
4) Ratio to be 120:1.
5) Primary fuses to be 1/2 E (two (2) total).

b. Primary connections shall be No. 4/0 AWG copper equivalent. The primary connections to the potential transformers shall be suitably treated to ensure low resistance, eliminate moisture, and resist oxidation. A two (2) bolt connection at each end of the potential transformer connections to the draw-out/dropout stabs is required.

c. Two (2) revenue metering potential transformers with primaries connected in an open delta configuration for a delta connected transformer. The high voltage side of the potential transformers shall be connected via two (2) current limiting fuses, type 1/2 E. The fuses shall indicate when blown.

d. Primary contacts for the draw-out carriage shall be of such design as to ensure continuous positive contact pressure. The design shall ensure the primary contacts are disconnected from the bus connections and grounded before the potential transformers and fuses become accessible for checking and replacement. Sufficient clearance shall be provided so that fuses can be changed while wearing high voltage insulating protective gloves. Preference shall be for braided connections shall be provide in lieu of spring connectors.

e. Two (2) spare fuses, type 1/2 E, shall be furnished for each set of metering potential transformers. Provisions shall be provided for fuse storage. The preferred location for the fuse storage is on the inside of the outside bay door.

f. The front of the potential transformer draw-out carriage shall extend up to close the section when the transformers are in the operating position. The section enclosing the fuses shall be so constructed that ionized gases and/or flame resulting from blowing of the fuses will not readily be conducted into other sections.

g. The manufacturer shall insure that potential transformer fuse clips are held rigid with double bolt connections and cannot pivot when removing fuses.

h. Mechanical latches shall be provided to allow the draw-out carriage to be held in fixed positions when the potential transformer carriage is in either the fully operational position or the fully disconnected position. The fully disconnected position is to mean the position the carriage would be in for fuse removal/insertion.

G. Secondary Wiring:

1. Secondary wiring from the current and potential transformers shall be limited to the following terminal blocks within the switchgear. Current transformer secondary

conductors require GE shorting type EB27A6S and potential transformers require EB25B04 terminal blocks; Or Approved Equal. The wiring shall consist of thirteen (13) conductors of No. 12 AWG flameproof switchboard wire with ring type connectors; three (3) wires from each current transformer and four (4) wires from the potential transformer (PECO electric meter drawing will be provided upon request). Secondary wiring beyond the terminal block will be installed by PECO.

2. No instruments or meters other than PECO electric revenue meters shall be connected to the secondary terminals of the metering current and potential transformers.

H. Meter Panel:

1. A remote outdoor cabinet with a meter panel drilled in accordance with a sketch furnished by PECO. The SEPTA Project Manager and the Contractor shall consult with the appointed representative of PECO for the location of the meter panel. The Contractor shall provide a run of 1 1/2 inch conduit from the terminal block location in the switchgear to the remote meter panel for the extension of the secondary wiring.

2.08 SEPTA Circuit Breaker Instrument Transformers

A. Refer to Section 16290 for instrument transformers requirements.

2.09 PECO Circuit Breaker Instrument Transformers

A. Instrument transformers shall satisfy the ANSI requirements, for relaying accuracy classification or metering accuracy classification as appropriate for the connected load, under the burdens imposed by the devices specified or implied. Instrument transformers shall be in accordance with the requirements of ANSI C57.13.

B. Current Transformers:

1. Two (2) window type current transformers shall be provided between the incoming line terminations and the circuit breakers.

2. Ratings to be 600/5 A, 15 kV, C200 relay accuracy class. Current transformer ratios are subject to change and confirmation up to the return of PECO approved shop drawings.

3. The secondary terminals of these current transformers shall be located in an isolated compartment with the incoming line terminals and shall have at least the mechanical and thermal strengths of the circuit breaker.

4. All metallic transformer bases and all secondary circuits shall be grounded by connection to the switchgear ground bus with a minimum No. 6 AWG bare conductor.

5. The current transformers shall be capable of withstanding high potential tests of 42 kV, DC for five (5) minutes.

6. Current transformer secondary neutrals shall be grounded to the switchgear bus with a minimum No. 12 AWG wire.

7. The lengths of these ground connections should be as short as possible and not grouped with other control wires.

8. Current transformers shall be provided with covered secondary terminal blocks. Secondary leads shall be wired to terminal blocks in secondary control compartment,

equipped with a device for conveniently shorting the current transformer, and readily identified.

C. Potential Transformers:

1. The phase presentation of the primary conductors of the potential transformers shall be 1-2-3 left to right as viewed from the draw-out carriage.
2. Potential transformers shall be of the draw-out, disconnecting type insulated for full voltage rating of the switchgear. The potential transformers shall have mechanical rating equal to the momentary rating of the circuit breakers. Potential transformers placed in the upper section of a vertical stack shall be housed in the lower portion of the section to facilitate ease of the operation of the draw-out unit.
3. Potential transformer primary leads shall be insulated for full insulation level of main bus and shall be run individually cleated with air separation. Individual insulating bushings shall be provided at barrier penetrations.
4. Potential transformers shall be provided with current limiting fuses mounted on the draw-out assembly. Withdrawing a unit shall disconnect and ground the assembly.
5. The potential transformer carriage shall be grounded by a two (2) flexible No. 1/0 AWG bare or clear jacketed copper conductors.
6. 15 kV connections from the 15 kV bus to the potential fuses shall be made with a minimum No. 4/0 AWG cable with double bolt connections at both ends of each connection.
7. The primary fuse clips shall be double bolted to their bases to prevent rotation and movement resulting in misalignment of the clips for fuse removal/insertion. A GPO-3 insulating material may be mounted across an individual fuse clip to prevent movement and rotation of the fuse clip in lieu of the double bolted base arrangement. In either case the fuse clips must be secured so that they do not rotate/move when the primary fuses are either inserted or removed.
8. Each potential transformer case shall have a positive bare copper connection to the ground bus equivalent to a No. 6 AWG wire. Daisy chain ground connections from one (1) potential transformer frame to another are not acceptable.
9. The primary contacts shall be disconnected and isolated from the bus connections and grounded before the fuses become accessible for checking and replacement.
10. Mechanical latches shall be provided to allow the draw-out carriage to be held in fixed positions when the potential transformer carriage is in either the fully operational position or the fully disconnected position. The fully disconnected position is to mean the position the carriage would be in for fuse removal/insertion. The fuse clips shall remain positively grounded with the carriage in the disconnected/latched position.

2.10 Primary Circuit Terminations

A. The switchgear shall be arranged for top or bottom entrance of incoming and outgoing feeder cables, as shown on the Contract Drawings with exceptions as noted. The Contractor shall provide necessary terminations for power cables connecting to the circuit breaker load side terminals. Solid dielectric, EPR-insulated cables shall be 15 kV class, 133% insulated and shall have 15 kV class stress cone type terminations. Buses and current transformers in the

cable entrance compartments of the switchgear shall be arranged to provide ample space for 15 kV cable termination stress cones.

B. Cable termination supports shall be insulated from the switchgear frame to prevent circulation of current between cable sheath and switchgear structure. The cable shields shall be connected to the insulated ground bus, by means of an insulated, braided flexible copper connector.

C. 15 kV class stress cone termination kits for the EPR cables shall be provided in accordance with the cable manufacturer's recommendations.

D. The Contractor shall provide heavy duty, bolted type terminal lugs for power cables. For 350 kcmil and smaller cables, the terminal lugs shall have NEMA two (2) bolt tongues; for 500 kcmil and larger cables, four (4) bolt tongues shall be provided.

E. The Contractor shall provide insulated cable supports for power cables, designed to withstand maximum short circuit stresses specified for the switchgear assembly. Cable clamps shall be provided to secure the cables to the supports.

F. Each circuit breaker connected to PECO service circuits shall have surge arresters installed within the switchgear cable compartment. Refer to Section 16335 for description of the surge arrester requirements.

2.11 Wiring and Terminal Blocks

A. Secondary and control wiring and terminal blocks shall be provided as follows:

1. Wiring and terminal blocks in the switchgear housings and on circuit breaker removable elements and on the GTD shall be rated for 600 V.

2. Circuits requiring external connections shall be wired to outgoing wiring terminal blocks readily accessible from the front, with circuit breaker removable element in test or connected position.

3. External control, indication and SCADA cabling shall enter and exit each control compartment from the top, front of the switchgear as indicated on the Contract Drawings. Cable tray above the switchgear shall be used for the routing of these cables.

2.12 Control Source

A. An ungrounded, two (2) wire, 136 V DC control bus shall be provided integral with the switchgear assembly. The control bus shall be No. 4 AWG, stranded switchboard wire insulated for 600 V, minimum. An alternative to No. 4 AWG may be proposed by the Contractor with supporting calculations for approval by the SEPTA Project Manager. The supply shall be wired to suitable screw type terminal blocks located at or near the middle of the switchgear lineup for connection to the supply conductors entering from the top.

B. Each circuit breaker control circuit shall be supplied from this bus through a separate set of disconnect switches and main (tripping circuit) fuses. Each circuit breaker closing circuit shall be provided with a secondary set of fuses with pullout disconnects to prevent blowing of main fuses on closing circuit faults.

C. Disconnect switches, fuse holders, and fuses shall be rated 250 V. Fuses shall be of the dual-element, finger safe style, cartridge type of appropriate rating. Necessary fuses shall be

furnished with the equipment. In addition, a minimum of 15 percent, but not less than two (2), spare fuses of each rating shall be furnished.

2.13 Special Requirements

A. A LED lamp receptacle, with conveniently located and properly labeled toggle switch or door operated switch, shall be provided in each compartment, accessible from the circuit breaker draw outside of the switchgear. The Contractor shall also provide a duplex, grounding type receptacle in each switchgear unit, connected for 120 V AC service.

B. The Contractor shall provide a 3 phase, 4 wire, 208/120 V AC supply bus, No. 8 AWG minimum, throughout the switchgear assembly. An alternative to No. 8 AWG wire size may be proposed by the Contractor with supporting calculations for approval by the SEPTA Project Manager. The heater, light and receptacle circuits shall be supplied from this bus through fusible pullout disconnects with dual-element, finger safe style, cartridge type fuses located in each switchgear unit. Fuse holders and fuses shall be rated at 250 V AC. Fuses shall be furnished with the equipment. A minimum of 15 percent, but not less than two (2), spare fuses of each rating shall be furnished. As far as practicable, loads shall be balanced between the phases of the supply bus. The supply shall be wired to terminal blocks located at or near the middle of the switchgear lineup for connection to the incoming supply from the TPSS 208/120 V distribution panel.

2.14 Nameplates

A. In addition to all regular nameplates required for safety and information, provide a nameplate on the front of the switchgear assembly, engraved with 'DANGER – 13,200 VOLTS". The nameplate shall have white letters, 2 inches high minimum, on red background. Two (2) similar nameplates shall be mounted on the rear of the switchgear assembly. The Contractor shall furnish and ship loose eight (8) similar nameplates for installation on exterior face of entry and exit doors of the TPSS.

B. The legends of all equipment nameplates shall be submitted to the SEPTA Project Manager for approval.

C. The switchgear identification nameplate shall be engraved "15 kV AC SWITCHGEAR".

D. Additional nameplates for the PECO incoming line circuit breakers shall be provided meeting PECO requirements.

2.15 Supervisory Control Requirements

A. The switchgear assembly shall be provided with supervisory control and indication, measuring and interface devices.

2.16 15 kV Circuit Breaker Test Cabinet

A. The Contractor shall provide a wall mounted test cabinet for electrical operation of the 15 kV class circuit breakers as shown on the Contract Drawings. The test cabinet shall include a control switch, similar to that furnished with the switchgear, to close and trip the circuit breaker; red and green LED circuit breaker position indicating lights; 10 feet of control cable with a connector at the end for connection to the circuit breaker; a set of properly sized finger safe style fuses to protect the control circuit; and screw type terminals for 136 V DC control supply No. 8 AWG conductors. An additional indicating LED with white

lens shall be provided for monitoring the control supply. The 136 V DC control power shall be provided from a dedicated circuit breaker in the TPSS DC distribution panel.

B. The control switch and the indicating lights shall be mounted on the door of the test cabinet.

C. A proper connector shall be provided for protecting the control cable at the point of entry. Provisions shall be made for storing or racking the control cable and the connector at the test cabinet.

D. The test cabinet shall be finished inside and out to a high standard.

E. The switchgear identification nameplate shall be engraved "15 kV AC CIRCUIT BREAKER TEST CABINET".

2.17 SEPTA Circuit Breaker Protective Relays

A. Refer to Section 16290 for protective relay requirements.

2.18 PECO Supply Circuit Breakers 52-L1 and 52-L2 Protective Relays

A. Relays shall be of the electronic type, and shall be designed, constructed, and tested in accordance with the applicable provisions of IEEE C37.2, IEEE C37.90 and IEEE C37.90.1. Relays shall have built-in test facilities. Specific relay type and model numbers will be provided if specified by PECO. The relays shall communication with TPSS automation system equipment.

B. The switchgear shall be furnished with all relays and accessories necessary to provide a complete and coordinated protective relay system for the circuits and switchgear as shown on the Contract Drawings or as required to provide proper interlocks and sequence of operation as specified. Device function numbers shall be the standard device numbers for automatic switchgear as listed in IEEE C37.2. The relays for circuit breaker operation shall have an adjustment range suitable for coordinated tripping with other circuit breakers in the switchgear. Relays shall provide all contacts shown. Where more contacts are required than are available on relays of the types specified, approved types of auxiliary relays shall be provided to supply the required additional contacts.

C. Protective relays shall be semi-flush, draw-out type mounted on the front doors of the switchgear. Auxiliary relays of the semi-flush mounted type may also be mounted on the front doors of the switchgear. Other auxiliary relays shall be mounted inside the switchgear on the side sheets and/or on the internal swinging panels designed for this purpose.

D. All relays, except certain auxiliary relays, shall be of a type that can be withdrawn by means of approved sliding contacts from the front of the panels without opening the current transformer secondary circuits or disturbing the external circuits, or requiring disconnection of leads on rear of the panels. Relays instruments and controls for individual feeders shall be located on the respective feeder panel, relays, indicating lamps, instruments and controls and for mains shall be located on the associated incoming main panel.

E. The relay cases shall be rectangular steel, zinc chromate primed and painted black, back connected, dust tight switchboard type. The case shall be provided with removable covers with windows and with means of sealing against tampering.

F. Each protective relay shall be free from errors due to normal variations in frequency, waveform, power factor and ambient temperature. All current coils shall be able to withstand currents caused by short circuits on the system. All potential coils shall be able to withstand 110 percent of normal voltage continuously without damage to the coils or equipment.

G. The necessary test devices shall be accessible from the panels and shall be arranged to isolate the relays completely from the instrument transformers and other external circuits so that no other device will be affected during tests. Multiple test plugs shall be provided for testing either by an external source of energy or from the instrument transformers and other external circuits so that no other device will be affected.

H. Relays shall operate successfully at voltages ranging from 80 percent to 110 percent of rated voltage without overheating, chattering or other malfunction. Protective and auxiliary relays shall not operate falsely due to vibration that may occur in closing or tripping operations of the circuit breaker or adjacent circuit breakers.

I. Each protective relay shall be provided with an operation indicator and an external target reset device.

J. Relays shall be suitable for use on 5 A current transformer secondary terminals and 120 V potential transformer secondary terminals, 136 V DC minimum tripping and closing circuits. The relay contacts shall have silver tips and shall be rated 5 A continuous and 25 A for one (1) second at 250 V DC. The relay coils shall be rated for continuous duty at rated operating voltage.

K. Lockout relays shall be electric trip reset type as shown on the Contract Drawings suitable for appropriate DC control and tripping power. Contacts shall be rated for ten thousand (10,000) operations and made of silver-overlaid bronze alloy. Single contact ratings shall be 30 A continuous and 60 A for one (1) minute and interrupting; 3 A resistive, 1 A inductive. Each lockout relay shall have an associated white light that is lit when the lockout relay is reset. Provide a "t'" operating handle and nameplate engraved "trip-reset".

L. All protective relays on the 52-L1 and 52-L2 circuit breakers are subject to the approval of PECO. The shop drawings are to clearly identify all protective relays proposed for the switchgear.

M. In any case where microprocessor relays are used it is required that the relay health be monitored over the SCADA system.

N. An FT-1 test switch shall be provided for each circuit breaker position offering four (4) current shorting poles and two (2) tripping poles.

O. All relaying arrangements are subject to the approval of PECO.

P. Stuck circuit breaker/circuit breaker fail relaying controls shall offer the following:

1. Circuit breaker failure protection shall be provided integral to the multifunction relay on each circuit breaker and shall trip all circuit breakers on the associated bus via the bus lockout relay.

2. If an integral protection element is not acceptable to PECO, then:

   a. Each feeder relay trip signal shall activate a 62 timing relay through an ‘a’ contact of the circuit breaker to be tripped.

b. The 62 timing relay will, at the expiration of the time delay trip a lock-out relay that will trip all the circuit breakers on the bus associated with the feeder circuit breaker calling for the original trip signal.
c. The 62 timing relay will be set for nine (9) cycles.
d. Should the feeder circuit breaker trip and the ‘a’ contact change logical state before the 62 times out, the 62 timer will automatically reset and will not trip the stuck circuit breaker lock-out relay.
e. Each 62 timing relay shall be equipped with a target to indicate the relay has timed out and called to trip the stuck circuit breaker lock-out relay or;
f. Each feeder circuit breaker shall be equipped with a dedicated stuck circuit breaker lock-out relay. In this case the stuck circuit breaker lock-out relay will serve as the relay target.

2.19 Accessories

A. Per TPSS, the Contractor shall furnish two (2) sets of special tools and equipment handling devices as recommended by the manufacturer for installation, assembly, adjustment and maintenance of the furnished switchgear and associated circuit breakers. Special tools are defined as tools not readily available on the open market. All items shall be furnished as part of the initial delivery of the switchgear equipment.

B. Per TPSS, the Contractor shall also furnish and ship with the switchgear auxiliary equipment and accessories necessary for operation, maintenance, testing and handling of removable components outside the switchgear assembly. These shall include, but not be limited to, the following:

1. One (1) floor mounted steel cabinet with hinged doors with three (3) point latching mechanism and key-locking handle and shelves for storing tools and accessories. Cabinet shall be fully rustproofed and finished in light gray enamel.
2. Two (2) SEPTA GTDs, rated 750 MVA nominal.
3. One (1) PECO GTD, rated 750 MVA nominal.
4. One (1) circuit breaker test cabinet.
5. Two (2) “fifth-wheel" devices for moving/handling the circuit breaker removable element. A circuit breaker lifting device and portable crane for moving the 15 kV AC circuit breakers in and around the TPSS may be proposed in lieu of the fifth wheel device.
6. Two (2) racking-in cranks.
7. Two (2) manual spring charging handles.
8. Two (2) sets of tools required for circuit breaker maintenance.
9. Two (2) sets of test plugs for draw-out relays (as applicable).
10. Two (2) one (1) quart cans of matching switchgear touch-up paint.
11. One (1) set of switchgear base channels for mounting the stationary units. These channels shall be shipped in advance of the switchgear for installation in the floor slab.
12. Two (2) 15 kV circuit breaker guide floor plates for aligning the circuit breaker for insertion into the cubicle. In addition to aligning the circuit breaker for insertion, these

plates shall maintain the cubicle door open at an angle of 95 degrees minimum, while the circuit breaker is being inserted or withdrawn.

2.20 Detailed Equipment Requirements

A. The Contractor shall furnish and deliver to the TPSS the switchgear assembly consisting of switchgear units of the type and quantity specified below. The individual units in the assembly shall be arranged to form a lineup as shown on the Contract Drawings.

B. Individual switchgear units shall consist of the equipment, devices and appurtenances of the types and quantities detailed on the Contract Drawings.

1. Incoming line circuit breakers, devices 52-L (also must comply with or exceed the requirements of PECO). Each 52-L circuit breaker unit includes, but not be limited to, the following:
    a. One (1) metal-clad stationary unit, nominal 750 MVA class with 1200 A insulated bus and 1200 A tap.
    b. One (1) 1200 A circuit breaker removable element, as specified, nominal 750 MVA class.
    c. Three (3) current transformers, connected for 600:5 A relaying and indication, ANSI accuracy class C-100.
    d. One (1) set of metering current transformers and potential transformers per PECO requirements located in adjacent switchgear cubicle.
    e. One (1) IED microprocessor based multifunction relay and metering unit with the following minimum functions:
        1) Phase overcurrent relay with instantaneous function for each phase, Devices 50/51, initially programmed with very inverse time coordination curve (TCC).
        2) Residually connected ground overcurrent relay with instantaneous function, Devices 50N/51N, initially programmed with very inverse TCC.
        3) Phase overcurrent relay, Device 51C, for cable overload alarm, providing annunciation and supervisory indication (provide same functionality as a Device 51CX auxiliary relay with 136 V DC coil and 3 single pole, double throw contacts). Relay shall be initially programmed with inverse long time TCC.
        4) Phase sequence relay, Device 47.
        5) Undervoltage relay, Device 27.
        6) Watt-hour demand metering with fifteen (15) minute demand interval. Outputs for the 52-L and 52-RF circuits shall be totalized for telemetry via supervisory system. Totalizing shall be provided by software within the SCADA Remote Terminal Unit (RTU).
        7) Circuit breaker failure detection contact closure which trips bus tie circuit breaker when line circuit breaker fails to trip after a user-selectable time delay.
    f. One (1) control switch, TRIP-CLOSE, with green, white, and red indicating LEDs, Device CS.
    g. One (1) indicating voltmeter, transformer rated, 0-18 kV scale.
    h. One (1) voltmeter switch, four (4) position OFF-AB-BC-CA.
    i. One (1) indicating ammeter, transformer rated, 0-600 A scale.
    j. One (1) ammeter switch, four (4) position OFF-A-B-C, center-of-circuit type.
    k. One (1) current transducer, as specified, for telemetering phase B current, Device A-XD.
    l. One (1) test switch, 10 pole, for four (4) potential and six (6) current circuits.

m. Two (2) potential transformers, 14400:120 V, draw-out mounted with primary current limiting fuses, connected to line side of circuit breaker, open delta primary, grounded open delta secondary.

n. Three (3) 15 kV class stress cone termination kit per Section 16121.

o. One (1) set of DC and AC control and auxiliary power disconnect devices with finger safe style fuses.

p. Three (3) surge arresters, if required by switching surge study.

2. TPSS Feeder Circuit Breakers, Devices 52-F. Each 52-F circuit breaker unit includes, but is not limited to, the following

a. One (1) metal-clad stationary unit, nominal 750 MVA class, with 1200 A insulated bus and 1200 A tap.

b. One (1) 1200 A circuit breaker removable element, as specified, nominal 750 MVA class.

c. Three (3) current transformers, 600:5 A multi-ratio, connected for 150:5 A relaying and indication, ANSI accuracy class C-100.

d. One (1) IED microprocessor based multifunction relay and metering unit with the following minimum functions:

1) Phase overcurrent relay with instantaneous function for each phase, Devices 50/51, initially programmed with very inverse time coordination curve (TCC).

2) Residually connected ground overcurrent relay with instantaneous function, Devices 50N/51N, initially programmed with very inverse TCC.

3) Phase overcurrent relay, Device 51C, for cable overload alarm, providing annunciation and supervisory indication (provide same functionality as a Device 51CX auxiliary relay with 136 V DC coil and 3 single pole, double throw contacts). Relay initially programmed with inverse long time TCC

4) Watt-hour demand metering with fifteen (15) minute demand interval, with outputs telemetered via supervisory.

5) Circuit breaker failure detection contact closure which trips associated line circuit breaker and bus tie circuit breaker when feeder circuit breaker fails to trip after a user-selectable time delay.

e. One (1) control switch TRIP-CLOSE, with green, white, and red indicating LEDs, Device CS.

f. One (1) indicating voltmeter, transformer rated, 0-18 kV scale.

g. One (1) voltmeter switch, four (4) position OFF-AB-BC-CA.

h. One (1) indicating ammeter, transformer rated, 0-150 A scale, connected to phase B.

i. One (1) ammeter switch, four (4) position OFF-A-B-C, center-of-circuit type.

j. One (1) current transducer, as specified, for telemetering phase B current, Device A-XD.

k. One (1) key interlock system.

l. One (1) test switch, 10 pole, for four (4) potential and six (6) current circuits.

m. Three (3) potential transformers, 14400:120 V, draw-out mounted with primary current limiting fuses, connected to line side of circuit breaker, open delta primary, grounded open delta secondary.

n. Three (3) 15 kV class stress cone termination kits per Section 16121.

o. One (1) set of DC and AC control and auxiliary power disconnect devices with finger safe style fuses.

3. Bus Tie Circuit Breaker Unit, Device 52-BT. Each 52-BT circuit breaker unit includes, but is not be limited to, the following:
   a. One (1) metal-clad stationary unit, nominal 750 MVA class, with 1200 A insulated bus and 1200 A taps.
   b. One (1) 1200 A circuit breaker removable element, as specified, nominal 750 MVA class.
   c. One (1) control switch, TRIP-CLOSE, with green, white, and red indicating LEDs, Device CS.
   d. One (1) set of DC and AC control and auxiliary power disconnect devices with finger safe style fuses.
   e. One (1) 120 V AC grounded duplex receptacle.
4. Rectifier Transformer Feeder Circuit Breaker Units, Device 52-T. Each 52-T rectifier transformer circuit breaker unit includes, but is not limited to, the following:
   a. One (1) metal-clad stationary unit, nominal 750 MVA class with 1200 A insulated bus and 1200 A tap.
   b. One (1) 1200 A circuit breaker removable element, as specified, 750 MVA class.
   c. Three (3) current transformers, 600:5 A multi ratio, connected for 300:5 A relaying and indication, ANSI accuracy class C-100.
   d. One (1) IED microprocessor based multifunction relay and metering unit with the following minimum functions:
      1) Phase overcurrent relay with instantaneous function for each phase, Devices 50/51, initially programmed with very inverse time coordination curve (TCC).
      2) Residually connected ground overcurrent relay with instantaneous function, Devices 50N/51N, initially programmed with very inverse TCC.
      3) Phase overcurrent relay, 3 phase, Device 51R, for rectifier overload detection. Relay initially programmed with inverse long time TCC.
      4) Phase sequence relay, Device 47.
      5) Undervoltage relay, Device 27.
      6) Watt-hour demand metering with fifteen (15) minute demand interval, with output telemetered to supervisory.
      7) If rectifier transformer circuit breaker fails to trip after a user-selectable time delay, trip all circuit breakers connect to the same bus.
   e. One (1) control switch TRIP-CLOSE with green, white, and red indicating LEDs, Device CS.
   f. One (1) indicating ammeter, transformer rated, 0-300 A scale, connected to phase B.
   g. One (1) ammeter switch, four (4) position OFF-A-B-C, center-of-circuit type.
   h. Three (3) potential transformers, 14400:120 V, draw-out mounted, with primary current limiting fuses, connected to the main bus, grounded wye primary, grounded wye secondary (mount in enclosure above rectifier transformer circuit breaker cubicle).
   i. One (1) test switch, 10 pole, with four (4) potential and six (6) current circuits.
   j. Three (3) 15 kV class stress cone termination kits per Section 16121.
   k. One (1) set of DC and AC control and auxiliary power disconnect devices with finger safe style fuses.
   l. One (1) 120 V AC duplex grounded receptacle.
   m. Three (3) surge arresters, if required by switching surge study.

PART 3 - EXECUTION

3.01 General

A. The Contractor shall install all equipment specified in this Section in accordance with requirements of this Section, Section 01010, and the Contract Drawings, with the SEPTA Project Manager approved changes only, if any. The completed installation shall provide fully coordinated and fully operational electrical system.

B. The Contractor shall take every precaution in handling, setting, aligning, and assembling the equipment to avoid distortion of frames. The Contractor shall become thoroughly familiar with the manufacturers' instructions before attempting to handle, install and operate the equipment. The Contractor shall ensure that all personnel working with the equipment fully understand the operation of the various components to avoid mis-operation, damage to equipment and possible personnel injury.

C. All equipment assembly connections to mechanically assemble the units shall be made by the Contractor, including all bolted connections between shipping units, and anchoring the equipment to the floor.

D. All electrical connections between shipping units, including all bolted bus connections and connections of control and auxiliary circuits shall be made by the Contractor.

E. Conduits, cable trays and cables for control and auxiliary circuits for interconnecting equipment and devices of this Section are not all shown on the Contract Drawings. The Contractor shall determine the routing of these cables and raceways as required to satisfy all specified control, indication, supervisory and auxiliary functions. The Contractor shall ensure that the specified cable entry locations identified in the equipment specifications and this Section are complied with. Installation of cables shall be in accordance with the Contractor prepared and SEPTA Project Manager approved cable schedules, routing diagrams and installation drawings. Cable trays directly above the area of the epoxy insulated floor, above the rectifiers and the DC switchgear shall be fiberglass.

F. The Contractor shall make all ground connections to the equipment from the ground buses in the TPSS as described in this Section and shown on the Contract Drawings.

G. All structural steel members used for support of electrical equipment and materials to be furnished shall be hot-dip galvanized in accordance with ASTM A 153/A 153M.

H. Complete installation shall be tested and checked out and as specified in other applicable Sections of this Specification.

I. The Contractor shall be responsible for all equipment during transportation, delivery and installation. All equipment shall be suitably packaged at all times meeting the requirements of the equipment manufacturers. Equipment packaged for transport and storage shall be protected from damage due to environmental conditions and properly secured. 'Shockwatch' labels shall be applied to all main equipment during transport. Where necessary equipment shall be heated or stored in a controlled environment during storage. Any signs of equipment deterioration or damage during shipping or storage shall be rectified to the satisfaction of and at no expense to SEPTA.

3.02 Installation

A. The switchgear shall be fully assembled and completely installed in accordance with the manufacturer's instructions at the locations shown on the Contract Drawings.

B. The switchgear base channels, furnished with the switchgear, shall be installed in the floor slab by the Contractor. The switchgear units shall be anchored to the base channels with a sufficient number of bolts to withstand impact resulting from circuit breaker operation and to satisfy the seismic requirements specified. All bolts required for anchoring the switchgear shall be furnished by the Contractor.

C. The switchgear units shall be assembled in such a manner as to ensure proper leveling, proper alignment between the various shipping groups, and proper placement of all primary circuit conduits installed for purposes of equipment interconnection.

D. Circuit breaker test cabinet shall be installed at the location shown on the Contract Drawings. A clear space of 1/4 inch, minimum, shall be provided between the back of the cabinet and the wall. Steel channels or straps, or equal of suitable thickness shall be fastened to the masonry and be drilled and tapped for mounting the test cabinet using galvanized bolts. The Contractor shall furnish, install, and connect the 136 V DC control supply wiring from a dedicated circuit breaker in the DC distribution panel.

E. The Contractor shall furnish and install 120 V AC and 136 V DC auxiliary circuits as required from dedicated circuit breakers in the AC and DC distribution panels.

F. After completion of the switchgear installation, the Contractor shall ensure that all doors and the draw-out fuse and potential transformer carriages operate freely and the circuit breaker removable elements and the GTD can be moved into and removed from the housings easily in a controlled and consistent manner. The Contractor shall correct all misalignments to the satisfaction of the SEPTA Project Manager.

3.03 Testing

A. General:

1. All equipment to be furnished and installed shall be subject to the following test program. Testing shall include factory tests and field tests.

2. The Contractor shall formulate an overall test program for all equipment furnished under this Section, which shall include but not be limited to the tests specified in this Section, to ensure equipment compliance with the relevant standards, this Section, and satisfactory and reliable performance in intended operation. The overall test plan and expected schedule for testing should be submitted to the SEPTA Project Manager for review and acceptance at least four (4) weeks prior to the first expected factory test. All factory tests shall be identified in the overall test plan, and all tests shall be offered for witnessing.

3. The Contractor shall furnish detailed, step-by-step test procedures for each factory and field test. The test procedures shall be submitted for approval by the SEPTA Project Manager. Blank sample test record and result sheets shall be included for approval. Where applicable, test pass/fail criteria shall be included in the test procedure and check off boxes shall be provided to indicate when each step has been successfully performed.

4. The Contractor shall maintain a consolidated factory and field testing punch list listing all items requiring repair, further testing and steps omitted for execution at a later date. All factory test punch list items must be addressed, and the SEPTA Project Manager notified of such prior to the equipment being released from the manufacturer's

premises. All punch list items shall be resolved to the satisfaction of the SEPTA Project Manager prior to equipment handover to SEPTA.

5. Tests at the factory shall include but not be limited to:
   a. Manufacturer's standard tests.
   b. Tests as per relevant NEMA, IEEE and ANSI Standards.
   c. Any other tests to ensure satisfactory performance of equipment (including 'mock-up' tests of the TPSS automation system).
6. Tests in the field shall include but not be limited to:
   a. Tests as per relevant NEMA, IEEE and ANSI Standards.
   b. Acceptance tests as per current NETA acceptance testing specifications.
   c. Any other tests to ensure satisfactory performance of equipment, including full detailed functional tests specific to the operational requirements of the equipment detailed in this Section.
   d. The Contractor shall meet the requirements for testing and shall furnish certified test reports for obtaining clearance for packing and shipment of equipment tested.

B. Conditions for Tests:

1. General Conditions:
   a. Prior to testing of any equipment specified in this Section, all of the following conditions shall be fulfilled by the Contractor:
      1) The Contractor has made the "For Record" submittal of shop drawings of the equipment scheduled for testing to the SEPTA Project Manager. Please note that the "For Record" submittal shall be made only after the previous submittal has been approved by the SEPTA Project Manager.
      2) The Contractor prepared test plan and detailed step by step test procedure has been submitted to and approved by the SEPTA Project Manager.
      3) Upon completion of (1) and (2) above, a minimum of four (4) weeks advance notification shall be given to the SEPTA Project Manager on the scheduled date of tests to enable him to witness the tests.
2. Witnessing Tests:
   a. The SEPTA Project Manager will witness complete testing of all equipment unless a waiver is granted, in which case test reports of equipment, and associated cleared punch list, for which waiver was granted shall be submitted for review to obtain clearance for packing and shipping. Waiver of witnessing tests on any one (1) piece equipment shall not be construed as a waiver for all remaining equipment either of the same type or different type.
   b. Prior to witness testing, the supplier shall have previously tested the equipment to prove compliance with the test procedure and equipment requirements. A copy of these completed test documents should be made available to the SEPTA Project Manager for review prior to the witness testing.

C. Responsibility:

1. The Contractor shall assume full responsibility during the factory and field testing of all equipment and installation provided by the Contractor. Should there be any loss or damage to such equipment, materials, or the building as result of these tests, the Contractor shall be fully responsible for replacing the damaged equipment and repairing the building. Replacement of damaged equipment shall include all costs, including but not limited to, transportation of, and installation and testing of replacement equipment.

D. Rejection and Re-testing:

1. Failure of equipment to withstand tests or to meet specified ratings or requirements shall be sufficient grounds for rejection of equipment.

2. Any equipment rejected shall be re-tested in presence of the SEPTA Project Manager, and/or his representative, after rectification. If the modifications or changes are such as to affect any of the drawings, diagrams or any other documents submitted and accepted by the SEPTA Project Manager, revised drawings of diagrams shall be submitted, showing proposed changes and SEPTA Project Manager's approval obtained before changes or modifications are made on the equipment. Modification or changes which do not warrant revision of any drawing shall be furnished to the SEPTA Project Manager along with notice of re-testing.

3. If it is not possible to rectify rejected equipment, new equipment shall be manufactured, and the requirements of the drawings and design calculations of the original unit shall be applicable for the new unit.

E. Cost of Rectification or New Unit:

1. The entire cost of rectification or new unit shall be borne by the Contractor including retesting and cost of witnessing retesting.

F. Costs of Tests:

1. The price for conducting all factory and field tests and witness testing in presence of the SEPTA Project Manager, and/or his representative, including entire cost of rectification, and re-testing, shall be deemed to be included in the Contract Price. The expense related to travel, lodging, and boarding for the SEPTA Project Manager and/or his representative for witnessing of test will, however, be borne by SEPTA at no expense to the Contractor, except when re-testing is required. In the latter case, all expenses for travel and lodging will be borne by the Contractor as directed by the SEPTA Project Manager. In the event a second retest is required for the same equipment, the Contractor shall bear, in addition to the above costs, the cost of all meals and the hourly payroll costs, including overhead and fringe benefits of the SEPTA Project Manager and/or his representative(s) attending the retest.

3.04 Factory Tests

A. General:

1. If facilities for conducting any of the tests listed below are not available at the manufacturer’s plant, these tests shall be conducted elsewhere by the manufacturer or by an independent agency as approved by the SEPTA Project Manager. The Contractor shall, however, clearly indicate in the Contractor’s proposal the tests for which the manufacturer does not have facilities and intends to submit test reports from an independent agency. This should also be clearly identified in the overall test plan as required in Article 3.03/A/2 in this Section.

B. Switchgear:

1. The following tests listed in IEEE C37.09 as "Design Tests" shall be conducted on one (1) 15 kV class representative circuit breaker with the circuit breaker inserted in its housing:

a. Maximum voltage tests.

b. Power frequency tests.
c. Continuous current carrying tests.
d. Dielectric withstand tests:
    1) Power frequency withstand voltage tests.
    2) Lightning impulse withstand voltage tests.
e. Standard operating duty tests.
f. Interrupting time tests.
g. Transient recovery voltage tests.
h. Short-circuit current interrupting tests.
i. Load current tests.
j. Capacitor switching current tests.
k. Mechanical endurance tests.
l. Control voltage tests.
m. Design tests on pressurized components.
n. Sealed pressure systems leakage tests.
o. Radio influence voltage tests as per NEMA SG4.

2. Following tests listed in IEEE C37.09 as "Design Tests" for high voltage circuit breakers shall be conducted on the GTD of the switchgear, with the GTD inserted in the switchgear:
    a. Maximum voltage tests.
    b. Power frequency test.
    c. Short circuit current interrupting tests to establish the closing and latching capability, applying the short circuit test supply between the line terminals of the GTD and the switchgear ground bus.
    d. Momentary current test, applying the test supply between the line terminals of the GTD and the switchgear ground bus.
    e. Dielectric withstand tests:
        1) Power frequency withstand voltage test.
        2) Lightning impulse withstand voltage test.
3. Following tests listed in IEEE C37.09 as "Production Tests" shall be conducted at the manufacturer's facility on each and every 15 kV class circuit breaker and GTD:
    a. Current and linear coupler transformer tests.
    b. Nameplate check.
    c. Resistors, heaters, and coil check tests.
    d. Control and secondary wiring check tests.
    e. Clearance and mechanical adjustment check tests.
    f. Mechanical operation tests.
    g. Timing tests (not required for GTD).
    h. Stored energy operating mechanism tests.
    i. Power frequency withstand voltage tests.
4. Following tests listed in IEEE C37.20.2 as "Design Tests" shall be conducted on the switchgear assembly:
    a. Dielectric tests:

1) Power frequency withstand tests.
2) Lightning impulse withstand tests.
3) Test of busbar insulation.

b. Rated continuous current tests.
c. Momentary current tests.
d. Mechanical operation tests.
e. Flame-retardant tests.

5. Following tests listed in IEEE C37.20.2 as "Production Tests" shall be conducted at the manufacturer's facility on the switchgear assembly:
   a. Mechanical operation tests.
   b. Grounding of instrument transformers cases test.
   c. Electrical operation and control wiring tests.
      1) Control wiring continuity test.
      2) Control wiring insulation test.
      3) Polarity tests.
      4) Functional and sequence tests.
   d. Checking of indicating instruments and transducers at zero, midpoint and full scale or full output.
   e. Nameplate check.
6. In lieu of Design Tests specified above for AC circuit breakers and switchgear assembly, the Contractor may submit detailed test certificates from the manufacturer, or an independent agency conducted on similar circuit breakers and similar switchgear assemblies for the SEPTA Project Manager's review. The SEPTA Project Manager may waive some or all of the tests at his discretion.

3.05 Field Tests

A. General:

1. The Contractor shall perform the following field tests on all equipment specified in this Section after installation of the equipment. Field tests are to be performed to supplement the factory tests and to ensure proper operation of equipment and proper calibration and coordination of protective devices. The Contractor shall furnish and set up all special equipment required for these tests, including relay test set, switches, properly calibrated indicating instruments, recording oscillographs, timing devices, shorting devices, loading devices and other associated appurtenances as may be required.
2. The work includes furnishing of labor, material, test instruments and services necessary to perform required testing and checking of electrical equipment and installation.
3. All tests shall be successfully completed to show that the installation meets the Specification requirements and that the equipment and devices operate as intended before final acceptance by SEPTA.
4. Tests and checkouts shall be conducted in accordance with the Contractor supplied, SEPTA Project Manager approved test procedures as specified herein and, in the NEC, and applicable Standards and Specifications of ANSI, NEMA, IEEE, ICEA, AEIC and NETA.

5. The Contractor shall provide properly qualified personnel who shall be responsible for supervising, coordinating, and performing all electrical field testing and checking work and who maintains a written record of all tests conducted and all punch list items for later correction or re-testing. The results of all field tests shall be verified by an independent test laboratory employed by the Contractor.
6. Testing and checkouts shall be performed in the presence of the SEPTA Project Manager.
7. The Contractor shall furnish five (5) copies of all test results to the SEPTA Project Manager. Results sheets shall include date of test, personnel involved, items tested, type of tests and test data and shall be signed off by the test engineer in charge. The Contractor shall also submit the punch list signed off to showing completion.
8. Any equipment or material damaged due to improper test procedure or test apparatus handling shall be replaced or restored to original condition by the Contractor at the Contractor's expense.
9. Safety devices including but not limited to rubber gloves and blankets, screens and barriers, danger signs, padlocks, etc., shall be used to protect and warn all personnel in the vicinity of the tests.
10. All test instruments used shall have a certified calibration sticker showing last date of calibration and expiration date.

B. Field Test Requirements:

1. The Contractor shall formulate a complete, detailed step by step field test procedure for all equipment to be furnished and installed under this Section and associated equipment interfaces associated with the work. Field test procedure shall be comprehensive and shall include the required tests as specified in relevant standards of ANSI, NEMA, IEEE and NETA, supplementing the factory test procedure. The field test procedure shall also include an index of all the proposed tests, estimated duration, overall schedule, test sequence and shall identify SEPTA personnel requirements to fulfill the test program. The detailed procedure for performing the specified short circuit tests shall include step-by-step test procedure supplemented by circuit diagrams, details of instrumentation, safety interlocks and back-up trips provided.
2. The Contractor shall submit the detailed, step-by-step test procedures to the SEPTA Project Manager for review and approval well in advance of the commencement of field tests. The Contractor may submit the procedures individually per equipment. The SEPTA Project Manager reserves the right to add, delete or make necessary changes in the test procedure. The Contractor is responsible for the performance and installation of the equipment furnished under this Section, he shall, therefore, prior to testing, verify that the installation is proper and in accordance with all applicable installation instructions specified herein.
3. Perform continuity and dielectric tests to prove the correctness of circuitry per the SEPTA Project Manager approved Contract Drawings.
4. Each and every circuit breaker shall be thoroughly inspected and certified by the Contractor's Engineer.
5. Check relay and trip device settings and coordination.

6. Perform functional and operational tests of all equipment and of all devices and circuits including operations between equipment.

C. Equipment and Instruments:

1. Check alignment and proper operation of all equipment including relays, operating mechanisms, clearances, adjustment of contacts and accessory equipment.

2. Test indicating instruments, such as ammeters, voltmeters, and other instruments, by checking and adjusting pointers on zero scale with no load or voltage applied, also at midpoint and full scale.

3. Check the isolation amplifiers/transducers for linearity and gain from 1-V-to-1-V through 1-V-to-100-V.

D. Test Reports:

1. The Contractor shall submit five (5) certified copies of test reports for all the tests conducted at the factory and in field for the SEPTA Project Manager's approval. Test reports shall be submitted to the SEPTA Project Manager within seven (7) days after completion of tests.

2. Result of circuit breaker function test shall be tabulated individually for each circuit breaker, indicating each function tested.

END OF SECTION

SECTION 16344

DC TRACTION POWER SWITCHGEAR ASSEMBLIES

PART 1 - GENERAL

1.01 Description

A. This Section includes DC switchgear lineup (DC cathode circuit breaker and DC feeder circuit breakers), wiring connections and installation of a rectifier control and protective relay system as specified within this Section and as indicated on the Contract Drawings.

B. Furnish and install DC feeder circuit breakers in an indoor switchgear assembly for use on 1000 V DC traction power service. Refer to the Contract Drawings and this Section for the quantity and sizes of circuit breakers.

C. Furnish the following required components associated with the DC switchgear:

1. DC feeder circuit breaker disconnect switches.
2. Feeder circuit breaker protective, control and indicating devices.
3. Feeder circuit breaker switchgear operational control sequence wiring.
4. DC switchgear insulated floor installation.
5. Rectifier control relays, meters, annunciator, contactor, control power circuit breakers and necessary auxiliary equipment and devices. This equipment shall be capable to operate with programmable logic control so that relay energized/de-energized indication, control and event logging is possible.
6. Rectifier protective relays and control sequence of equipment operation.

D. Furnish and install DC circuit breakers including compartment, protective and control relays as indicated on the Contract Drawings and specified herein. The control equipment shall effectively protect each rectifier against abnormal operating conditions and insure proper functioning of the DC switchgear.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01752 – Spare Parts and Maintenance Materials – Traction Power Equipment

C. Section 01810 – Commissioning of Systems

D. Section 01832 – Operations and Maintenance Manuals – Traction Power Equipment

E. Section 09662 – Electrically Insulated Floor Covering

F. Section 16075 – Electrical Identification

G. Section 16260 – Traction Power Rectifier

H. Section 16273 – Traction Power Rectifier Transformers

1.03 Submittals

A. Submit the following in accordance with Section 01300 and the requirements of this Section:

1. Product data for each product specified.
2. Shop drawings for DC switchgear assembly and components, DC feeder circuit breaker, circuit breaker compartments, accessory components and the rectifier control cubicle. Include dimensional plans, sections, and elevations showing minimum clearances, installed devices, major features and materials lists.
3. Wiring diagrams, both elementary and schematic, differentiating between manufacturer installed and field installed wiring.
4. Manufacturer's certification signed by the manufacturer certifying that they meet the Specification requirements. Upon request submit evidence of experience.
5. Product certification signed by the manufacturer of equipment certifying that products meet the Specification requirements.
6. Installer’s certification signed by the installer certifying that they meet the Specification requirements.
7. Factory testing organization certificates signed by the testing organization certifying that the organization meets the Specification requirements.
8. Certified copies of field tests including ground resistance tests.
9. Maintenance data for materials and products, for inclusion in operating and maintenance manual.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. IEC 60751, Industrial Platinum Resistance Thermometers and Platinum Temperature Sensors.
2. IEC 61850, Communication Networks and System for Power Utility Automation.
3. IEEE C2, National Electrical Safety Code (NESC).
4. IEEE C37.1, IEEE Standard for SCADA and Automation Systems.
5. IEEE C37.14, IEEE Standard for DC (3200 V and below) Power Circuit Breakers used in Enclosures.
6. IEEE C37.16, IEEE Standard for Preferred Ratings, Related Requirements, and Application Recommendations for Low-Voltage AC (635 V and below) and DC (3200 V and below) Power Circuit Breakers.
7. IEEE C37.20.1, IEE Standard for Metal Enclosed Low Voltage (1000 VAC and below, 3200 VDC and below) Power Circuit Breaker Switchgear.
8. IEEE C37.20.2, IEEE Standard for Metal-Clad Switchgear.
9. IEEE C37.20.3, IEEE Standard for Metal-Enclosed Interrupter Switchgear (1 kV thru 38 kV).

10. IEEE C37.90, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays and Relay Systems Associated with Electric Power Apparatus.
11. IEEE C57.13, IEEE Standard Requirements for Instrument Transformers.
12. INETA, Acceptance Testing Specifications (ATS) for Electrical Power Distribution Equipment and Systems.
13. NFPA 70, National Electrical Code (NEC).
14. UL 486A-486B, Wire Connectors.

1.05 Nomenclature

A. The device numbers referred to in this Section are the functional numbers assigned to equipment by IEEE.

PART 2 - PRODUCTS

2.01 DC Switchgear Assembly

A. DC switchgear assembly shall consist of indoor metal enclosed; self-supporting structures rated for operation on 1000 V DC traction service. Switchgear assembly shall be directly supplied from the power rectifiers via enclosed ventilated bus duct. Switchgear shall be suitable for operation with its structure high resistance grounded and shall employ suitable means and insulating materials to achieve isolation from building steel ground and negative return. Provisions to accommodate future extension of switchgear assembly from one (1) or both ends shall be included in accordance with the available space shown on the Contract Drawings.

2.02 DC Switchgear Structure

A. DC switchgear assembly to be metal-enclosed and shall consist of rigid self-supporting and self-contained electrically welded steel structures. Interior and exterior surfaces and metal subpanels shall be thoroughly cleaned and treated prior to painting with two (2) coats of semi-gloss light grey paint. Treatment for bare metal shall be phosphatizing or chromatizing and the treatment for galvanized steel shall be "pickling" with acetic acid or a similar oxidizing agent. Coat machined or drilled fiberglass panels, subpanels, barriers, insulators and spacers with a light epoxy gel finish; Or Approved Equal; to reduce surface porosity and voltage "tracking" or "creep". Enclose individual circuit breaker unit with not less than 12 gauge formed steel sheets. Individual units shall be bolted to each other to form a continuous, free standing switchgear assembly, broken down into shipping sections adequate to fit through hatchways or Traction Power Substation (TPSS) entrances. Hinged doors made of 12 gauge steel shall be provided at front and rear of each circuit breaker unit. The front of the circuit breaker enclosure including the front of the circuit breaker frame shall be suitable for mounting relays, meters, instruments and control devices. A hinged door, which can be used for mounting control devices, may be installed in front of each circuit breaker enclosure. Doors shall be formed of either 12 gauge or from a lesser gauge where properly reinforced against distortions by suitable flanges and stiffening members. Hinges shall be heavy duty type. Full height doors shall be securely fastened in the closed position with a minimum of three (3) latches easily opened without the use of tools. For doors less than the full height of the equipment, a

minimum of two (2) latches will be acceptable. Provide doors with stops to hold them securely in the open position. With the front door of any compartment in the fully open position, the adjacent compartment door shall be capable of being opened and its circuit breaker completely removed from its housing.

2.03 DC Switchgear Compartments

A. Separate, steel enclosed compartments shall be provided for each of the following:

1. Circuit breakers.
2. Bus with bus taps.
3. Control devices (relays, instruments, meters, etc.).

B. Provide separate compartment for an emergency circuit breaker where indicated on the Contract Drawings. Provide compartments for circuit breaker, outgoing cables, relays and control devices, with a separate hinged door for servicing without exposing circuits in adjacent compartments. Cable compartments shall be accessible for connection of power cables from the rear of the unit. Bus compartment shall contain the main (positive) bus and bus taps and shall be provided with either a separate hinged door or a removable bolted-on cover for complete access to the bus and the taps. Bus shall not be run less than 18 inches from the floor. Provide barriers at the side of cubicles to insulate the bus compartment of each circuit breaker unit from the bus compartment of adjacent units.

C. Circuit breaker compartment shall be completely enclosed except for the insulated vent opening at the top, designed for rapid exhaust and deionization of ionized gases. The design shall prevent striking an arc to conductive members of the DC switchgear during and after fault interruption. Provide screws made of non-conducting material and insulating barriers for all surfaces exposed to ionizing gases. Alternatively, metal screws may be covered with high temperature rated insulating caps. Compartments shall be sufficiently gas tight to assure that no ionized gas will pass from one (1) compartment to the other. Insulation of circuit breaker compartment and its vent openings are not required when it can be shown that the gases exhausted from the circuit breaker removable element during fault interruption are completely deionized and that these exhaust gases do not contain solid metallic particles that would otherwise contaminate the compartment. Vent openings shall be designed to prevent damage to or malfunctioning of the circuit breaker, control circuits and other components from foreign objects and shall be so located that hot gases or other materials cannot be discharged through them in a manner which might be injurious to operating personnel.

D. Provide each circuit breaker housing with protective shutters which close and block access to the positive bus and circuit breaker load terminals as the removable element of circuit breaker is racked from the cubicle. Protective shutter mechanism shall be designed and installed so that it can be removed for repair without necessitating de-energization of the main bus.

E. Width of individual DC switchgear units shall not exceed 24 inches for the feeder circuit breakers (Devices 172).

2.04 DC Switchgear Buses

A. Main bus and bus taps of the DC switchgear shall be of copper and be rated at the continuous current carrying capacity of the buses and bus taps. Support and brace main internal bus and bus taps to withstand short circuit stresses as great as those for which circuit breakers are rated. Support buses on high strength flame retardant fiberglass, porcelain; Or Approved Equal; insulators designed to insure adequate electrical clearances.

2.05 DC Switchgear Heaters

A. Each circuit breaker enclosure shall contain one (1) electric heater approximately 1 foot from the finished floor. Each heater shall have double the thermal capability to raise the temperature of each enclosure above the dew point of the air at 100 percent ambient humidity. Heaters shall be controlled by two (2) approved temperature compensated humidistats mounted at each end of the DC switchgear lineup.

2.06 DC Switchgear Wiring

A. Openings for wiring installed through metal barriers and structural members shall be free of sharp edges. Protect wires against abrasion by approved grommets. Circuits requiring external connections shall be factory wired to readily accessible terminal blocks, within the control compartment(s) for connection to field wiring. Provide sufficient number of terminals to satisfy all external connection requirements and 20 percent additional unassigned terminals. Terminal blocks shall be heavy duty, washer head screw type with insulating barriers between circuits, rated for 1000 V DC, minimum; Or Approved Equal; complete with marking strips and plastic covers. The terminal blocks supplied with a black marking strip with white numbers on one (1) side, and white unmarked on the reverse side for circuit identification. Connect control devices operated on 700 V DC with red colored wire, which shall be kept segregated from all 136 V DC wiring.

2.07 DC Circuit Breakers

A. DC switchgear shall consist of 1000 V DC, high speed, DC cathode circuit breakers, DC feeder circuit breakers, Wayside Energy Storage System (WESS) circuit breakers and DC emergency circuit breakers. DC cathode circuit breakers shall consist of Device 76, rated not less than 8000 A and have features as indicated on the Contract Drawings and as specified. DC feeder circuit breakers shall consist of Device 172, rated not less than 6000A, with load measuring circuit, overload protection and definite time lockout features as indicated on the Contract Drawings and as specified. WESS circuit breakers shall consist of Device 176, rated not less than 6000 A and have features as indicated on the Contract Drawings and as specified. DC emergency circuit breakers shall be rated for not less than 2000 A and have features as indicated on the Contract Drawings and as specified. Circuit breakers shall be subject to local and supervisory control.

B. Device 172 shall be an air circuit breaker capable of opening a circuit having a short circuit current of 200,000 A without damage to itself or necessity for maintenance or repair upon the device before a service restoration could be affected. Furnish SEPTA with notarized, certified oscillographic records of the device the Contractor proposes to furnish showing its successful opening of a DC circuit having a rate of current rise not less than 10 amps/microsecond.

C. Circuit breaker shall be mechanically latched, having a solenoid release to trip the circuit breaker as well as a door shunt trip operating independent of any external control power or other tripping means. Magnetically latched circuit breakers will be considered only if designed such that the loss of control power does not trip the circuit breaker. Circuit breakers shall also have a solenoid type closing coil or closing motor operating through adequate link work, for closing the circuit breaker. Coils or motors shall operate properly on auxiliary voltages which are plus or minus 15 percent of the nominal 136 V DC power supply. Circuit breakers up to 6000 A shall have single pole, single contact main contacts. Single pole two (2) contact circuit breakers will not be accepted. Circuit breakers shall have a means of manually closing during loss of control power.

D. Provide an overcurrent device connected in series with the main contacts of the circuit breaker, calibrated to trip the circuit breaker over a range from 4000 A to 16,000 A.

E. Circuit breakers shall be 1000 V DC class minimum, single pole, air break, draw out type without negative disconnecting device, capable of withstanding a continuous no load or light load voltage of 1000 V DC. The circuit breakers shall be of high speed classification as per IEEE C37.16. Each circuit breaker shall be mounted on a mobile steel frame (truck) equipped with power and control circuit disconnecting devices, to make the circuit breaker and the operating mechanism a removable element. The roll out truck shall be capable of being moved in any direction on the TPSS floor without benefit of any ancillary rolling devices or dollies. Mount four (4) digit register type operations counter on the removable element of each circuit breaker. The power disconnecting devices shall consist of self-aligned assemblies. Female contacts shall be constructed of bridging segments designed to ensure high pressure contact guaranteed not to distort or fail under the mechanical stresses and heating due to duties specified for circuit breakers. The control disconnecting devices shall provide connections for the control circuits and interlocks between the removable element and the housing. The devices shall be accurately located and securely mounted to maintain alignment. The DC feeder circuit breaker shall be interchangeable with similar circuit breakers in the same or other TPSSs.

F. Circuit breaker components requiring periodic maintenance and/or replacement and those which may require replacement due to deterioration shall be easily accessible without removal of major circuit breaker assemblies. Frames of relays and other devices mounted on energized circuit breaker frame and operated on 136 V DC shall be insulated for 1500 V DC, minimum, to prevent rectifier voltage being imposed on the station battery. The DC switchgear enclosure line-up will be tested at 2500 V DC and all wiring which may be exposed to this potential shall be suitably insulated. All auxiliary switches, whether cell mounted or mounted on removable element, and circuit breaker control circuit wiring connected through control disconnecting devices shall be made up and operable when the circuit breaker is racked to the test position so that the circuit breaker may be closed and tripped electrically or mechanically with power disconnecting devices open. Provide a mechanical indicator at the front of the circuit breaker compartment to show that the circuit breaker is in the "test" or "connected" position.

G. Equip each circuit breaker unit with a cranking device for moving the removable circuit breaker element to and from its operating position. Operate the mechanism by a removable hand crank, arranged to rack the circuit breaker from disconnected to test position and from test to operating position. Provide suitable guide rails for centering the circuit breaker in proper position when inserting or withdrawing the removable element.

Provide a positive stop to prevent over travel of the removable element when moving it into operating position. A similar positive stop shall be provided for the test position. Where the design of the circuit breaker unit has the access door mounted on the stationary structure of the DC switchgear, the door shall permit closing of the compartment door with the circuit breaker in the test position. Provide positive acting interlocks so that a circuit breaker in the closed position cannot be disconnected from or connected to the bus. Arrange the circuit breaker so that personnel are guarded from contact with energized parts while racking the circuit breaker into or out of the connected position.

H. Circuit breakers shall be subject to local and/or supervisory control. Circuit breakers shall be single pole design. The single pole contact may be comprised of several paralleling contact springs. The substitution of two (2) or more electrically and/or mechanically linked lower current rated circuit breakers for a single higher current rated circuit breaker by means of paralleling their poles will not be permitted. Each circuit breaker shall contain only one (1) operating and tripping mechanism. Provide circuit breakers from one (1) of the following manufacturers:

1. Balfour Beatty Rail Inc.
2. Hawker Siddley.
3. Myers Power Products, Inc.
4. Or Approved Equal.

2.08 DC Cathode Circuit Breaker Devices

A. The devices in the DC cathode circuit breaker enclosures or mounted thereon shall include as a minimum, the following equipment:

1. DC high speed air circuit breaker, Device 76.
2. Auxiliary closing contactor and cutoff relay, Device 76X-Y (continuous rated coil).
3. Ground protection auxiliary relay, Device 64P.
4. Master control relay, Device 04.
5. Two pole, single throw knife switch, with 30 A fuse in two (2) legs, Device 108-1.
6. Ground protection test switch, Device 8T.
7. Provide a standard momentary control switch which is connected to the TPSS 43 L/S switch. Provide momentary control switches from one (1) of the following manufacturers:
   a. Electroswitch Electric.
   b. General Electric.
   c. Or Approved Equal.

B. 0-800 V scale voltmeter with 1 percent accuracy.

C. Control circuit knife switches on the DC cathode circuit breaker enclosures shall be 250 V, 100 A, solid blade, with silver plated contacts, split clip, Type A, provided with stops.

2.09 DC Feeder Circuit Breaker Devices

A. The devices in the DC feeder circuit breaker enclosures or mounted thereon shall include as a minimum, the following equipment:

1. DC high speed air circuit breaker, Device 172.
2. Auxiliary closing contactor and cutoff relay, Device 172X-Y (continuous rated coil).
3. Ground protection auxiliary relay, Device 64P.
4. Isolating contactor, Device 129.
5. DC overcurrent and rate of rise (multifunction) detector, Device 150F/176.
6. Two pole, single throw knife switch, with 30 A fuse in two (2) legs, Device 108-1.
7. Ground protection test switch, Device 8T.
8. Provide a standard momentary control switch which is connected to the TPSS 43 L/S switch. Provide momentary control switches from one (1) of the following manufacturers:
   a. Electroswitch Electric.
   b. General Electric.
   c. Or Approved Equal.

B. 8000-0-8000 A long scale ammeter with 4000 A, 50 millivolt shunt, 1 percent accuracy.

C. Operation of the long time delay relay shall be readily visible and show when it is timed out. All spare auxiliary contacts shall be wired to terminal blocks.

D. Control circuit knife switches on the DC feeder circuit breaker enclosures shall be 250 V, 100 A, solid blade, with silver plated contacts, split clip, Type A, provided with stops.

2.10 DC WESS Circuit Breaker Devices

A. The devices in the DC WESS circuit breaker enclosures or mounted thereon shall include as a minimum, the following equipment:

1. DC high speed air circuit breaker, Device 172.
2. Auxiliary closing contactor and cutoff relay, Device 172X-Y (continuous rated coil).
3. Ground protection auxiliary relay, Device 64P.
4. Two pole, single throw knife switch, with 30 A fuse in two (2) legs, Device 108-1.
5. Ground protection test switch, Device 8T.
6. Provide a standard momentary control switch which is connected to the TPSS 43 L/S switch. Provide momentary control switches from one (1) of the following manufacturers:
   a. Electroswitch Electric.
   b. General Electric.
   c. Or Approved Equal.

B. Control circuit knife switches on the DC WESS circuit breaker enclosures shall be 250 V, 100 A, solid blade, with silver plated contacts, split clip, Type A, provided with stops.

2.11 DC Emergency Circuit Breaker Devices

A. The devices in the DC emergency circuit breaker enclosures or mounted thereon shall include as a minimum, the following equipment:

1. Ground protection auxiliary relay, Device 64P.
2. Two pole, single throw knife switch, with 30 A fuse in two (2) legs, Device 108-1.
3. Ground protection test switch, Device 8T.
4. Provide a standard momentary control switch which is connected to the TPSS 43 L/S switch. Provide momentary control switches from one (1) of the following manufacturers:
   a. Electroswitch Electric.
   b. General Electric.
   c. Or Approved Equal.

B. Control circuit knife switches on the DC emergency circuit breaker enclosures shall be 250 V, 100 A, solid blade, with silver plated contacts, split clip, Type A, provided with stops.

2.12 DC Overcurrent and Rate of Rise Detection Equipment (Device 150F/176)

A. Each DC circuit breaker shall be equipped with multifunction DC overcurrent, instantaneous and rate of rise detection equipment.

B. Detection equipment shall receive its input from the 50 mV shunt. A built-in calibration control and test switch shall be provided to allow functional check of thresholds and time delays of all current detector channels.

C. The detection equipment shall include, as a minimum, the following channels:

1. Instantaneous overcurrent.
2. Short time overcurrent.
3. Rate of rise.

D. The rate of rise channel shall permit adjustment of the initial slope (di/dt), the current step (delta i) and the time duration. Unless the current pulse is steep enough, high enough and long enough, it will be rejected and will not cause a trip. The system shall be able to discriminate between remote faults and other high current transients such as train starting currents, train currents due to crossing over a power section gap and currents due to charging of propulsion capacitors.

2.13 DC Feeder Circuit Breaker Voltage and Current Telemetry

A. Devices specified in this Section shall be used in conjunction with a protective relay to monitor the DC voltage and current on each DC feeder circuit breaker.

B. Provide a DC voltage transducer for the telemetering system for each DC feeder circuit breaker. The voltage transducer shall be fully calibrated by the manufacturer to coordinate with the maximum voltage spikes of the WESS. Voltage transducer shall have high grade insulation between input, output and auxiliary voltage terminals. Input and output circuits shall be galvanically isolated and protected against damage by shock or

permanent overload. The floating output shall be fully protected against open or short circuited conditions and voltage transients. Voltage transducer shall have flame retardant case and self-extinguishing.

C. A DC current transducer for the telemetering system shall be provided for each DC feeder circuit breaker. The DC current transducer shall be fully calibrated by the manufacturer for use with a 4000 A, 50mV shunt with no further adjustments required. The DC current transducer for lead/cable sheath protection instrument's panel shall be fully calibrated by the manufacturer for use with a 1000 A, 50 mV shunt with no further adjustments required. Current transducers shall have high grade insulation between input, output and auxiliary voltage. Input and output circuits shall be galvanically isolated and protected against damage by shock or permanent overload. The floating output shall be fully protected against open or short circuited conditions and voltage transients. Current transducer shall have a flame retardant case and be self-extinguishing.

2.14 Rectifier Current Telemetry

A. The current teleductor shall be provided by one (1) of the following manufacturers:

1. Westinghouse model No. 4087D01G03.
2. Or Approved Equal.

B. The current teleductor shall meet or exceed the following ratings:

1. Input to be nominally 0 A to 5 A.
2. Input burden to be less than 1.0 volt-amperes.
3. Overload to be sixty (60) times the rated input for one (1) second. 7 A continuous thermal rating.
4. Frequency to be 60 Hz.
5. Output to be 0 mA to 3 mA DC into fixed load up to 10,000 ohms. Analog boards in the Remote Terminal Unit (RTU) are 0 mA to 1 mA. (For inductive loads a capacitor must be used across the output to prevent saturation of the transformer). Unfiltered DC output has the one hundred and twenty (120) pulses per one (1) second characteristic of a full wave rectifier. Less than plus or minus 0.5 percent of full scale variation with temperature changes from minus 28°C to plus 72°C.
6. High potential test to be between all terminals (connected together) and case:

a. 1500 V, 60 Hz, between windings to be 1000 V, 60 Hz.

7. Temperature range to be minus 20°C to plus 65°C.

C. Compensator shall be an adjustable line resistance compensator of the potentiometer type having a resistance of 2500 ohms and capable of carrying a current of 90 mA.

D. Install the passive components which comprise the filter systems within the transmitter case and shall be of such proportions that will effectively smooth out alternating current ripples in the circuit and shall pass essentially pure direct current to the line wires.

E. The secondary current transformer shall reduce the current delivered by the relaying current transformer to a value suitable for the instrument's rectifier. The transformer shall have suitable turns ratio between the primary and the secondary so that 25 mA

rectified current can be delivered with an input of 5 A. The transformer shall be supplied with an adjustable spark gap across its secondary winding which will be capable of relieving the pressure across the secondary winding should an open circuit occur in the rectifying system.

2.15 Control and Auxiliary Power

A. Use 136 V DC auxiliary power for the operation of the rectifier's control devices. Use AC power for auxiliary equipment.

2.16 Rectifier Control Compartment

A. Furnish, mount and connect in each rectifier control compartment, switches, meters, relays, motor starters, annunciator and other necessary devices. This equipment shall include, but shall not be limited to, the following:

1. Sequence timing relay, Device 48.
2. Tripping relay, Device 94.
3. Auxiliary relay for Device 72, Device 72Z.
4. Lockout relays, Device 86.
5. AC ammeter, 0 A to 400 A for 13.2 kV TPSSs. Provide AC ammeter from one (1) of the following manufacturers:
   a. Digital Set Point Ammeter, Model # 307 AC, Part # 307-1-1-01-00-0-16-05-05 by Jay Control Co., 21 Sequin Drive, Glastonbury, Conn. 06033.
   b. Or Approved Equal.
6. DC voltmeter, 0 V to 750 V.
7. Selector switch, stop supervisory run, Device 43.
8. Master relay, Device 3.
9. Master contactor, Device 4, with operation counter to register when device closes, five (5) digit, non-resettable, 136 V DC, panel mounted. Provide master contactor from one (1) of the following manufacturers:
   a. Veeder-Root of Canada Ltd. Series No. 4737 (5 figures).
   b. Or Approved Equal.
10. Auxiliary relay for Device 186, Device 186Y.
11. Annunciator with required number of drops, Device 30 and auxiliary relays to provide remote indication for all annunciator functions. Provide annunciator from one (1) of the following manufacturers:
    a. Ametek AN-3100D.
    b. Or Approved Equal.
12. Control power circuit breakers, Device 8.
13. Circuit breakers, motor starters, switches and relays for operation and control of TPSS and rectifier auxiliaries.
14. Air temperature thermometer with maximum temperature indicator.

15. Diode monitor relay, Device 58A, 58T.
16. Surge monitor relay, Device 99X.

B. Equipment mounted remotely as directed by SEPTA

1. DC overcurrent relay, Device 76.
2. Phase sequence under voltage relay with time delay, Device 47.

2.17 Device 58A and 58T Diode Fuse Monitor Relays

A. Mount these devices in pairs, there being one (1) pair of relays to monitor the diode fuses in each arm of the rectifier. Relay 58A shall be picked up if any one (1) fuse blows and relay 58T shall be picked up if a second fuse blows in the same arm, this system is fully described in Article 2.18/D in this Section.

B. If any 58A relay operates, it will close a contact to operate the annunciator window marked 'DIODE FAILED" thus giving local and remote alarms indications.

C. If any 58T relay operates, a contact will close and pick up the auxiliary relay 58TX. A contact of relay 58TX will pick up relay 86 which will trip and lockout the rectifier. It should be noted that when a diode fuse has blown, the indicator will eject a red pin which is not retractable. This pin operates a micro-switch which picks up the monitoring circuit so that the 58A and 58T relays will remain in the operated condition until the blown fuse has been replaced.

D. Diode Fuse Failure Indicting Panels:

1. Connect each diode in the rectifier in series with a specially designed fuse which has a separate indictor fuse in parallel. The indicator fuse, when blown, shall eject a captive pin from one (1) end to operate a micro-switch which is fitted over the end of the fuse. This pin shall be red in color and cannot be reset.
2. Furnish and install micro-switches in each phase and connect them in two (2) parallel groups, one (1) for the positive arm and one (1) for the negative arm, each group being connected to operate a pair of relays 58A and 58T. Mount a rack containing the relays for twelve (12) circuits inside the control cubicle. Mounted immediately above each pair of relays shall be an indication lamp which will be lit if two (2) or more fuses have blown in any one (1) phase and will thus indicate which phase is in trouble. Final location of the blown fuse may then be made visually by looking for the extended red pins on the indictor fuses of phase concerned. Each pair of relays is further identified by the suffix letters to the device number, i.e., P = positive arm or N = negative arm, by the phase number.
3. If the fuse operating the micro-switch 98-1 blows, the switch contact will close and remain closed thus energizing relay 58A/PRI via the blocking diode MD. This relay operates the annunciator window marked "DIODE FAILED" and closes a contact in series with the coil of relay 58T/PRI.
4. Relay 58T/PRI is now energized via the contact 98-1, resistor R1, the contact 58A/PRI and resistor R2 but will not draw enough current to pick up. If the fuse operating the micro-switch 98-2 now blows, a second R1 resistor will be connected in parallel with the first and relay 58T/PRI will then draw sufficient current to enable it to pick up and close a contact, which will energize the auxiliary relay 58TX. A contact of relay 58TX

will pick up relay 86 which will trip and lockout the rectifier. The indication lamp mounted immediately above relays 58A/PRI and 58T/PRI will be lit to indicate the phase in trouble.

5. A blocking diode MD and a resistor R1 are required for each micro-switch and these shall be mounted on printed circuit boards in groups of fifteen (15).
6. The printed circuit board for each phase shall be mounted on the barriers provided between phases and all connections to them shall be made with push-on connectors. In the event of trouble any board can be readily replaced with a spare unit.
7. Component Values:
   a. R2 to be 1 watt, 100 ohms.
   b. R1 to be 5 watts, 6800 ohms.
   c. MD to be I.R.C. diode type 10D10.
   d. 58A to be D2600/21/FP7/110 V DC with a resistance of 3500 ohms.
   e. 58T to be D2600/14/FB8/50 V DC with a resistance of 850 ohms.
   f. Neon indicating lamp to be I.T.T. code SGF1717/YL/110.

2.18 Device 99 and 99X Surge Circuit Monitor

A. DC surge circuit fuses one (1) through four (4) shall be monitored by striker pin fuses, connected across each fuse and arranged so that the ejected pin will operate a micro-switch designated 99-1 through 99-4. The double throw contacts of these micro-switches shall be connected in series via the normally closed side of each contact to an indicating lamp across the 136 V DC supply protected by fuses. Therefore, the indicating lamp will be lit to indicate a good condition.

B. When a surge circuit fuse has blown the appropriate micro-switch contact will change to extinguish the indicating lamp and energize the alarm relay 99X. This relay will close a contact to operate the annunciator window marked "SURGE FAILED", and thus will give a local and remote alarm indications.

2.19 Nameplates

A. Refer to Section 16075 for nameplate requirements.

2.20 Protective Circuits

A. The type and number of protective devices for the rectifier cannot be fully determined in advance, but should be essentially as shown in the table 16344-1:

Table 16344-1 Typical Rectifier Protective Devices

Device	Fault Detected	Shutdown	Lockout	Alarm Lamp	Annunciator	Remote Indication
26A	Rectifier Air Over Temperature				X	X
26T	Rectifier Transformer Over Temperature	X	X		X	X
27	Undervoltage	X	X		X	X

Device	Fault Detected	Shutdown	Lockout	Alarm	Annunciator	Remote
33R	Rectifier Compartment Door Safety Interlock	X	X		X	X
47	Phase Sequence	X			X	X
48	Rectifier Incomplete Sequence	X	X		X	X
50	AC Instantaneous Overcurrent **	X	X		X	X
51, 51N	AC Time Overcurrent **	X	X		X	X
58A	First Blown Fuse in Leg			X	X	X
58T	Second Blown Fuse in Leg	X	X	X	X	X
64P	Positive Bus Fault on Rectifier Case	X	X		X	X
64N	Ground on Rectifier Case				X	X
76	DC Overcurrent	X	X		X	X
99X	Blown Fuse in Surge Protection Circuit			X	X	X
58A	First Blown Fuse in Leg			X	X	X
GDR	Ground Detection	X	X		X	X

+ A voltage dip in the high voltage feeder or in the auxiliary or control power shall not lock out the rectifier.

** The overcurrent relays shall be set so that the overload ratings of the rectifier specified in Section 16260 may be achieved.

2.21 Meters and Devices

A. The types of meters and devices used in local and supervisory control shall have been proved successful in similar applications.

B. All control and instrument switches shall be of the rotary type with properly designated escutcheon plates clearly marked to show the operating position.

C. All control and auxiliary relays shall be suitable for use in DC switchgear equipment as defined in IEEE. Operating coils for direct current relays shall be suitable for continuous operation between 80 percent and 110 percent of nominal rating.

2.22 Temperature Telemetry

A. Equipment specified in this Article shall provide the telemetry interface with the Supervisory Control and Data Acquisition (SCADA) Remote Terminal Unit (RTU) to monitor rectifier transformer, rectifier and TPSS temperature. Provide temperature sensors and temperature transducers as described herein.

B. Refer to Sections 16260 and 16273 for the Resistance Temperature Detector (RTD) sensors for the rectifier transformer enclosure and the rectifier enclosure. The resistance of the RTD at 0°C shall hold less than a 0.05°C shift per year. The RTD shall withstand a vibration level of 30g over the frequency range 10 Hz to 1 KHz. It shall also be insensitive to large changes of pressure. When tested in accordance with the requirements of IEC 60751, the indicated temperature rise in the temperature detector, with a power of 10 mW dissipated in it, shall not exceed plus 0.3°C.

C. Refer to Section for the RTD sensor for the measurement of the ambient temperature of the TPSS. The resistance of the RTD at 0°C shall hold less than a 0.05°C shift per year. The RTD shall withstand a vibration level of 30g over the frequency range 10 Hz to 1 KHz. It shall also be insensitive to large changes of pressure. When tested in accordance with the requirements of IEC 60751, the indicated temperature rise in the temperature detector, with a power of 10 mW dissipated in it, shall not exceed plus 0.3°C.

D. Provide two (2) types of temperature transducers. One (1) type shall be fully calibrated by the manufacturer for 0°C to 200°C with no further adjustments required. Provide one (1) of these types for the temperature sensors in the rectifier transformer enclosure and one (1) of these types for the temperature sensor in the rectifier enclosure. In total, two (2) of these types of transducers are required per rectifier unit. The other type of temperature transducer shall be fully calibrated by the manufacturer for 0°C to 80°C with no further adjustments required. This transducer shall be dedicated for the TPSS temperature sensor and shall be mounted in an approved cast iron junction box on the TPSS wall. Provide one (1) of this type of temperature transducer per TPSS.

E. Each temperature transducer shall have the following characteristics:

1. High grade insulation between input, output and auxiliary voltages.
2. Galvanic isolation between the input and output circuits.
3. Protection against damage by shock or permanent overload.
4. Full protection of the floating output signal against open or short circuited conditions and voltage transients.
5. A flame retardant case and self-extinguishing capability.

PART 3 - EXECUTION

3.01 DC Switchgear

A. DC switchgear shall be fully assembled and completely installed on the operating floor in accordance with the approved manufacturer's drawings at locations indicated on the Contract Drawings. Install insulated anchors, furnished with the DC switchgear, in the floor slab in accordance with the manufacturer's instructions. Cover floor area at the DC switchgear with a layer of insulation material to insulate the DC switchgear enclosure from building structure or other grounds per Section 09662. Care shall be taken that the insulated floor area is not scraped or otherwise damaged during installation. Provide all hardware required for anchoring the DC switchgear.

B. Assemble DC switchgear units in such a manner as to ensure proper leveling, proper alignment between the various shipping groups and for proper placement of all the conduits that are required for equipment interconnection.

C. The Contractor shall carry out a study of the load profile for each DC feeder circuit breaker under all load conditions. The Contractor shall use this study to determine the optimum settings for all functions of the multifunction DC protective relay and set relay accordingly. The study procedure, results of study and relay settings shall be approved by SEPTA.

D. Refer to Section 09662 for electrically insulated flooring covering installation requirements.

3.02 Control and Auxiliary Power

A. Provide and mount circuit breakers for the control devices in the rectifier control cubicle as indicated on the Contract Drawings. 125 VDC power shall be supplied for the control circuits.

3.03 DC Cathode Circuit Breaker Voltage Transducer

A. Mount a voltage transducer in each DC cathode circuit breaker's control compartment.

B. Connect the positive input terminal of this voltage transducer to the DC cathode circuit breaker via 10 A current limiting fuse and connect the negative input terminal to the rectifier negative switch via a 10 A fuse.

3.04 DC Cathode Circuit Breaker Current Transducer

A. Mount a current transducer in each DC cathode circuit breaker's control compartment.

B. Input terminals of the current transducer shall be connected to the shunt of the DC cathode circuit breaker via 10A current limiting fuses. The output terminals of the current transducer shall be connected to the protective relay and ammeter.

3.05 DC Switchgear Voltage Transducer

A. Mount a voltage transducer in one (1) of the DC feeder circuit breaker's control compartments.

B. Connect the positive input terminal of this voltage transducer to the DC switchgear positive bus via 10 A current limiting fuse and connect the negative input terminal to the negative and drainage switchboard via a 10 A fuse.

3.06 DC Feeder Circuit Breaker Current Transducer

A. Mount a current transducer in each DC feeder circuit breaker's control compartment.

B. Input terminals of the current transducer shall be connected to the shunt of the DC feeder circuit breaker via 10 A current limiting fuses. The output terminals of the current transducer shall be connected to the protective relay and ammeter.

3.07 Rectifier Control Compartment

A. Meters and counters shall be readable at eye level.

B. Terminal blocks for outgoing wires shall be accessible to conduit for outgoing control wires in the roof of the cubicle and shall be supplied with 10 percent spare capacity. Payment for such terminal blocks and wiring of panel and its cubicle is deemed to be included in the price paid for the panel mounted equipment.

C. The rectifier control compartment shall have sufficient strength for the support of control conduits and the DC buses. The compartment shall be illuminated with two (2) lights and shall be provided with two (2) three (3) way switches and two (2) duplex

receptacles, all isolated from building AC power ground. The receptacles shall be marked "No Equipment Ground". Provide cubicle doors with adjustable door stops.

D. Protect the top and sides of the rectifier control compartment against water leakage.

3.08 Rectifier Current Telemetry

A. Mount a current teleductor as specified in each rectifier control cubicle.

B. Connect the input terminals of the current teleductor in the secondary circuit of the current transformer in phase B of the feed for the rectifier.

3.09 Temperature Telemetry

A. Each temperature sensor's output shall be wired to the input terminals of a temperature transducer after all the sensors and transducers are mounted. Each temperature transducer will be dedicated to only one (1) temperature sensor. Wire the outputs of the temperature transducers to an IEC 61850 compatible IED that communicates to the SCADA RTU.

B. Install a RTD sensor in each of the following locations:

1. Each rectifier transformer enclosure.

2. Each rectifier enclosure.

3.10 Nameplates

A. Refer to Section 16075 for nameplate installation requirements.

3.11 Meters and Devices

A. Relays shall be mounted in semi-flush test type, draw out cases with dust tight covers. Devices to be mounted on the front of the panels shall be back connected.

B. Indicating instruments shall be semi-flush mounted and shall have black figures on a white background. They shall be approximately 4 1/4 inches square or round and of the 250 degrees scale design.

3.12 External Connections

A. Positive and negative buses external to the DC switchgear shall be assembled, spaced, insulated and supported as approved. Include details indicating copper bar sizes, insulators, clamps, expansion connectors, joint plates and supports. Bus shall meet the on-site routing requirements. Bus supports shall relieve stresses due to thermal expansion, contraction of the copper buses. Brace all buses to withstand DC switchgear rated short circuit stresses. Avoid scheduling delays by fabricating bus on-site or manufacturing ahead of time. Omit a short section of bus which may be easily adjusted to fit after the equipment is in place.

3.13 Tests

A. Circuit breakers shall be tested to the requirements of IEEE C37.14 and IEEE C37.16.

B. Design tests on the circuit breakers shall include the following:

1. Trip device calibration check test.
2. AC dielectric withstand test.
3. Short time current test.
4. Continuous current test.
5. Electrical and mechanical endurance tests.
6. Peak current test.
7. Short circuit current test.
8. Load (low) current switching tests.

C. The circuit breaker manufacturer shall submit certified design test reports showing that the product manufactured has been tested and meets the minimum requirements. Design test shall be made only on representative circuit breakers.

D. Production tests shall be made by the manufacturer on each circuit breaker at the factory after final assembly.

E. Production tests shall include the following:

1. Calibration test.
2. Control, secondary wiring and device check test.
3. Dielectric withstand voltage test.
4. No-load operation test.

F. Certified test reports shall be submitted, to show, to the satisfaction of SEPTA, that the circuit breakers do fulfill the requirements herein specified. SEPTA reserves the right to witness all design and production tests.

G. The rectifier control equipment, as a unit shall be tested after installation, so as to clearly demonstrate to the satisfaction of SEPTA that the equipment will perform in accordance with the requirements of this Section.

H. Refer to Section 09662 for electrically insulated floor covering testing requirements.

3.14 Calibration and Adjustment

A. The manufacturer shall inspect, calibrate and adjust all circuit breakers and relays after the installation is completed. Adjustments shall include a check of the alignment of the primary draw-out contacts on the circuit breakers as well as any auxiliary contact switches or cells which are activated by insertion of the circuit breakers within the cubicles. Primary draw-out contact surfaces shall be checked for proper alignment by observing wipe patterns in heavy silicon grease. Grease will be cleaned off after acceptance. These adjustments shall be witnessed by SEPTA.

3.15 Spare Parts

A. Refer to Section 01752 for spare parts and maintenance material requirements.

3.16 Tools

A. Refer to Section 01752 for spare parts and maintenance material requirements.

3.17 Field Manuals

A. Refer to Section 01832 for operations and maintenance manual requirements.

END OF SECTION

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SECTION 16348

NEGATIVE AND DRAINAGE SWITCHBOARD

PART 1 - GENERAL

1.01 Description

A. This Section includes:

1. Furnishing, installing, and testing negative and drainage switchboard.
2. Furnishing, installing and testing of Digital Trace Recorders (DTR).

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01810 – Commissioning of Systems

1.03 Submittals

A. Submit the following in accordance with Section 01300 for approval:

1. Shop drawings including but not limited to schematics and interconnecting drawings; connection diagrams and outline drawings; assembly, erection, and installation drawings.
2. Product data for all components including manufacturer's catalog cuts, materials specifications, installation instructions and other data pertinent to stray current drainage equipment.
3. Qualifications of National Association of Corrosion Engineers (NACE) certified Corrosion Specialist including name and certification number. Specialist can be an employee of the equipment fabrication company.

B. Submit manufacturer's product and performance data.

C. Submit certificate of compliance.

D. Submit parts and special tools list.

E. Submit operations and maintenance manual for negative and drainage switchboard.

F. Submit test reports.

1.04 Quality Assurance

A. Select a manufacturer who is regularly engaged in the production of similar equipment and has demonstrated a successful record of providing equipment of similar type and rating for extra heavy duty traction service for at least five (5) similar Projects.

B. Submit factory test plans and procedures in accordance with the Contract Documents. No test results will be accepted prior to receipt and approval of test plans and procedures. Factory test requirements are as follows:

1. Negative and drainage switchboard dielectric withstand test:

a. Test all live parts of the negative and drainage switchboard, completely assembled, except without reverse current switches at a voltage level of 2800 V DC, RMS, 60 Hertz or 4100 V DC for sixty (60) seconds. DTR to be isolated during this test.

C. Meet the applicable provisions of the most recent issues of the following references:

1. Codes and regulations of Authority Having Jurisdictions.
2. ANSI Z535, American National Standard for Safety Colors.
3. ANSI/NEMA CC 1, Electric Power Connection for Substations.
4. NFPA 70, National Electrical Code (NEC).
5. NFPA 130, Standard for Fixed Guideway Transit and Passenger Rail Systems.
6. National Association of Corrosion Engineers International (NACE).

1.05 Delivery, Storage and Handling

A. Equipment for each facility shall be delivered in accordance with the specified or agreed schedule.

B. Ship each unit securely packaged and labeled for safe handling. Where necessary, brace for hoisting, lowering, and skidding into positions. Label temporary internal bracing; TEMPORARY-REMOVE BEFORE OPERATION.

C. Properly receive, handle, and store all materials and equipment in conformance to the manufacturer's requirements.

PART 2 - PRODUCTS

2.01 Materials and/or Equipment

A. Negative and Drainage Switchboard:

1. Free standing, metal enclosed, suitable for indoor service and including the following equipment:
   a. Negative switches.
   b. DC negative equalizer bus and bus connections.
   c. Stray current corrosion control equipment.
   d. Drainage bus and bus connections to stray current corrosion control equipment.
   e. Negative return cable terminal connectors.
2. Enclosure:
   a. Metal enclosed, rigid, self-supporting, self-contained, ventilated steel structure, assembled as one (1) unit with switchgear style construction. Minimum sheet steel gauge shall be 12 gauge.
   b. Designed and arranged to provide convenient access to all components for normal operation and maintenance.
   c. Access opening for future negative equalizer bus extension covered by a removable metal cover.
   d. Finish to be metallic surfaces degreased, primed, and finished with standard light gray enamel color 61, ANSI Z535; 2 mils minimum dry film thickness.

3. Negative Switches:
   a. Description:
      1) No-load break, single pole non-fused, enclosed knife switches, connected to the negative equalizer bus mounted in individual compartments in the negative and drainage switchboard with danger signs provided at each negative switch. Signs made of 20 gauge steel, 7 inches by 10 inches with corner mounting holes and worded to say "NO LOAD BREAK SWITCHES - OPEN ALL RECTIFIER DC CATHODE CIRCUIT BREAKERS BEFORE OPENING THESE SWITCHES".
      2) Back connected with provisions for connecting 2000 KCMIL negative return cables from the running rails through 4000 A/50mV shunt.
      3) All current carrying components electrically isolated from the negative and drainage switchboard enclosure. Insulation to be rated for a minimum of 1000 V DC.
      4) Designed so as to allow for the compartment doors to close with the negative switches in the open position.
   b. Rating to be 1000 V DC, 4000 A continuous and capable of withstanding short circuit currents imposed by parallel rectifier units of 6000 kW total capacity.
   c. Terminal connectors of the long barrel, double indentation compression type with two (2) hole contact pad and of one (1) piece tubular construction formed of pure electrolytic copper and tin plated to resist corrosion. Terminal connectors in accordance with ANSI/NEMA CC 1. Provide six (6) connectors per switch.
4. DC Negative Equalizer Bus and Bus Connections:
   a. Copper of high electrical conductivity, 1000 V DC, rated DC continuous current as shown on the Contract Drawings. Size based on a maximum current density of 800 A per square inch shall be provided.
   b. Bus to be bare, except where close clearances may make insulation necessary. Bus bars mounted on barrier type insulation or post type insulators of sufficient strength to withstand, without damage or permanent distortion, all stresses produced by specified short circuit currents.
   c. Bus Connections:
      1) Connection surfaces shall be silver or tin plated.
      2) Joints shall be treated to prevent corrosion. Each joint having conductivity at least equal to that of the bus bar.
      3) Bolt with cadmium plated, galvanized, or similarly coated high strength steel bolts of sufficient number and size to provide solidly bolted connection.
      4) Terminate negative equalizer bus reference wire on a terminal block for connection to the negative bus of the DC switchgear. Size will be as shown on the Contract Drawings.
5. Stray Current Corrosion Control Equipment:
   a. Each stray current corrosion drainage circuit, number as indicated, consists of the following:
      1) Cable connector.
      2) Fuse holder and current limiting fuse.
      3) Shunt.
      4) Variable resistor.
      5) Diode.
      6) Disconnect switch.
      7) Connection to drainage bus.

b. Cable connector to be long barrel, double indentation compression type of one (1) piece tubular construction, formed of pure electrolytic copper and tin plated to resist corrosion, for 250 KCMIL cable. In accordance with ANSI/NEMA CC 1 except contact pads may be one (1) hole.

c. Fuse holders and fuses to be rated 1000 V DC.

d. Fuses to be current limiting, non-venting, rated and coordinated with the withstand capability of the drainage disconnect switches. Bolt-on, 60 A, Chase Shawmut Form 101, Catalog No. A100P60; Or Approved Equal.

e. Shunts for test usage to be copper, rated to produce 1 mV drop per ampere, 100 A capacity, installed in each stray current control circuit.

f. Disconnect Switches:

1) Installed between the incoming stray current control cable and the TPSS drainage bus as shown or required.

2) Single pole, load break, knife blade switch rated at 60 A continuous at 700 V DC. Coordinate switch rating with current limiting fuse to provide adequate withstand capability under fault conditions.

3) Mounted on an insulating base with adequate clearances to increase strike and creepage voltage levels to 750 V DC minimum.

g. Diode to be rated 60 A, 200 V DC peak inverse voltage, 20 mV to 80 mV threshold voltage, complete with two (2) No. 4/0 AWG connectors. Specifically designed and tested for use as a stray current control device. Provide adequate ventilation for diode, associated protective devices, wiring and terminals.

h. Variable resistor to be rated 1.1 Ohms, 11 A to 104 A, 620 W to 820 W heat dissipation per unit, cylindrical core type and furnished with an adjustable clamp type terminal.

6. Drainage Bus and Bus Connections:

a. High quality copper of electrical conductivity rated 400 A continuous and 750 V DC shall be provided.

b. Bus bars shall be mounted on barrier type insulation or post type insulators. Bus bars shall be bare, except where close clearances may make insulation necessary.

c. Bus Connections:

1) Connection surfaces shall be silver or tin plated.

2) Joints shall be treated to prevent corrosion. Each joint having conductivity at least equal to that of the bus bar.

3) Bolt with cadmium plated, galvanized, or similarly coated, high strength steel bolts of sufficient number and size to provide solidly bolted connection.

4) Drainage bus shall be solidly connected to the negative equalizer bus.

d. Bus compartment to be isolated from the stray current corrosion control equipment compartments. Includes drainage bus work, connection bars, bus supports, cable connections and cable supports.

7. DTR and transducers to measure rail to ground voltage and metallic structure voltage and drainage current as follows. All transducers shall be protected by current limiting fuses.

a. Measurement and recording by DTR of the voltage between rails and TPSS ground bus, via 2 kV insulated cable terminated in an insulated box inside the negative and drainage switchboard. Both rail of both tracks to be monitored independently, i.e. upstream of the negative switches.

b. Measurement and recording by DTR of negative return current.

c. Measurement and recording by DTR of the voltage and current in each drainage circuit.

d. Provision for the future measurement and recording by DTR of voltage and current in four (4) drainage circuits.

e. Voltage transducers to be shunt/isolation/amplifier. Provide one (1) voltage transducer in each channel. The shunt amplifier shall be a linear amplifier designed to amplify DC shunt millivolt signals. The input shall be from 0-1000 V DC and output shall be 1 mA. Provide complete isolation of the input signal. A magnetic amplifier shall be used in the input circuit to isolate the inputs from all other circuits and grounds. The input shall be tested at 4000 V DC for one (1) minute to ensure that no breakdown will occur when connected to shunts operating at high voltage above ground. The output shall be a hybrid amplifier operating in the transconductance mode to provide a constant current output. Load resistance variations from 0-10K shall have less than 0.1 percent effect on the output current to make the amplifier an ideal device for telemetering, scaling, and recording applications. The output should be filtered.

f. A variation resistor from zero to maximum gain adjustment shall be provided and be accessible through the top cover. Large gain changes should be accomplished by changing the auxiliary gain resistor.

g. Power requirements to be 136 V DC plus 10 percent 10VA maximum.

h. Input impedance to be 5000 Ohms/V.

i. Load impedance to be any load between 0-10K.

j. Accuracy to be plus 0.5 percent RO at 25°C.

k. Temperature range to be minus 10°C to plus 70°C.

l. Temperature coefficient to be plus 0.04 percent °C.

m. The transducer shall be compatible with the rating of the DC switchgear furnished under the Contract.

n. The shunt/isolation/amplifier shall be SMC SWARTZ type; Or Approved Equal.

8. Current transducers to be shunt/isolation/amplifier. The shunt amplifier shall be a linear amplifier designed to amplify DC shunt milliamp signals. The input shall be 50 mV rated at 100 A with 1 mA output. Provide complete isolation of the input signal. A magnetic amplifier shall be used in the input circuit to isolate the inputs from all other circuits and grounds. The input shall be tested at 4000 V DC for one (1) minute to ensure that no breakdown will occur when connected to shunts operating at high voltage above ground. The output shall be a hybrid amplifier operating in the transconductance mode to provide a consistent current output. Load resistance variations from 0 to 10K shall have less than 0.1 percent effect on the output current to make the amplifier an ideal device for telemetering, scaling, and recording applications. The output should be filtered.

   a. A variable resistor from zero to maximum gain adjustment shall be provided and be accessible through the top cover. Large gain changes should be accomplished by changing the auxiliary gain resistor.

   b. Power requirements to be 136 V DC plus 10 percent 10VA maximum.

   c. Input impedance to be 5000 ohms/V.

   d. Load impedance to be any load between 0-10K.

   e. Accuracy to be plus 0.5 percent RO at 25°C.

   f. Temperature range to be minus 10°C to plus 70°C.

   g. Temperature coefficient to be plus 0.04 percent °C.

h. The transducer shall be compatible with the rating of the DC switchgear furnished under the Contract.

9. Provide DTR interfaces for remote monitoring.

B. Nameplates:

1. Three (3) ply, laminated phenolic plates engraved through black face to white core and attached by means of stainless steel rivets or screws. Vertical gothic lettering using a round or square cutter.

2. Provide nameplate on each negative and drainage switchboard showing the manufacturer's name and brand designation, the referenced standard, type, class and rating as applicable in accordance with referenced standard.

3. Provide additional functional nameplates for each component.

4. Each enclosure labeled, front and back, with nameplate 2 1/2 inches by 6 1/2 inches, inscribed in letters 1/2 inch high: “NEGATIVE AND DRAINAGE SWITCHBOARD”.

5. In addition to other information normally displayed on equipment, provide 1 inch nameplate showing in letters 1/2 inch high switch positions, meaning of indicator lamp and other pertinent information.

PART 3 - EXECUTION

3.01 Installation

A. Install negative and drainage switchboard in accordance with approved shop drawings.

B. Install conduit and raceway in accordance with the approved shop drawings.

C. Make cable connections in accordance with the approved shop drawings.

D. Install negative bus duct as shown on the Contract Drawings.

E. Install DTR per the manufacturer’s recommendations and the NEC.

3.02 Field Quality Control

A. Field testing and inspection is as specified in the Contract Documents.

B. Current injection and voltage application tests to verify the functionality of the DTR and its communication with the Supervisory Control and Data Acquisition (SCADA) system.

END OF SECTION

SECTION 16411

ENCLOSED SWITCHES

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of materials for furnishing, installing, connecting, energizing, testing, cleaning and protecting enclosed disconnect switches and fuses, if so equipped.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 16075 – Electrical Identification

C. Section 16950 – Testing

1.03 Submittals

A. Submit product data, evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. If not listed, provide from the product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

B. Indicate clearly the usage of each product.

C. Submit manufacturer's instructions.

D. Submit fuse data and the time-current curves for the range of fuses offered for each type of product. Include a protection curve from the Contractor short-circuit study (Section 01010) demonstrating the adequacy of the product ratings.

1.04 Quality Assurance

A. Provide products that are listed or labeled by Underwriters Laboratory, approved by factory mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available, or unless standards do not exist for the products.

B. Install work under supervision of licensed electricians.

C. Meet the applicable provisions of the most recent issues of the following references:

1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
3. NFPA 70, National Electrical Code (NEC).
4. UL 98, Enclosed and Dead-Front Switches.
5. UL 198E, Class R Fuses.

PART 2 - PRODUCTS

2.01 Enclosed Disconnect Switches

A. Provide enclosed disconnect switches meeting NEMA KS 1, UL 98 and the following requirements. Horsepower, voltage, amperage, number of poles and type shall be as indicated on the Contract Drawings, as detailed by the Contractor during final design.

1. Enclosure to be NEMA 250 Type 1, unless indicated otherwise on the Contract Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust inhibiting phosphate and finished in gray baked enamel. Furnish enclosure with the manufacturer's permanent record of switch type, catalog number and horsepower rating.
2. Switch mechanism to be quick make, quick break operating handle and mechanism forming an integral part of the box, not the cover, with positive padlocking provisions in the OFF position. Electroplate switch current carrying parts for resistance to corrosion. Provide product with switch blades visible in the OFF position when door is open and switch lugs UL listed for copper cables and front removable.
3. Heavy duty type fusible and non-fusible disconnect switches to be dead front construction with permanent arc suppressors and dual cover interlock (to prevent unauthorized opening of switch in ON position) and positive pressure fuse clips, if fusible.

B. Manufacturers:

1. Square D Company.
2. General Electric.
3. Eaton/Cutler-Hammer.
4. Or Approved Equal.

2.02 Fuses

A. Current limiting type, of voltage and amperage as indicated on the Contract Drawings. Provide one (1) set of spare fuses for each ampere size indicated for each switch.

1. Use Limitron, fast acting, single element type, UL Class RK1 for non-motor loads.
2. Use Fusetron, dual element, time delay type, UL Class RK5 for inductive loads.

B. Manufacturers:

1. Bussman.
2. Gould-Shawmut.
3. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Ensure that painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.

B. Verify that all indoor areas are enclosed from the weather before installing products.

C. Conduct inspections and insulation tests on cables prior to terminating cables at the switches.

3.02 Installation

A. Space enclosures out from surfaces mounted on 1/4 inch spacers or U-Channel supports.

B. Install disconnect switches in accordance with the manufacturer's instructions.

C. Set enclosure top 6 feet 6 inches above finished floor or grade unless otherwise indicated or specified.

D. Punch holes for conduit entries in the enclosures.

E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

F. Interface with other work:

1. Connect conduits to enclosure with watertight hubs except as follows:
    a. The bottom of enclosures in damp locations may have a sealing locknut and interior locknut, and grounding bushing in place of a watertight hub.
    b. In dry locations, two (2) locknuts and bushings may be used in place of a watertight hub.
2. Connect wiring to line and load terminals with lugs provided or approved by the manufacturer. Remove interior or protect interior components during wire pulling.
3. Identify each switch in accordance with Section 16075. Provide a nameplate with the fuse type and rating on each fusible switch enclosure.

G. Protection:

1. During painting, mask all nameplates, all plastic parts, push buttons, operating shafts, current carrying parts and all items not to be painted.
2. Protect all items during work of other trades including welding and cutting.
3. Protect disconnect switches against overloads, short circuits and improper operation. Tag out and padlock off when work is being done on downstream circuits.

3.03 Field Quality Control

A. Site Testing:

1. Prior to making final connections and energizing, verify that all load side wiring is clear of shorts and has received and passed the insulation tests of Section 16950.
2. Perform tests in accordance with Section 16950.

END OF SECTION

SECTION 16412

DC ENCLOSED SWITCH CABINETS

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of materials for furnishing, installing, connecting, energizing, testing, cleaning and protecting enclosed DC disconnect switches and fuses, if so equipped.

1.02 Related Sections

A. Section 01010 – Summary of Work

B. Section 16075 – Electrical Identification

C. Section 16950 – Testing

1.03 Submittals

A. Submit product data, evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. If not listed, provide from the product manufacturers a written statement indicating why an item does not have a quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

B. Indicate clearly the usage of each product.

C. Submit manufacturer's instructions.

D. Submit fuse data and the time-current curves for the range of fuses offered for each type of product. Include a protection curve from the Contractor short-circuit study (Section 01010) demonstrating the adequacy of the product ratings.

1.04 Quality Assurance

A. Provide products that are listed or labeled by Underwriters Laboratory, approved by factory mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory (ETL) for the location installed in, and the application intended, unless products meeting the requirements of these testing laboratories are not available, or unless standards do not exist for the products.

B. Install work under supervision of licensed electricians.

C. Meet the applicable provisions of the most recent issues of the following references:

1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
2. NEMA KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
3. NFPA 70, National Electrical Code (NEC).
4. UL 98, Enclosed and Dead-Front Switches.
5. UL 198E, Class R Fuses.

PART 2 - PRODUCTS

2.01 Enclosed Disconnect Switches

A. Provide enclosed disconnect switches meeting NEMA KS 1, UL 98 and the following requirements. Horsepower, voltage, amperage, number of poles and type shall be as indicated on the Contract Drawings, as detailed by the Contractor during final design.

1. Enclosure to be NEMA 250 Type 1, unless indicated otherwise on the Contract Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust inhibiting phosphate and finished in gray baked enamel. Furnish enclosure with the manufacturer's permanent record of switch type, catalog number and horsepower rating.
2. Switch mechanism to be quick make, quick break operating handle and mechanism forming an integral part of the box, not the cover, with positive padlocking provisions in the OFF position. Electroplate switch current carrying parts for resistance to corrosion. Provide product with switch blades visible in the OFF position when door is open, and switch lugs UL listed for copper cables and front removable.
3. Heavy duty type fusible and non-fusible disconnect switches to be dead front construction with permanent arc suppressors and dual cover interlock (to prevent unauthorized opening of switch in ON position) and positive pressure fuse clips, if fusible.

B. Manufacturers:

1. Square D Company.
2. General Electric.
3. Eaton/Cutler-Hammer.
4. Or Approved Equal.

2.02 Fuses

A. Current limiting type, of voltage and amperage as indicated on the Contract Drawings. Provide one (1) set of spare fuses for each ampere size indicated for each switch.

1. Use Limitron, fast acting, single element type, UL Class RK1 for non-motor loads.
2. Use Fusetron, dual element, time delay type, UL Class RK5 for inductive loads.

B. Manufacturers:

1. Bussman.
2. Gould-Shawmut.
3. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Ensure that painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.

B. Verify that all indoor areas are enclosed from the weather before installing products.

C. Conduct inspections and insulation tests on cables prior to terminating cables at the switches.

3.02 Installation

A. Space enclosures out from surfaces mounted on 1/4 inch spacers or U-Channel supports.

B. Install disconnect switches in accordance with the manufacturer's instructions.

C. Set enclosure top 6 feet 6 inches above finished floor or grade unless otherwise indicated or specified.

D. Punch holes for conduit entries in the enclosures.

E. In all areas except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

F. Interface with other work:

1. Connect conduits to enclosure with watertight hubs except as follows:
    a. The bottom of enclosures in damp locations may have a sealing locknut and interior locknut, and grounding bushing in place of a watertight hub.
    b. In dry locations, two (2) locknuts and bushings may be used in place of a watertight hub.
2. Connect wiring to line and load terminals with lugs provided or approved by the manufacturer. Remove interior or protect interior components during wire pulling.
3. Identify each switch in accordance with Section 16075. Provide a nameplate with the fuse type and rating on each fusible switch enclosure.

G. Protection:

1. During painting, mask all nameplates, all plastic parts, push buttons, operating shafts, current carrying parts and all items not to be painted.
2. Protect all items during work of other trades including welding and cutting.
3. Protect disconnect switches against overloads, short circuits and improper operation. Tag out and padlock off when work is being done on downstream circuits.

3.03 Field Quality Control

A. Site Testing:

1. Prior to making final connections and energizing, verify that all load side wiring is clear of shorts and has received and passed the insulation tests of Section 16950.
2. Perform tests in accordance with Section 16950.

END OF SECTION

SECTION 16413

ENCLOSED TRANSFER SWITCHES

PART 1 - GENERAL

1.01 Description

A. The Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.
2. Bypass/isolation switches.
3. Remote annunciation and control systems.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. Section 01820 - Demonstration and Training

E. Section 03300 - Cast-In-Place Concrete

F. Section 16050 - Basic Electrical Materials and Methods

G. Section 16060 - Grounding and Bonding

H. Section 16075 - Electrical Identification

I. Section 16123 - Building Wire and Cable

J. Section 16130 - Raceways and Boxes

K. Section 16950 - Testing

1.03 Submittals

A. Submit product data for each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties and accessories.

B. Submit shop drawings including dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1. Show connections between transfer switch, bypass/isolation switch, power sources, and load; and show interlocking provisions for each combined transfer switch and bypass/isolation switch on a single line diagram.

1.04 Quality Assurance

A. Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight (8) hours from time of notification.

B. An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing agency's field supervisor to be a person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3 in this Section.

C. Obtain automatic transfer switches, bypass/isolation switches and remote annunciator and control panels through one (1) source from a single manufacturer.

D. Meet the applicable provisions of the most recent issues of the following references:

1. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
2. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
3. NEMA ICS 1, Industrial Control and Systems: General Requirements.
4. NEMA ICS 6, Industrial Control and Systems: Enclosures.
5. NEMA KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
6. InterNational Electrical Testing Association (NETA).
7. NFPA 70, National Electrical Code (NEC).
8. NFPA 110, Standard for Emergency and Standby Power Systems.
9. 29 CFR 1910.7, Definition and Requirements for a Nationally Recognized Testing Laboratory.
10. UL 98, Enclosed and Dead-Front Switches.
11. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
12. UL 508, Industrial Control Equipment.
13. UL 869A, Reference Standard for Service Equipment.
14. UL 1008, Transfer Switch Equipment.

1.05 Delivery, Storage and Handling

A. Secure non-moving parts that may shift in transportation.

B. A list of all temporary equipment restraints which were installed at the factory, shall accompany the shipment to serve as a checklist for installation and energizing the equipment.

C. Provide protection from concealed damage by providing within shipping container mechanical impact recorder of rating recommended by the manufacturer for shipment by railroad and submit impact record chart with the manufacturer's instructions for disposition of damaged materials.

D. Store in a clean dry location.

E. Handle transfer switches using only lifting eyes and brackets provided for handling purposes.

F. Protect units against damage from rain, sleet or snow if handled in inclement weather.

1.06 Operations and Maintenance Data

A. Furnish hard copies of the maintenance instruction manual as required by Section 01300 and one (1) electronic file copy on CD-ROM in Adobe Acrobat (PDF) format for the following:

1. Operation and maintenance manual.
2. Maintenance schedule for the first cycle of scheduled maintenance, not less than twelve (12) months.
3. Spare parts list, renewable parts list, and consumable list.
4. As-built drawings including final fabrication drawings.

B. Electronic file copy of shop drawings, factory test report, field commissioning report and other related data, contained on CD-ROM in Adobe Acrobat (PDF) format.

1.07 Warranty

A. The standard warranty for design, material and workmanship shall apply as follows:

1. The warranty shall begin upon Traction Power Substation (TPSS) acceptance by SEPTA. Provide a (1) year warranty.

B. The warranty shall include full repair or replacement at no cost to SEPTA.

1.08 Field Conditions

A. Do not interrupt existing electrical service to facilities occupied by SEPTA or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service:

1. Notify SEPTA no fewer than five (5) days in advance of proposed interruption of electrical service.
2. SEPTA's written permission.

1.09 Coordination

A. Coordinate size and location of concrete bases. Cast anchor bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 03300.

PART 2 - PRODUCTS

2.01 Manufacturers Units

A. Contactor Transfer Switches:

1. Manufacturers are subject to compliance with requirements, provide products by one (1) of the following manufacturers:
   a. Caterpillar; Engine Division.

b. Emerson; ASCO Power Technologies, LP.
c. Kohler Power Systems; Generator Division.
d. Onan/Cummins Power Generation; Industrial Business Group.
e. Russelelectric, Inc.
f. Or Approved Equal.

2.02 General Transfer Switch Product Requirements

A. Indicated current ratings and apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.

B. Tested fault current closing and withstand ratings to be adequate for duty imposed by protective devices at installation locations in the Contract under the fault conditions indicated, based on testing according to UL 1008.

C. Solid state controls to provide repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20°C to plus 70°C.

D. Components shall meet or exceed voltage surge withstand capability requirements when tested according to IEEE C62.41.1. Components shall meet or exceed voltage impulse withstand test of NEMA ICS 1.

E. Electrical operation to be accomplish by a non-fused, momentarily energized solenoid or electric motor operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch to be designed for continuous duty repetitive transfer of full rated current between active power sources.

1. Switches using molded case switches or circuit breakers or insulated case circuit breaker components are not acceptable.

2. Switch action to be double throw; mechanically held in both directions.

3. Contacts to be silver composition or silver alloy for load current switching. Conventional automatic transfer switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Where 4 pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

H. Neutral terminal to be solid and fully rated, unless otherwise indicated.

I. Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels shall have communication capability matched with remote device.

J. Train and bundle factory wiring and label, consistent with shop drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.

1. Designated terminals to use pressure type, suitable for types and sizes of field wiring indicated.

2. Power terminal arrangement and field wiring space to be suitable for top, side or bottom entrance of feeder conductors as indicated.

3. Control wiring to be equipped with lugs suitable for connection to terminal strips

K. Enclosures to be general purpose NEMA 250, Type 3R, meeting NEMA ICS 6 and UL 508, unless otherwise indicated.

2.03 Automatic Transfer Switches

A. Meet requirements for Level 1 equipment according to NFPA 110.

B. Switching arrangement to be double throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Automatic switch operation to be under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual switch operation to be unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from one (1) to thirty (30) seconds.

F. Digital communication interface to be matched to capability of remote annunciator or annunciator and control panel.

G. Transfer switches based on molded case switch components to meet UL 489 and UL 869A.

H. In-phase monitor to be factory wired, internal relay controls transfer so it occurs only when the two (2) sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.

I. Motor disconnect and timing relay controls designate starters, so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between one (1) and sixty (60) seconds, and settings are as indicated. Relay contacts handling motor control circuit inrush and seal currents are rated for actual currents to be encountered.

J. Switch operator has a programmed neutral position arranged to provide a midpoint between the two (2) working switch positions, with an intentional, time controlled pause at midpoint during transfer. Pause is adjustable from one-half (0.5) to thirty (30) seconds minimum and factory set for one-half (0.5) second, unless otherwise indicated. Time delay occurs for both transfer directions. Pause is disabled unless both sources are live.

K. Automatic Transfer Switch Features:

1. Undervoltage sensing for each phase of normal source to sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable time delay for override of normal source voltage sensing to delay transfer and engine start signals. Adjustable from zero (0) to six (6) seconds, and factory set for one (1) second.
3. Time delay for retransfer to normal source to be adjustable from zero (0) to thirty (30) minutes, and factory set for ten (10) minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
4. Test switch to simulate normal source failure.
5. Switch position pilot lights to indicate source to which load is connected.
6. Source available indicating lights to supervise sources via transfer switch normal and emergency source sensing circuits.
    a. Normal power supervision to be a green light with nameplate engraved "Normal Source Available."
    b. Emergency power supervision to be a red light with nameplate engraved "Emergency Source Available."
7. Unassigned auxiliary contacts to be two (2) normally open, single pole, double throw contacts for each switch position, rated 10 A at 240 V AC.
8. Transfer override switch overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status

2.04 Bypass/Isolation Switches

A. Meet requirements for Level 1 equipment according to NFPA 110.

B. Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer switch operation, except for testing or maintenance.
2. Draw-out arrangement for transfer switch to provide physical separation from live parts and accessibility for testing and maintenance operations.
3. Bypass/isolation switch current, voltage, closing, and short circuit withstand ratings to be equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.
4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer switch contacts when they are carrying rated load.
5. Constructed so load bypass and transfer switch isolation can be performed by one (1) person in no more than two (2) operations in fifteen (15) seconds or less.
6. The manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.

7. Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of bypass/isolation switches with automatic transfer switches to be factory installed copper bus bars; plated at connection points and braced for the indicated available short circuit current.

2.05 Remote Annunciator and Control System

A. Include the following functions for indicated transfer switches:

1. Indication of sources available, as defined by actual pickup and dropout settings of transfer switch controls.
2. Indication of switch position.
3. Indication of switch in test mode.
4. Indication of failure of digital communication link.
5. Key switch or user code access to control functions of panel.
6. Control of switch test initiation.
7. Control of switch operation in either direction.
8. Control of time delay bypass for transfer to normal source.

B. Malfunction of annunciator, annunciation and control panel, or communication link shall not affect functions of automatic transfer switch. In the event of failure of communication link, automatic transfer switch automatically reverts to stand alone, self-contained operation. Automatic transfer switch sensing, controlling or operating function shall not depend on remote panel for proper operation.

C. Remote annunciation and control panel to be constructed of solid state components. Include the following features:

1. Controls and indicating lights grouped together for each transfer switch.
2. Label each indicating light control group. Indicate transfer switch it controls, location of switch and load it serves.
3. Digital communication capability to be matched to that of transfer switches supervised.
4. Mounting to be flush, modular, steel cabinet, unless otherwise indicated.

2.06 Source Quality Control

A. Factory test and inspect components, assembled switches and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time delay settings for compliance with specified requirements. Perform dielectric strength test meeting NEMA ICS 1.

PART 3 - EXECUTION

3.01 Installation

A. Design each fastener and support to carry load.

1. Concrete bases to be 4 inches high, reinforced, with chamfered edges. Extend base no more than 4 inches in all directions beyond the maximum dimensions of switch, unless otherwise indicated.

B. Annunciator and control panel to be surface mounted, unless otherwise indicated.

3.02 Connections

A. Wiring to remote components to match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by the manufacturer. Increase raceway sizes at no additional cost to SEPTA if necessary, to accommodate required wiring.

B. Ground equipment according to Section 16060.

3.03 Field Quality Control

A. Engage a qualified testing agency to perform tests and inspections.

B. Engage a factory authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

C. Perform the following tests and inspections with the assistance of a factory authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by the manufacturer. Meet the manufacturer's specified minimum resistance.

   a. Check for electrical continuity of circuits and for short circuits.

   b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers and safety features.

   c. Verify that manual transfer warnings are properly placed.

   d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three (3) times.

   a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

   b. Simulate loss of phase-to-ground voltage for each phase of normal source.

   c. Verify time delay settings.

   d. Verify pickup and dropout voltages by data readout or inspection of control settings.

e. Test bypass/isolation unit functional modes and related automatic transfer switch operations.

f. Perform contact resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.

5. Coordinate with testing of ground fault protective devices for power delivery from both sources.

a. Verify grounding connections and locations and ratings of sensors.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

E. Remove and replace malfunctioning units and retest as specified above.

F. Prepare test and inspection reports.

G. After Substantial Completion, but not more than sixty (60) days after final acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Perform an additional follow-up infrared scan of each switch eleven (11) months after date of Substantial Completion.

2. Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

3. Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken and observations after remedial action.

3.04 Demonstration

A. Train SEPTA's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment. Refer to Section 01820.

END OF SECTION

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SECTION 16421

ENCLOSED MOTOR CONTROLLERS

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of materials for furnishing, installing, connecting, energizing, testing, cleaning, and protecting enclosed low voltage individually mounted enclosed starters and contactors and related accessories.

1.02 Related Sections

A. Section 01300 - Submittals

B. Section 01305 - Requests for Information

C. Section 01400 - Quality Requirements

D. All sections of Division 15,

E. Section 16050 - Basic Electrical Materials and Methods

F. Section 16060 - Grounding and Bonding

G. Section 16070 - Hangers, Anchors and Supports

H. Section 16075 - Electrical Identification

I. Section 16123 - Building Wire and Cable

J. Section 16950 - Testing

1.03 Submittals

A. Make all submittals in accordance with Section 01300.

B. Submit with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of SEPTA.

C. Submit product data and catalog cuts for all products provided. Indicate clearly the usage of each product.

D. Submit shop drawings of all enclosed low voltage starters.

E. Submit manufacturer’s instructions for all enclosed starters and contactors.

1.04 Quality Assurance

A. Install work under supervision of skilled licensed electricians.

B. Meet the applicable provisions of the most recent issues of the following references:

1. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

2. NEMA ICS 1, Industrial Control and Systems: General Requirements.

3. NEMA ICS 2, Industrial Control and Systems Controllers, Contactors and Overload Relays Rated 600V.
4. NEMA ICS 4, Application Guideline for Terminal Blocks.
5. NEMA ICS 5, Industrial Control and Systems Control - Circuit and Pilot Devices.
6. NEMA ICS 6, Industrial Control and Systems: Enclosures.
7. NFPA 70, National Electrical Code (NEC).
8. UL 98, Enclosed and Dead-Front Switches.
9. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
10. UL 508, Industrial Control Equipment.

PART 2 - PRODUCTS

2.01 Motor Starters

A. Provide manual motor starters in NEMA 250 Type 1 enclosure, unless indicated otherwise on the Contract Drawings, and having the correct number of poles needed and sufficient horsepower or fractional horsepower rating to operate the connected motors.

1. Fractional horsepower manual starters to consist of a manually operated quick make, quick break toggle switch equipped with melting alloy type thermal overload relay. Thermal unit shall be sized to suit imposed load and of one (1) piece construction and interchangeable. Starter rendered inoperative when thermal unit is removed. Starter contacts of double break silver alloy type in a trip free switch mechanism.
2. Manufacturers:
   a. Square D Company.
   b. General Electric.
   c. Eaton/Cutler Hammer.
   d. Or Approved Equal.

B. Provide combination line starter units as indicated on the Contract Drawings and meeting the following requirements:

1. Magnetically held, electrically operated, 3 pole assemblies with arc extinguishing characteristics and double break silver alloy renewable contacts meeting NEMA ICS 2. Full Voltage Reversing (FVR) type single speed, Full Voltage Non-Reversing (FVNR) type single speed, Reduced Voltage Non-Reversing (RVNR) type single speed, or three (3) winding transformer closed transition type having three (3) taps at 80 percent, 65 percent and 50 percent. Starters to accommodate three (3) overload relay thermal units properly sized and installed on each phase of the respective motor to be controlled. Thermal unit must be in position to operate starter.
2. Provisions to add a minimum of four (4) normally open, or normally closed, electrical interlocks.
3. 3 pole melting alloy element block type overload relays, trip free hand reset. Furnish thermal units.

4. Circuit breakers of the magnetic trip type meeting UL 489. Provide adjustment screw to simultaneously set the magnetic trip level of each individual pole with a single magnetic adjustment, with adjustment continuous throughout the trip range. Provide clear indication of whether the circuit breakers are in the ON, OFF or TRIPPED position by the position of the external operating handle. Mechanically interlock handle with the unit door to prevent access unless the circuit breaker is in the OFF position. Provide padlocking facilities to positively lock the circuit breaker in the OFF position with one (1) to three (3) padlocks with the door open or closed.
5. UL Listed short circuit rating not less than short circuit current indicated on the Contract Drawings, and not less than 22,000 A Root Mean Square (RMS) symmetrical.
6. Provide starters with operating and indicating devices as indicated on the Contract Drawings.
7. Provide each starter with an individual terminal board within the unit, completely accessible from the front, and so arranged that connection to starter can be made from the front when unit frame and starter are in place. Provide clearly marked studs for line, load and control connections. Clearly mark terminals and indicate on the manufacturer's supplied interconnection diagrams.
8. Voltage:
    a. Control voltage to be 120 V AC, using individual control transformers. Control transformers having a capacity of 100 VA more than the capacity required to operate external solenoids, relays, alarms and such other control voltage components.
    b. Service voltage as indicated on the Contract Drawings.
9. Enclosure to be NEMA 250 Type 1, unless indicated otherwise on the Contract Drawings. Construct enclosures of code gauge (UL 98) sheet steel treated with a rust inhibiting phosphate and finished in gray baked enamel.
10. Manufacturers:
    a. Square D Company.
    b. General Electric.
    c. Eaton/Cutler Hammer.
    d. Or Approved Equal.

2.02 Contactors

A. Provide contactors which meet the following:

1. Multi-pole, electrically operated, mechanically or magnetically held type.
2. Continuous duty for each type of load.
3. Number of poles per contactor, amperages and load voltages.
4. Construction shall be flush dead back design with arc shields and barriers to prevent pole-to-pole flashover. Parts shall be accessible for inspection and maintenance. Contacts shall be readily replaceable from front. Contactors suited for tungsten and ballast lighting and resistance heating loads. The contactor interrupting capacity shall be 150 percent of rating with no de-rating for high inrush loads.

5. Enclosure to be NEMA 1 surface type, unless indicated otherwise on the Contract Drawings, with provision for padlocking.

B. Manufacturers:

1. Square D Company.
2. General Electric.
3. Eaton/Cutler Hammer.
4. Or Approved Equal.

2.03 Control Relays

A. Unless otherwise noted on the Contract Drawings, provide industrial control relays having characteristics, components and enclosure as follows:

1. Relay coil voltage of 120 V AC.
2. Number of normally open convertible contacts as indicated on the Contract Drawings, contacts rated 600 V AC, 10 A.
3. NEMA 250 Type 1 enclosure unless indicated otherwise on the Contract Drawings.

B. Manufacturers:

1. Square D Company.
2. General Electric.
3. Eaton/Cutler Hammer.
4. Or Approved Equal.

2.04 Operating and Indicating Devices

A. Provide operating and indicating devices manufactured in accordance with current NEMA ICS 1 and NEMA ICS 5 standards for heavy duty control stations.

1. Multi-position selector switches to be single-hole mounted, heavy duty, oil tight, watertight, industrial type multiple position selector switches. Double break silver switch contacts rated 600 V AC, 7200 VA make, 720 VA break, 10 A continuous at 35 percent inductive power factor.
2. Pushbutton switches to be single-hole mounted, heavy duty, oil tight, water tight, industrial type pushbutton switches with momentary contacts. Double break silver switch contacts rated 600 V AC, 7200 VA make, 720 VA break, 10 A continuous at 35 percent inductive power factor.
3. Pilot lights to be single-hole mounted, heavy duty, oil tight, water tight, industrial type transformer pilot lights with interchangeable Fresnel lenses.

B. Manufacturers:

1. Square D Company.
2. General Electric.
3. Eaton/Cutler Hammer.

4. Or Approved Equal.

2.05 Timing Relays and Repeat Cycle Timers

A. Provide relays having characteristics and components as follows:

1. Solid state CMOS timing circuit with transient protection. Type of timing circuit shall be as indicated on the Contract Drawings.
2. Knob adjustable time delay.
3. Double pole double throw contacts, 10 A at 120 V AC.
4. High impact plastic case with eight (8) pin octal or eleven (11) pin round base. Include matching socket with screw terminals.
5. 120 V AC operation.
6. UL Recognized component.

B. Manufacturers:

1. IDEC.
2. Diversified Electronics.
3. Agastat.
4. Potter & Brumfield.
5. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Ensure that painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

C. Verify direction of motor rotation in equipment being served by motor starters before making final connections of such to motor starters.

3.02 Installation

A. Space enclosures out from surfaces mounted on 1/4 inch spacers or U-Channel supports. Provide supports as specified in Section 16070.

B. Install all starters in accordance with the manufacturer instructions.

C. Set enclosure top 6 feet 6 inches above finished floor or grade unless otherwise indicated or specified. If other equipment is installed in an area the top of the circuit breaker may be set lower than 6 feet 6 inches but in no case set the bottom of the enclosure lower than 6 inches above the finish floor or grade.

D. Punch holes for conduit entries in the enclosures.

E. In all areas, except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

F. Interface with other work:

1. Connect conduits to enclosure with water tight hubs except in damp locations on the bottom of enclosures. A sealing locknut may be used in place of water tight hubs and in dry locations two (2) locknuts and bushings may be used.

2. Connect wiring to line and load terminals with lugs provided or approved by the manufacturer to meet Section 16123 requirements. Remove interior or protect interior components during wire pulling.

G. Protection:

1. During painting mask all nameplates, all plastic parts, pushbuttons, operating shafts and all items not to be painted.

2. Protect all items during work of other trades including welding and cutting.

3. Protect circuit breaker against overloads, short circuits and improper operation. Padlock off when work is being done on downstream circuits.

3.03 Field Quality Control

A. Consult Section 16950 for requirements for field inspection and testing of motor starters.

3.04 Cleaning

A. Clean installed products of this Section where deposits of oil, grease, dirt, dust, mud or debris are present after installation. Use detergent-water solution, solvents where necessary, or other liquid cleaners not harmful to material and equipment finishes, making sure not to get moisture on cable or current carrying components.

END OF SECTION

SECTION 16440

PANELBOARDS

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of all materials for furnishing, installing, connecting, energizing, testing, cleaning and protecting wall mounted panelboards.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 16070 – Hangers, Anchors and Supports

C. Section 16075 – Electrical Identification

D. Section 16123 – Building Wire and Cable

E. Section 16240 – Battery Equipment

F. Section 16950 – Testing

1.03 Submittals

A. Make all submittals in accordance with Section 01300.

B. Submit all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

C. Submit product data for all products provided. Indicate clearly the usage and designation of each product.

D. Submit shop drawings for all panelboards.

E. Submit manufacturer’s instructions for all panelboards.

1.04 Quality Assurance

A. Provide panelboards which have been design tested in accordance with NEMA PB 1.

B. Provide panelboards which have been production tested in accordance with NEMA PB 1.

C. Install work under supervision of licensed electricians.

D. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI Z535, American National Standard for Safety Colors.
2. ASTM B 117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
3. ASTM B 164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
4. ASTM B 187/B 187M, Standard Specification for Copper, Bus Bar, Rod and Shapes and General Purpose Rod, Bar, and Shapes.

5. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
6. NEMA PB 1, Panelboards.
7. NEMA PB 1.1, General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less.
8. NFPA 70, National Electrical Code (NEC).
9. UL 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
10. UL 67, Panelboards.
11. UL 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.

1.05 Performance Requirements

A. Panelboards are connected to system voltages as follows:

1. 208Y/120 V, 3 phase, 4 wire, 60 Hz.
2. 136 V, 1 phase, 2 wire, DC (Refer to Section 16240).

PART 2 - PRODUCTS

2.01 Materials and Equipment

A. Those products such as conduit, wireways, wire and connectors, cable, support devices, fasteners and similar devices as required for work of this Section are as specified in other Sections of these Specifications.

2.02 Panelboards

A. Provide dead front panelboards as follows:

1. Accommodate bolt-on molded case circuit breakers as specified below.
2. Conform to NEMA PB 1 and the NEC.
3. Consist of interiors, matching enclosures and covers of a single manufacturer as specified below.
4. Have circuit breakers of frame sizes, trip ratings, number of poles, and types as scheduled, indicated and noted.
5. Provide branch circuits phased in sequence vertically and numbered uniformly left to right, top to bottom.

B. Provide panelboards that are fully rated for a short circuit capacity as scheduled, indicated and noted on the Contract Drawings.

C. Provide interiors, as follows:

1. Provide tin plated main, ground and neutral copper buses meeting ASTM B 187/B 187M having not less than 98 percent conductivity.
2. Mount interiors on galvanized steel back plate.

3. Make provisions for future circuit breakers and for circuit breakers in all future spaces as indicated, scheduled or noted and so that additional circuit breakers can be mounted without additional connectors or extension of busses.

D. Provide solder-less type main, sub-feed, and through feed lugs rated for copper and aluminum conductors of size, number and type, as indicated, scheduled and noted on the Contract Drawings.

E. Enclosures:

1. Provide enclosures meeting NEMA 250 for the types as indicated, scheduled, noted and specified. Provide NEMA 1 enclosures unless otherwise indicated on the Contract Drawings.

2. Fabricate from galvanized steel without knockouts.

3. Provide side, bottom and top gutters of minimum 4 inch width, of minimum 5 1/2 inch depth, and sized as indicated, scheduled and noted and as required by the NEC for the actual entry point.

4. Provide circuit directory of sufficient size to allow forty (40) characters per circuit; indicate the source of service (i.e., upstream panelboard, switchboard, motor control center, etc.) to the panelboard. Mount the directory in a transparent protective covering.

F. Provide doors as follows:

1. Provide concealed hinges and trim clamps.

2. Provide combination catch and master keyed, flat key lock with two (2) keys for each lock and common keying throughout each building of the facility.

G. Finishes:

1. Factory finish enclosure cover completely using an electro-deposition process that deposits a complete finish coat of paint on all interior and exterior surfaces as well as bolted joints.

2. Include in the paint process cleaning, rinsing, phosphatizing, pre-paint and post paint rinses, bake cure and cool down steps.

3. Finish switchboards with rust inhibiting primers and electro-disposition acrylic baked enamel top coating of No. 61 medium light grey meeting ANSI Z535.

4. Provide overall finish capable of passing a three hundred (300) hour salt spray per ASTM B 117 with less than 1/8 loss of paint from a scribed line.

H. Molded Case Circuit Breakers:

1. Provide inverse time and instantaneous tripping characteristics.

2. Provide trip ratings, frame sizes and number of poles as indicated, scheduled and noted on the Contract Drawings.

3. Provide full rated circuit breakers with short circuit ratings equal to the panelboard installed as scheduled on the Contract Drawings.

4. Provide molded case circuit breakers meeting UL 489.

5. Provide circuit breakers of the same manufacture and type as the panelboard installed.

I. Panelboard Types:

1. Branch Power and Lighting (208Y/120V).
2. Distribution.

J. Manufacturers:

1. Square D.
2. General Electric.
3. Eaton/Cutler Hammer.
4. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Ensure that painted surfaces which will be covered by items of this Section have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

3.02 Installation

A. Space enclosures out from surfaces mounted on 1/4 inch spacers or U-channel supports. Provide supports as specified in Section 16070.

B. Install all panelboards and circuit breakers in accordance with the manufacturer's instructions and NEMA PB 1.1.

C. Set enclosure top 6 feet 6 inches above finished floor or grade unless otherwise indicated or specified.

D. Punch holes for conduit entries in the enclosures.

E. In all areas, except dry areas, install conduit drain fitting in punched hole in bottom of enclosure, conduit breather fitting in top of enclosure.

F. Interface with other work:

1. Connect conduits to enclosure with watertight hubs, except in damp locations on the bottom of enclosures a sealing locknut may be used in place of watertight hubs, and in dry locations two (2) locknuts and bushings may be used.
2. Connect wiring to line and load terminals with lugs provided or approved by the manufacturer in conformance with Section 16123. Remove interior or protect interior components during wire pulling.
3. Identify in accordance with Section 16075.

G. At the end of the Contract update the circuit directories to reflect as-built conditions. Circuit directions shall be typed.

H. Protection:

1. During painting, mask all nameplates, all plastic parts and all items not to be painted.
2. Protect all items during work of other trades including welding and cutting.
3. Protect panelboards against overloads, short circuits and improper operation; padlock off when work is being done on downstream circuits.

3.03 Field Quality Control

A. Site Testing:

1. Prior to Energizing:
   a. Have insulation testing and setting of overcurrent protective device adjustments made in conformance of Section 16950.
   b. Ensure that all load side wiring is clear of shorts and has received and passed the insulation tests of Section 16950.
   c. Open all downstream disconnects and open circuit breaker.
2. Perform tests in accordance with Section 16950.

3.04 Cleaning

A. After wiring, vacuum out interior and wipe clean of all foreign material.

B. After painting in areas, remove all over paint, drips and splashes.

END OF SECTION

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SECTION 16460

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.01 Description

A. The work specified in this Section consists of material for furnishing, installing, connecting, energizing, testing, cleaning and protecting transformers.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01600 – Materials and Equipment

C. Section 01830 – Operations and Maintenance Data

D. Section 16060 – Grounding and Bonding

E. Section 16123 – Building Wire and Cable

F. Section 16130 – Raceways and Boxes

G. Section 16950 – Testing

1.03 Submittals

A. Make all submittals in accordance with Section 01300.

B. Submit all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from the product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of the SEPTA Project Manager.

C. Submit product data:

1. List of transformers and accessories to be furnished and installed.
2. Catalog cuts of all transformers and accessories.

D. Submit shop drawings for the following:

1. Complete outline drawing in English Units, showing overall length, width and height and including ratings of equipment, impedance and installation restrictions.

E. Submit factory test reports as specified in this Section.

F. Submit installation certificates for transformers.

G. Submit record drawings, shop drawings, product data and operation and maintenance manuals for Project closeout.

1.04 Quality Assurance

A. All work shall conform to regulatory requirements of all state, local, and national governing codes and requirements.

B. Install work under supervision of skilled licensed electricians.

C. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI Z535, American National Standard for Safety Colors.
2. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
3. IEEE C57.12.59, IEEE Guide for Dry-Type Transformer Through-Fault Current Duration.
4. IEEE C57.12.70, IEEE Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers.
5. IEEE C57.12.91, IEEE Standard Test Code for Dry-Type Distribution and Power Transformers.
6. NEMA ST 20, Dry Type Transformers for General Applications.
7. NFPA 70, National Electrical Code (NEC).

1.05 Delivery, Storage and Handling

A. Protect items from damage during delivery, storage and handling in accordance with Section 01600.

1.06 Factory Testing

A. Prior to shipment, perform the following tests on each transformer in accordance with NEMA ST 20 and IEEE C57.12.91:

1. Turns ratio.
2. Winding resistance.
3. Impedance.
4. Load loss.
5. Exciting current.
6. Induced potential.
7. Sound level.
8. Applied potential.
9. Power factor.

B. Submit certified test certificate.

1.07 Performance Requirements

A. Design Criteria:

1. Provide transformers with ratings as indicated on the Contract Drawings.
2. Provide transformers designed for the following conditions:
   a. 40°C maximum ambient temperature.
   b. Minus 20°C minimum ambient temperature.

c. 100 feet above sea level.
d. Indoor unless otherwise indicated or specified.

B. Provide transformers for connecting to systems with a let through fault capability up to the limits of IEEE C57.12.59.

1.08 Qualifications

A. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

1.09 Operations and Maintenance Data

A. Submit operation and maintenance manual in binder form with indexes and tabs for each Section. Meet Section 01830.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Manufacturers:
1. Square D.
2. General Electric.
3. Eaton/Cutler Hammer.
4. Or Approved Equal.
a. Request for substitutions shall be made in conformity with Section 01600 and in addition the following must be included with each request:
1) Guaranteed performance data for each size including sound level, losses at full load, impedances, and size and number of taps.
2) Overall dimensions for each size.
3) Capacitance between windings for each shielded isolation transformer.

2.02 Secondary Transformers

A. Provide general purpose, indoor, double wound, ventilated, dry type transformers conforming to NEMA ST 20.

B. Provide copper windings.

C. Design transformer for continuous operation at rated KVA, twenty-four (24) hours a day, three hundred and sixty-five (365) days a year, with normal life expectancy, without exceeding 80°C temperature rise above 40°C ambient. 80°C rise transformers shall be capable of carrying a continuous 30 percent overload without exceeding a 150°C rise in a 40°C ambient.

D. The maximum temperature of the top of the enclosure shall not exceed 35°C rise above a 40°C ambient.

E. Provide 220°C insulation systems. Provide final insulation treatment of total immersion in an insulating varnish that provides superior bond strength, high dielectric strength and outstanding power factors at temperatures. Cure at normal operating temperatures for

sufficient time to complete curing of the varnish and drive off all volatile elements in the varnish solvent. Provide sufficient air ducts to prevent any undesirable hot spots in the winding.

F. Wind secondary low voltage winding next to the core, for step down service; wind secondary high voltage winding next to the core for step up service.

G. Construct transformer core of a high quality, non-aging, low loss silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Design and size core to keep flux density well below the saturation point. Clamp core laminations securely with heavy gauge steel angles.

H. Mount core on rubber, vibration absorbing mounts and securely bolt the core to the base. Provide design to meet NEMA ST 20 standards according to KVA rating.

I. Provide mechanical bracing to brace the cores and coils to withstand short circuit currents established by IEEE C57.12.59.

J. Provide wall mounted transformers with wall brackets adequate for the supporting weight.

K. Provide transformer materials that are flame retardant and that shall not support combustion as defined in ASTM D 635.

L. Provide terminals marked in accordance with IEEE C57.12.70.

M. Provide taps in accordance with Table 16460-1.

Table 16460-1 Transformer Taps

Phase	Rating	Full Capacity Above Normal (FCAN)		Full Capacity Below Normal (FCBN)	
		Number	Size	Number	Size
Single	15 through 100 kVA	Two (2)	2.5%	Four (4)	2.5%

N. Enclosures:

1. Provide transformers with NEMA 1 code gauge sheet metal enclosures with removable front and back panels.
2. Provide screens or grills for all ventilation openings. Design screens and grills to prevent accidental access to electrified parts.
3. Degrease, clean, phosphatize, prime coat and finish coat with an ANSI Z535 number 61 gray baked enamel.

PART 3 - EXECUTION

3.01 Preparation

A. Ensure that ground cable of proper size is installed in floor or wall as required in conformity with Section 16060.

B. Check conduit stub-ups for correct type, size and location.

C. Correct any and all defects.

3.02 Installation

A. Install, set level and plumb. Shim as required at each support point with shims on all sides of anchor bolts. After leveling, replace multiple shims with a single machined plate and no more than two (2) small shims at each location. Unless otherwise noted, set transformer level to within 1/16 inch from end to end and side to side.

B. Provide 4 inch steel platforms for all floor mounted transformers. Extend platform to wall if the wall is less than 8 inches from the transformer and extend platform 2 inches beyond the transformer.

C. Provide through bolts with 1/8 inch thick galvanized steel backing plates for all wall mounted transformers mounted on masonry walls when the wall opposite the transformer is an unfinished masonry wall. On masonry walls that are exterior walls or interior walls with finish, grout in mounting bolts as wall is constructed. For wall mounted transformers mounted on wood walls, provide 4 inch by 6 inch wood blocking in the wall during construction of wall.

D. Provide sufficient anchor bolts to restrain transformer movement against tipping.

E. Connect transformer to conduit system in accordance with Section 16130 and as follows:

1. Use liquid tight flexible metal conduit formed into a J-hook shape with sufficient slack to prevent transmission of vibration or provide bottom entry of conduit without direct connection to enclosure. Use insulating grounding bushing and two (2) locknuts on all conduit entries.

F. Make electrical connections as follows and in accordance with the NEC and Section 16123. Make electrical connections with compression lugs approved by the manufacturer. Leave sufficient slack to allow for remaking connections twice and also allow for any expansion and contraction and limit the transmission of vibration.

G. Grounding:

1. Ground neutral of all 3 phase transformers with wye connected secondaries.

2. Ground neutral of all single phase transformers with three (3) wire secondaries and secondaries of all two (2) wire single phase transformers.

3. Ground transformer to closest equipment ground bus bar.

H. Protection:

1. Protect against short circuits and overloads. Replace any transformer subjected to a short circuit exceeding the allowable magnitude and time limits of IEEE C57.12.59.

2. Protect against painting splash and spray.

3. Protect against damage during work of other trades.

3.03 Field Quality Control

A. Perform the initial start-up under the direct supervision of a licensed electrician in the presence of SEPTA.

B. Prior to Startup/Energization:

1. Perform insulation tests in accordance with Section 16950 prior to energization. Dry out all transformers with low readings and retest.
2. Insure that all wiring connected to the transformer is free of shorts.
3. Insure that the proper size of overcurrent protective device is installed and set to the proper settings.

C. Conduct field tests in the presence of SEPTA.

D. Perform tests in accordance with Section 16950.

E. Correct all defects found and retest after correction of defects.

F. Submit a certified report of the test. Certified test report to include detailed losses.

END OF SECTION

SECTION 16500

LIGHTING

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for general and emergency egress lighting equipment, components and related installations.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01305 – Requests for Information

C. Section 01400 – Quality Requirements

D. Section 16010 – Basic Electrical Requirements

E. Section 16050 – Basic Electrical Materials and Methods

F. Section 16060 – Grounding and Bonding

G. Section 16070 – Hangers, Anchors and Supports

H. Section 16075 – Electrical Identification

I. Section 16123 – Building Wire and Cable

J. Section 16950 – Testing

1.03 Submittals

A. Make all submittals in accordance with Section 01300.

B. Submit shop drawings showing specially fabricated supporting and fastening devices and details of all assemblies and sub-assemblies.

C. Submit shop drawings showing light fixture wiring diagrams.

D. Submit bill of material consisting of an itemized list of each part identified by a part number and/or the manufacturer's numbers (i.e. LED Drive, etc.). This bill of material must be referenced to the shop drawings.

E. Submit manufacturer’s literature to describe lighting fixtures, exit signs, emergency battery backup LED Drive and indicated appurtenances including all required photometrics.

F. The Contractor to submit calculations for interior and exterior illuminance using photometrics of the proposed luminaires.

G. Submit a light fixture schedule.

H. Submit one (1) sample of each type of light fixture, as requested or directed by SEPTA, prior to manufacturing/ordering.

I. Submit verification that each light fixture is in compliance with applicable codes, regulations, reference standards and specifications for the location at which it is to be used. Indicate

requirements that each light fixture is required to meet; expected energy efficiency, lamp life, etc.; which will be met or exceeded by the installed light fixtures.

J. Submit certified test data to show compliance with the specified requirements including providing actual THD, in-rush current level, performance at minimum and maximum ambient temperatures, efficiency, power factor level, maximum recommended operating temperature, CRI index level, lumen level, wattage and operating life. Test data shall also show that the operating temperatures stay within the manufacturer's recommendations.

1.04 Quality Assurance

A. Products to be Underwriters' Laboratories (UL) listed, and each light fixture, emergency battery backup LED Drive and exit sign bears the UL label. Light fixtures to be installed in areas subject to the weather to be UL listed as "enclosed and gasketed suitable for wet locations". The execution of work of this Section must satisfy the applicable requirements of the NEC, regulations of jurisdictional authorities and the National Occupational Safety and Health Act.

B. Experience:

1. The Contractor shall demonstrate experience in completing similar work and have been engaged in electrical contracting for a minimum of five (5) years prior to the bid opening of this Contract. Railroad experience shall be specifically identified.

2. Furnish products, preferably by the same manufacturer, that have been in satisfactory use for a period of five (5) years prior to the bid opening of this Contract.

3. The manufacturer(s) shall have local representatives in or around the Philadelphia area available on short notice to respond to design, pricing, operation or maintenance questions related to their products.

C. Meet the applicable provisions of the most recent issues of the following references:

1. Aluminum Association (AA).

2. American Association of State Highway and Transportation Officials (AASHTO), Standard Specifications for Highway Bridges.

3. American Iron and Steel Institute (AISI).

4. American National Standards Institute (ANSI).

5. ASTM A 53/A 53M, Standard Specification for Pipe, Steel Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.

6. ASTM A 123/A 123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

7. ASTM A 276/A 276M, Standard Specification for Stainless Steel Bars and Shapes.

8. ASTM A 507, Standard Specification for Drawing Alloy Steel, Sheet and Strip, Hot-Rolled and Cold-Rolled.

9. ASTM A 575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.

10. ASTM B 26/B 26M, Standard Specification for Aluminum-Alloy Sand Castings.

11. ASTM B 86, Standard Specification for Zinc and Zinc-Aluminum (ZA) Alloy Foundry and Die Castings.
12. ASTM B 117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
13. ASTM B 136, Standard Method for Measurement of Stain Resistance of Anodic Coatings on Aluminum.
14. ASTM B 137, Standard Test Method for Measurement of Coating Mess Per Unit Area on Anodically Coated Aluminum.
15. ASTM B 209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
16. ASTM B 221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. ASTM B 244, Standard Test Method for Measurement of Thickness of Anodic Coatings on Aluminum and of Other Nonconductive Coatings on Nonmagnetic Basis Metals with Eddy-Current Instruments.
18. ASTM D 635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
19. ASTM D 1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
20. ASTM D 2240, Standard Test Method for Rubber Property-Durometer Hardness.
21. ASTM D 7091, Standard Practice for Nondestructive Measurement of Dry Film Thickness of Nonmagnetic Coatings Applied to Ferrous Metals and Nonmagnetic, Nonconductive Coatings Applied to Non-Ferrous Metals.
22. ASTM F 3125/F 3125M, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.
23. The Energy Policy and Conservation Act of 1975 and all amendments thereto, including the National Appliance Energy Conservation Act (NAECA) of 1988 and the Energy Policy Act of 1992.
24. Federal Communications Commission (FCC) Rules and Regulations, Part 18.
25. FS FF-B-588D, Bolt, Toggle; and Expansion Sleeve, Screw.
26. FS FF-S-325, Shield, Expansion; Nail Expansion, and Nail, Drive Screw (Devices, Anchoring, Masonry).
27. FS FF-P-395, Pin Drive, Power Actuated.
28. IEEE C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
29. IEEE C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
30. National Association of Architectural Metal Manufacturers (NAAMM).
31. National Electrical Manufacturers Association (NEMA).

32. NFPA 70, National Electrical Code (NEC).
33. Occupational Safety and Health Administration (OSHA).
34. SSPC-SP 6, Commercial Blast Cleaning.
35. SSPC-SP 10, Near White Blast Cleaning.
36. UL 508, Industrial Control Equipment.
37. SEPTA Standard Specifications:
    a. PRAC00022rev001, Standard Practice for the Illumination of SEPTA's Substations.

1.05 Performance Requirements

A. Design Criteria:

1. Light fixture manufacturers and corresponding model numbers and light fixture description as included in the lighting fixture schedule indicated on the Contract Drawings, constitute the Contract design.
    a. Lighting fixtures as scheduled are correct for the Contract design with respect to visible style; number of lamps and lenses desired but may not cover special required design details. Provide lighting fixtures having such special details as noted in Part 2 of this Section. SEPTA assumes no responsibility for clearance, dimensions, tolerances or exact hanging frame dimensions.

1.06 Maintenance Service and Extra Material

A. Provide a single wall mounted steel storage cabinet with capacity for the items listed below and a set of maintenance manuals.

B. Provide two (2) complete spare light fixtures of each type and ten (10) sets of replaceable components applicable to each light fixture including lamps, lenses and reflectors.

C. Provide in a toolbox kit one (1) each of maintenance tools as may be necessary for light fixture maintenance.

D. Provide in sealed bags cloths suitable for cleaning the luminaire during periodic maintenance.

E. Mount on the door of the cabinet a complete schedule with detailed product description and reorder information.

PART 2 - PRODUCTS

2.01 Materials

A. General Requirements for Light Fixtures:

1. Components of the same type, size, rating, functional characteristics and make are to be interchangeable.
2. Materials for Housings:
    a. Grade of steel as recommended by the manufacturer, unless otherwise shown on the Contract Drawings.

b. Grade of stainless steel as recommended by the manufacturer, unless otherwise shown on the Contract Drawings.

c. Aluminum alloy as recommended by the manufacturer, unless otherwise shown on the Contract Drawings.

d. Approximate shape and size will be determined by the Contractor's selection of LED light fixtures. LED light fixture bodies shall be sealed to a preferred rating of IP66, but a minimum rating of IP65 to prevent ingress of moisture and dust.

e. The housings shall be vandal resistant.

3. Lamps:

a. In accordance with applicable ANSI standards.

b. LED Light:

1) Wattage as determined by the light design performed by the Contractor to meet the foot-candle level criteria found on the Contract Drawings.

2) Base as recommended by the manufacturer.

3) Operating voltage as determined by the design of the Contractor at 60 Hz.

4) Rated life to be a minimum of fifty thousand (50,000) hours.

5) Color to be white.

6) Color Rendering Index (CRI) to be 75+.

7) Color temperature to be between 3000 and 4500 Kelvin.

8) Approximate lumens output as determined by the light design performed by the Contractor to meet foot-candle level criteria on the Contract Drawings.

9) Total Harmonic Distortion (THD) less than 15 percent.

10) Light distribution pattern as determined by the light design performed by the Contractor to meet foot-candle level criteria found on the Contract Drawings.

4. Lampholders:

a. LED Lamps:

1) In accordance with UL 496 and per the manufacturer's standards.

2) Provide vibration proof mounting to prevent damage to the lamp.

5. LED Driver:

a. Provide internal driver factory installed operating at voltage as indicated in luminaire schedule.

6. Internal Type Emergency Power Unit:

a. Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.

b. Emergency connection to operate lamp(s) continuously at an output of 1100 lumens upon loss of normal power. Connect unswitched circuit to battery inverter unit and switched circuit to luminaire driver.

c. Relay automatically turns lamp on when unswitched power supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1) Ambient temperature to be less than 0°F or exceeding 104°F, with an average value exceeding 95°F over twenty-four (24) hour period.

2) Humidity to be more than 95 percent (condensing).
3) Altitude to be < 1000 feet.

e. Test Push-Button and Indicator Light:
1) Visible and accessible without opening luminaire or entering ceiling space.
1) Push button to be push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
2) Indicator light to be LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicated charging at end of discharge cycle.

f. Battery to be sealed, maintenance free, lead acid type.

g. Charger to be fully automatic, solid state, constant current type with sealed power transfer relay.

7. Reflectors:
a. Reflector material to be aluminum or stainless steel polished to a mirror finish to provide improved light efficiency.

8. Diffusers:
a. Shape and size as shown on the luminaire schedule on the Contract Drawings. One (1) piece molded or extruded polycarbonate plastic or tempered glass lens having the following properties:
1) Suitable for Traction Power Substation (TPSS) environment.
2) Wall mounted type light fixtures shall have plastic or refractory.
3) Self-extinguishing, in accordance with ASTM D 635.
4) No apparent yellowing after five hundred (500) hours exposure to lamp source.
5) No alteration to optical properties of the light fixture when finished diffuser treated with anti-static wax.

b. Formed so that the finished piece retains its design contours and dimensions at normal operating temperature.

c. Resistant to shrinking, wrapping, crazing, cracking or discoloring, either in service or when stored in the manufacturer's standard shipping containers under normal conditions.

9. Lenses:
a. Plastic lenses to be heat resistant, prismatic polycarbonate, minimum thickness of 0.06 inches to prevent glare. UV stabilized.

b. Glass lenses to be 1/4 inch tempered glass, laminated glass, or 1/8 inch double strength clear glass.

c. Refractory lenses to be heat resistant annealed prismatic borosilicate glass, with the following additional requirements:
1) Minimum efficiency to be 85 percent.

10. Light fixture wiring to meet the requirement of Section 16050.

11. Gaskets:
a. Keyed gaskets to be one (1) piece extruded solid neoprene having Type A durometer hardness of 30 plus or minus 5 when tested in accordance with ASTM D 2240.

b. Self-Retaining Gaskets:
1) One (1) piece, closed cell sponge neoprene, soft or medium density.
2) Resistant to aging, heat, ultra-violent light, water, oil, weathering and setting as determined by ASTM D 1056, NEMA 12.

3) Cemented to component with resilient neoprene sealing compound compatible with finish; adhesive not applied to diffuser.

c. Silicone gaskets equal to neoprene; at the Contractor's option.

d. Provide gaskets for light fixtures located in tunnels having UL labeling for wet locations and able to withstand water hose spray cleaning with 100 psi water pressure.

12. Hardware:

a. Latches, catches, release mechanism, hinges, screws, bolts, studs, nuts, rivets, washers and springs to be heavy duty stainless steel or bronze. Where possible, hinges and catches shall be the concealed type.

b. Latches and catches to be captive type.

c. Operating hardware to be self-retaining type

13. Construction:

a. Light fixture body, reflectors, wiring channels, end caps and castings formed to prevent buckling or distortion.

b. Minimum of two (2) wire clips provided in wiring channels to support wiring.

c. Seams and joints continuously welded and ground smooth.

d. When aluminum is in contact with a dissimilar metal, separate contact surfaces with a gasket, non-absorptive type or coating to prevent corrosion.

e. Light fixtures shall be provided with anti-vandal features that do not modify the required photometric performance.

f. All light fixtures shall be suitable for use in a TPSS environment where strong winds are experienced.

g. All light fixtures shall be designed to prevent the ingress of dust.

h. Light fixtures shall be able to withstand washing with industrial detergents applied from a high-pressure hose. Water shall not enter the light fixture.

i. Light fixtures shall be designed such that all components can withstand the expected lamp operating temperatures without reduction in the capability of the light fixture.

14. Finish:

a. Suitable for railroad tunnel environment. The finish shall be resistant to corrosion from water and chemicals.

b. Baked enamel to be non-specular finish consisting of six (6) stage hot cleaning wash, phosphate coat, prime coat and finish coat of sprayed white or other acrylic enamel as shown, baked at 3500°F for a minimum of thirty (30) minutes, with the following additional requirements:

1) Dry film thickness (DFT) per ASTM D 7091 to be 1.25 mils minimum.

2) Undercutting of enamel film from scored line after exposing to 10 percent slat spray for one thousand five hundred (1,500) hours, per ASTM B 117 to be 0.067 inch maximum.

3) Baked white enamel after one hundred (100) hours exposure to fadeometer to be 86 percent minimum reflectance factors, no appreciable visual color change.

c. Specular anodized coating to be fourteen (14) stage process for permanently sealed specular or semi-specular finish, as shown, in accordance with patented electrolytic process, Alzak or equal.

d. Anodic coating to meet AA-M22-C22-A41, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot water seal overall, tested in accordance with the following requirements:

1) Coating weight to meet ASTM B 137.
2) Coating thickness to meet ASTM B 244.
3) Sealing test to meet ASTM B 136.
4) Undercutting of anodic film from scored line after exposing to 10 percent salt spray for one thousand five hundred (1,500) hours, in accordance with ASTM B 117 to be 0.067 inch maximum.

e. Zinc coating to meet ASTM A 123/A 123M.
1) Prepare surfaces in accordance with SSPC-SP 6 for shop painting. Apply coating of 8.0 mil total OFT as follows:
a) First coat to be inorganic zinc silicate primer applied with a dry film thickness of 2.5 to 3 mils.
b) Second coat to be high building epoxy primer applied with a dry film thickness of 4 mils.
c) Third coat to be aliphatic polyester polyurethane with a dry film thickness of 1.5 to 2.5 mils.
2) Color anodized finish to meet AA-M22-C22-A42, minimum coating thickness 0.8 mil, coating weight 35 milligrams per square inch, hot water seal overall, tested in accordance with the following requirements:
a) Coating weight to meet ASTM B 137.
b) Coating thickness to meet ASTM B 244.
c) Sealing test to meet ASTM B 136.
3) Prepare surfaces for electrostatic powder coating by sandblast cleaning method SSPC-SP 10 near white blast cleaning, apply coating promptly after cleaning. Ground material shall be coated. Apply coating as electrostatically charged dry powder using electrostatic spray gun to product OFT of 6 mils plus or minus 2 mils. Cure by heat treatment.

15. Mark each light fixture and its components in accordance with applicable reference standard.
16. Fasteners to be size and type shown or as approved by SEPTA:
a. Expansion anchors to meet FS FF-S-325, Group II, Type 3, Class I, stainless steel, Type 303.
b. Per the manufacturer's recommendations.
17. Fuses:
a. All light fixtures shall be factory equipped with individual fuses.

2.02 Light Fixtures

A. All light fixtures provided for this Contract to be LED. Refer to the luminaire schedule on the Contract Drawings for the basis of design light fixtures for this Contract.

2.03 Lighting and Emergency Battery Unit Support Devices

A. In addition to the supporting devices and fasteners as previously specified in Section 16070, provide with the lighting equipment and luminaries specified or indicated suspension accessories, canopies, casing, sockets, holders, reflectors, plaster frames, recessing boxes, etc., as required for support.

B. Supply pendant stems, special mounting supports and hardware, miscellaneous materials and incidentals required to install the products in place.

C. Spacers for maintaining clearance between products and concrete, mortar and other masonry surfaces are to be neoprene.

2.04 Grounding

A. Provide the housing of each light fixture with a separate, factory installed grounding device and ground conductor. The grounding device is to be used for connecting a separate grounding conductor and meet the requirements specified in Section 16060.

2.05 Light Fixture Brackets

A. Light fixture brackets are to be of the type and style as indicated or scheduled on the Contract Drawings:

1. Designed and fabricated to be compatible with configuration of light fixture and color matched to light fixture.

2. Provide outlet boxes, neoprene gaskets and stainless steel hardware to render the installation waterproof.

2.06 Lighting Contactors

A. The remote control switch shall be electrically operated by a dual acting, single solenoid mechanism that is inherently interlocked and mechanically held in both the open and closed positions. The main contacts shall be power driven in both directions. Positive locking of contact positions shall not be dependent on gravity, hooks, latches or semi-permanent magnets.

B. The remote control switch shall be capable of operating in any position. Provisions shall be incorporated for manual operation during inspection and maintenance.

C. The remote control switch shall be Underwriters' Laboratories listed under UL 508. Main contacts shall be double break, continuous duty rated 20 A at 600 V AC, 60 Hz (30 A at 600 V AC, 60 Hz, for general purpose loads), and be marked for ballast lighting (electric discharge lamps), tungsten and general purpose loads. Lighting contactors requiring de-rating when used in an enclosure or with tungsten lamp loads shall not be acceptable.

D. The remote control switches shall be provided with clamp type, self-rising terminal plates for solder-less connection of line, load and control conductors. Terminals shall accept a copper wire range of No. 18 AWG to No. 10 AWG.

E. The number of poles, up to a maximum of twelve (12), on a single remote control lighting contactor, shall be provided as indicated on the Contract Drawings.

F. The remote control switches shall be UL listed for the following short circuit withstand current ratings when coordinated with a UL listed molded case circuit breaker rated 30 A:

1. 22,000 A RMS symmetrical, 250 V, 60 Hz.

2. 14,000 A RMS symmetrical, 480 V, 60 Hz.

3. 10,000 A RMS symmetrical, 600 V, 60 Hz.

G. The operating coil and main contacts shall be replaceable from the front without major disassembly and visual indication shall be provided for each contact.

H. Provisions shall be included to permit remote pilot lamp type visual indications without the necessity for auxiliary contacts or additional wiring.

I. Each remote control switch shall be furnished with an Owner's manual providing installation and operating instructions.

J. Each remote control switch shall be furnished in a NEMA 1 enclosure.

K. Manufacturers:

1. ASCO, Model 918.

2. Or Approved Equal.

2.07 Photoelectric Controls

A. Cadmium sulphide hermetically sealed cell for remote mounting. Photoelectric control fully temperature compensated and designed to provide for a fifteen (15) second time delay to prevent false switching. Provide two (2) photoelectric controls; one (1) for the light over the main entrance door and one (1) for the dawn shut off function.

B. Photoelectric controls required for individual luminaries are to be of the plug-in, twist-to-lock type, and be of the voltage characteristics compatible with the unit.

C. Photoelectric control required for a group of lighting fixtures is to be of the conduit mounted type and be of the voltage characteristics as indicated on the Contract Drawings.

D. Manufacturers:

1. Tork.

2. Area Lighting Research, Inc.

3. Paragon.

4. Or Approved Equal.

PART 3 - EXECUTION

3.01 Preparation

A. Verify that other construction work is complete to the extent that light fixtures may be installed on the site or in the building as indicated on the Contract Drawings.

B. Verify locations and clearances of other installed or proposed work and coordinate lighting fixture installations accordingly.

3.02 Installation

A. Coordinate the installation of lighting fixtures with all building systems and components so as to avoid any conflicts of installation.

B. Assemble where required, wire and install lighting fixtures, supports, brackets, and accessories at locations and mounting heights indicated on the Contract Drawings.

1. Perform wiring as specified in Section 16123.

2. Ground light fixtures according to requirements of the NEC and Section 16060.

C. Install surface mounted and exposed light fixtures as indicated on the Contract Drawings.

1. Hang suspended light fixtures plumb, with continuous rows of light fixtures in alignment.

2. Unless indicated otherwise on the Contract Drawings, mount suspended light fixtures in each room or area at the same height regardless of varying clear height conditions.

3. Install surface mounted light fixtures drawn up tight against the substrate to eliminate gaps, except where the NEC or local code restrictions require a separation between light fixtures and substrate.

4. Install exit fixtures directly over doorways, for those doors as indicated on the Contract Drawings. Center exit fixtures over doorway and install exit fixtures to clear door and associated hardware.

D. Install all photoelectric controls facing north for proper operation.

E. Apply touch-up paint if necessary.

3.03 Field Quality Control

A. Refer to Section 16950 for functional and photometric testing requirements.

B. Verify installation is per the Contract Drawings and the manufacturer's recommendations.

C. Test lighting circuits for continuity and operation.

D. Test light fixtures and equipment enclosures for continuity of grounding system.

E. Aim and adjust light fixtures to provide required distribution pattern.

3.04 Cleaning

A. New Light Fixtures:

1. Follow the cleaning procedures as recommended by the light fixture manufacturer with respect to new light fixture cleaning for construction work practice.

2. Use only those products for cleaning as outlined in the light fixture manufacturer's literature.

3.05 Warranty

A. The Contractor shall provide a warranty for new light fixtures and all associated components for a minimum of five (5) years from the final acceptance by SEPTA. The Contractor shall be responsible, at no cost to SEPTA, to replace any and all components that become defective during the warranty period, due to material defects, workmanship or design, or do not meet the identified Specification requirements.

B. The LED lamp and ballast shall be guaranteed for a minimum for forty thousand (40,000) hours of operating life.

3.06 Rejection

A. SEPTA expressly reserves the right to reject any light fixture which does not meet all the requirements of this Specification and other SEPTA standards. SEPTA further has the right to reject any light fixtures received in cartons which are obviously damaged or have not been

adequately protected from injury, in the opinion of SEPTA. Upon notice to the Contractor or supplier, any such rejected material shall be removed promptly from SEPTA's property and shall be replaced, at no additional cost to SEPTA, with material which meets this Specification.

END OF SECTION

SECTION 16700

COMMUNICATIONS

PART 1 - GENERAL

1.01 Description

A. This section includes work consisting of materials for furnishing, installing, connecting, energizing, testing, cleaning, and protecting a structured wiring system for voice and security.

B. System Overview:

1. Voice and security runs for Traction Power Substation (TPSS).

2. Building entrance terminals with primary and secondary protection for copper.

3. “Wire set” to each outlet to be one (1) Category 6 white jacketed voice cable. The voice outlet shall have color icon indicating the cable connected to the jack which shall be white cable – white icon. Voice cables shall be terminated on one hundred and ten (110) blocks. Security cables shall be terminated on a separate rack mounted patch panel.

1.02 Related Sections

A. Section 01810 – Commissioning of Systems

B. Section 16060 – Grounding and Bonding

1.03 Submittals

A. Submit with all product data evidence of testing agency/quality verification, listing, and labeling either by printed mark on the data or by a separate listing card. Provide from product manufacturers a written statement indicating why an item does not have quality assurance verification. Such statements are subject to the approval of SEPTA.

B. Submit with all product data evidence of third party performance testing by a Nationally Recognized Independent Testing Laboratory.

C. Submit product data and catalog cuts for all products provided. Clearly indicate the usage of each product.

D. Submit shop drawings:

1. Provide Registered Communications Distribution Designer (RCDD) approved drawings complete with wiring diagrams and details required to prove that the distribution system shall properly support connectivity from the equipment cabinet to telecommunications work area outlets. Show the entrance facility and layout of cabling and pathway runs, cross connect points, grounding system, terminating block arrangements and type. Drawings shall depict final telecommunications cabling configuration, including location, color coding, gauge, pair assignment, polarization, and terminating blocks layout at cross connect points and patch panels after telecommunications cable installation.

2. Provide shop drawing showing layout of applicable equipment inside distribution frames including incoming cable stub or connector blocks, building protector assembly, outgoing cable connector blocks and equipment spaces and racks.

E. Prior to installation, submit data of the installer's experience and qualifications. Installers shall be a Building Industry Consulting Service International (BICSI) registered cabling installation technician. Include names and locations of two (2) Projects successfully completed using copper communications cabling systems. Include written certification from the users that the systems have performed satisfactorily. Include specific experience in installing and testing structured telecommunications distribution systems using Category 6 cabling systems.

F. Submit a complete and detailed test plan for the telecommunications cabling system including a complete list of test equipment for the Unshielded Twisted Pair (UTP) components and accessories. Include procedures for certification, validation, and testing.

G. Submit operation and maintenance manuals which shall include detailed parts lists, lists of recommended spare parts, circuit diagrams, maintenance procedures and operating instructions.

1.04 Quality Assurance

A. Provide products that are listed and labeled by Underwriters Laboratories Inc., approved by Factory Mutual, or certified as meeting the standards of UL by the Electrical Testing Laboratory unless products meeting the requirements of these testing laboratories are not readily available or unless standards do not exist for the products. Provide products that are listed and labeled or approved as stated above for the location installed in and listed and labeled or approved as indicated and specified for the applications the items are intended for.

B. Provide products that have been third party performance tested by a Nationally Recognized Independent Testing Laboratory. Test results shall be provided upon request of SEPTA.

C. Firm specializing in manufacturing products of this Section with sufficient previous experience to successfully manufacture the products indicated.

D. Conform all work to the NEC.

E. Firm specializing in installing work of this Section with sufficient previous experience to conduct satisfactorily the installation indicated.

F. Install work under supervision of skilled licensed electricians.

G. Meet the applicable provisions of the most recent issues of the following references:

1. ANSI/NEMA WC 63.1, Performance Standard for Twisted Pair Premise Voice and Data Communications Cable.

2. ANSI/TIA/EIA-455-21A, Fiber Optics - Mating Durability for Fiber Optic Interconnecting Devices.

3. ANSI/TIA/EIA-568-A, Commercial Building Telecommunications Cabling Standard.

4. ANSI/TIA/EIA-568-B, Commercial Building Telecommunications Cabling Standard.

5. ANSI/TIA/EIA-568-B.1, Commercial Building Telecommunications Cabling Standard - General Requirements.
6. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard - 100 Ohm Twisted Pair Cabling Standards.
7. ANSI/TIA/EIA-568-B.3, Commercial Building Telecommunications Cabling Standard - Optical Fiber Standards.
8. ANSI/TIA/EIA-569-A, Commercial Building Standard for Telecommunications Pathways and Spaces.
9. ANSI/TIA/EIA-606, Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
10. ANSI/TIA/EIA-607, Commercial Building Grounding and Bonding Requirements for Telecommunications.
11. ASTM E 814, Standard Test Method for Fire Tests of Penetration Firestop Systems.
12. Factory Mutual (FM).
13. ICEA S-84-608, Telecommunications Cable, Filled Polyolefin Insulated, Copper Conductor.
14. ICEA S-90-661, Category 3, 5, & 5e Individually Unshielded Twisted Pair Indoor Cables (With or Without an Overall Shield) for Use in General Purpose and Communication Wiring Systems Technical Requirements.
15. IEEE 802.3ab, IEEE Standard for Information Technology - Telecommunications and Information Exchange Between Systems - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications - Physical Layer Parameters and Specifications for 1000 Mb/s Operation over 4 pair of Category 5 Balanced Copper Cabling, Type 1000BASE-T.
16. NFPA 70, National Electrical Code (NEC).
17. UL 444, Communications Cables.
18. UL 467, Grounding and Bonding Equipment.
19. UL 497, Protectors for Paired-Conductor Communication Circuits.
20. UL 1479, Standard for Fire Tests of Penetration Firestops.
21. UL 1863, Standard for Communications-Circuit Accessories.
22. 7 CFR 1755.390, RUS Specification for Filled Telephone Cables.

1.05 General Requirements

A. Provide a completely cabled and terminated communication system (voice/data) in a star topology.

B. Communications system cabling, raceways, pathways, and spaces shall at minimum meet ANSI/TIA/EIA-568-B.1, ANSI/TIA/EIA-568-B.2, ANSI/TIA/EIA-568-B.3, ANSI/TIA/EIA-569-A and ANSI/TIA/EIA-607.

C. Provide grounding and bonding per, at minimum, ANSI/TIA/EIA-607, NFPA 70 and UL 467.

PART 2 - PRODUCTS

2.01 Connection

A. UTP Copper Cable:

1. Voice and Data:
   a. Connectors shall meet FCC Part 68.5 and ANSI/TIA/EIA-568-B. UTP outlet/connectors shall be UL 1863 listed, non-keyed, four (4) pair, constructed of high impact rated thermoplastic housing and shall meet Category 6 requirements. Connectors shall be RJ45 terminated using a one hundred and ten (110) style PC board connector. UTP connectors shall meet durability for five hundred (500) mating cycles. Connector shall be color coded for telephone as directed by SEPTA.
2. Manufacturers:
   a. TE Connectivity part number 1375192-1.
   b. Or Approved Equal.

2.02 Outlet

A. Outlets consisting of box, wallplate and connectors.

B. Wallplates shall be stainless steel.

C. Manufacturers:

1. The Siemen Company.
2. Leviton Voice and Data Division.
3. Hubbell Premise Wiring.
4. TE Connectivity.
5. Or Approved Equal.

D. Faceplates shall be four (4) port Almond color with color icons labeling the designated jacks as follows:

1. Voice to be white cable white icon.
2. Data to be gray cable black icon.
3. Data to be blue cable blue icon.
4. Pink cable red icon.

E. Surface mounted boxes shall be single gang almond.

2.03 Patch Panels

A. UTP Copper Cable (Data):

1. Panel shall be constructed of 0.09 inch minimum aluminum and shall be compatible with an EIA 19 inches equipment rack.
2. Panel shall be equipped with the indicated quantity of non-keyed, RJ45 ports, wired to ANSI/TIA/EIA-568-A. Patch panels shall terminate the building cabling on one hundred

and ten (110) style insulation displacement connectors and shall utilize a printed circuit board interface color coded for both ANSI/TIA/EIA-568-A and ANSI/TIA/EIA-568-B wiring. Panels shall have each port factory numbered and be equipped with laminated plastic nameplates above each port.

3. The rear of each panel shall have incoming cable strain relief and routing guides and shall accommodate top, bottom or side cable entry.
4. Panel shall meet the performance requirements of ANSI/TIA/EIA-568-B for Category 6 and be 1000BASE-T compliant. Krone style not acceptable.

2.04 Equipment Cabinets

A. Standard 19 inch, height 42 RU, depth 30 inches minimum, lockable equipment cabinet.

B. Provide cabinet with vertical and horizontal cable management channels and copper bus bar.

C. Provide rack mounted power strip equipped with six (6) simplex receptacles and level 3 surge protection.

D. Manufacturers:

1. Hubbell Premise Wiring.
2. Bison.
3. The Siemen Company.
4. Corning Cable Systems.
5. Or Approved Equal.

E. For Castor location only, equipment cabinet shall be Standard 19 inch, height 13 RU, depth 30 inches minimum, wall mounted, lockable equipment cabinet.

2.05 Uninterruptible Power Supply (UPS)

A. AC UPS:

1. AC UPS shall be 2200 VA, mount 2U.
2. UPS shall provide seventy (70) minutes of battery backup for all equipment within cabinet.
3. Ethernet monitoring with Simple Network Management Protocol (SNMP) card.

2.06 Copper Cable

A. Category 6 Horizontal Cable:

1. Meet NFPA 70, ANSI/NEMA WC 63.1, ICEA S-90-661 and performance characteristics in ANSI/TIA/EIA-568-B.
2. UTP cable to be 100 ohm. Provide four (4) each individually twisted pair, No. 24 AWG conductors, NFPA 70 plenum (CMP) rated. Individual pairs shall be constructed to contain a minimum two (2) twists per foot per each pair. Overall diameter of four (4) pair cable shall not exceed 0.25 inches. Ultimate breaking strength shall be minimum 90 pounds. Four (4) pair cable shall withstand a bend radius of 1 inch minimum at a

temperature of minus 20°C maximum without jacket or insulation cracking. Conductors shall be color coded and polarized in accordance with ANSI/TIA/EIA-568-B. Jacket sequentially marked at 2 foot intervals. Shall meet Category 6 requirements and be 1000BASE-T compliant. Outdoor cameras, limited purpose to be type CMX cable.

3. Manufacturers:
   a. Belden.
   b. General Cable.
   c. Mohawk/CDT.
   d. Or Approved Equal.

2.07 Twenty-Five (25) Pair Cable Assemblies

A. Factory assembled Category 3 CMP twenty-five (25) pair cable assemblies factory tested for opens, shorts and continuity.

B. Manufactured with FCC part 68 subpart F compliant gold plated contacts, and ANSI/TIA/EIA-568-B.2 Category 3 compliant cable.

C. Cable length and connector ends (single ended male or female, double ended male or female, or one (1) male/one (1) female configuration) shall be as required for the application.

D. Manufacturers:
   1. The Siemen Company.
   2. Or Approved Equal.

2.08 Building Entrance Terminals

A. UL 497 Listed for primary and secondary protection.

B. Input to be a one hundred and ten (110) block.

C. Output to be RJ21.

D. Pair count as indicated on the Contract Drawings.

E. Large splice chamber.

F. Compact, lightweight 18 gauge welded steel housing.

G. Connection cover to be a small swing radius to provide more room in tight quarters.

H. Fully loaded with protector modules to be gas tube type with voltage and current protection.
   1. Porta Systems 115SCG-240V.
   2. Or Approved Equal.

I. Manufacturers:
   1. Porta Systems, Series 24.
   2. Or Approved Equal.

2.09 Rack Mount Lightning Surge Protection

A. Shall be rated for Category 6 10/100/1000 BASE-T performance.

B. Shall support a minimum of twelve (12) ports.

C. Shall fit a standard 19 inch cabinet and 1RU.

D. Shall be 802.3af POE compatible.

2.10 Standard Telephone Wall Phone

A. Tone dial.

B. Single line.

C. 5 foot cord.

D. Sturdy bell ringer.

E. No external power requirements.

F. Color to be black.

G. Five (5) year manufacturer warranty.

PART 3 - EXECUTION

3.01 Preparation

A. Ensure that painted surfaces that will be covered by items of this Section have a prime and finish coat of paint.

B. Ensure that all indoor areas are enclosed from the weather.

3.02 Installation

A. Outside wire and cable shall be installed in ducts. Inside wire and cable shall be installed in conduit or cable tray. Use of cable tray limited to equipment rooms.

B. During the installation of cables in conduits and ducts, the cable manufacturer’s recommended pulling tension shall not be exceeded. A suitable lubricating medium, harmless to the cable jacket, shall be used when pulling cables into conduits, pipes or duct banks. No oil or grease substances not specifically manufactured for cable installation will be permitted for such use on this Contract.

C. Lengths of cables which are not installed in conduits and are run inside equipment rooms shall be secured to cable trays or cable ladders using nylon cable ties and attached to walls and backboards using nylon cable clamps or hangers or using a plastic wiring system such as manufactured by Panduit; Or Approved Equal. Cables shall be attached or otherwise supported at intervals not to exceed 18 inches.

D. Provide sufficient strain relief (slack) in all cables, cable conductors, and wiring to avoid stress on all cables, wires and wiring connections.

E. Cables shall not be bent to a radius less than ten (10) times the diameter of the cable, or less than the manufacturer's recommended minimum bending radius, during installation or as finally installed.

F. All cable runs shall be continuous without splices between cable terminating locations, except as specified or directed by the SEPTA Project Manager.

G. All conduit and cable entrance openings into equipment rooms and huts shall be sealed with a pliable sealing compound after the cable is in place. Sealing compounds for rooms, huts, walls or other partitions shall be fire retardant per ASTM E 814. Sealing compound shall be used to seal the area around the cable where the cable emerges from the end of a conduit, pipe, or duct bank. All spare conduits shall be sealed or plugged in an approved manner.

1. Fire retardant pliable sealing compound shall be an intumescent fire stop putty, reusable and re-penetrable, meeting ASTM E 814 and UL 1479, Nelson FSP Fire Stop Putty; Or Approved Equal.

H. At all transition points where a cable runs from inside a conduit into a cable trough; or onto a cable tray or plywood backboard, the end of the conduit shall be fitted with a plastic bushing to prevent abrasive damage to the cable.

I. Cable installed in cable trays or cable troughs shall be laid therein and not pulled in place. Cables installed in cable trays and cable troughs shall have a minimum amount of crossover and shall not be pulled tightly around bends.

J. Provide appropriate special protection for cables in areas where the cables are unavoidably exposed to hazardous conditions, such as sharp corners on equipment. Cables damaged due to neglect by the Contractor, during installation, shall be replaced by the Contractor, at no additional cost to SEPTA.

K. All cables shall be continuous and without splices between the specified termination locations. The cable termination points shall be located within communication interface cabinets, equipment enclosures, splice cases, and equipment termination boxes as shown on the Contract Drawings and as described in the Specifications.

L. The shield of each section of communication cable shall be electrically continuous for the entire cable length.

M. All cables shall be terminated in standard order, according to the ANSI/EIA/TIA and ICEA color codes. Individual cables shall be identified at each cable termination with self-adhesive labels. All spare pairs in each cable shall be terminated and identified.

N. Provide pull rope in all empty conduit runs with not less than 12 inches of slack both ends.

O. Conduits shall be restricted to no more than two (2) 90 degree bends or equivalent without a pull box.

P. Maintain minimum bending radius of changes in direction as follows:

1. Ten (10) times diameter of 4 inch and larger conduits.

2. Six (6) times the diameter of smaller conduits.

Q. Avoid bends in conduits from pull boxes.

R. Except as noted hereinafter for telecommunications cabling and pathways with copper media, keep conduit and cable tray a minimum of 6 inches away from parallel runs of electrical power equipment, flues, steam, and hot water pipes.

S. Telecommunications cabling and pathways with copper media shall be installed in accordance with the following criteria to avoid potential electromagnetic interference between power and telecommunications equipment.

1. The interference ceiling shall not exceed 3.0 V per meter measured over the usable bandwidth of the telecommunications cabling.

2. Pathways shall be installed in accordance with the following minimum clearance distances of 4 feet from motors, generators, frequency converters, transformers, x-ray equipment or uninterruptible power system, 12 inches from power conduits and cable systems, 5 inches from fluorescent or high frequency lighting system fixtures.

T. Install voice and data telecommunications cabling and pathway system as detailed in ANSl/TIA/EIA-568-B and ANSI/TIA/EIA-569-A. Screw terminals shall not be used except where specifically indicated on plans. Use an approved Insulation Displacement Connection (IDC) tool kit for copper cable terminations. Do not untwist Category 6 UTP cables more than 1/2 inch from the point of termination to maintain cable geometry. Provide service loop on each end of the cable, 10 feet in the telecommunications closet, 12 inches in the work area outlet. Do not exceed the manufacturers' cable pull tensions for copper cables. Utilize a running line tensiometer with continuous data display and recording capabilities to monitor cable pull tensions. Do not exceed 25 pounds pull tension for four (4) pair copper cables. Do not chafe or damage outer jacket materials. Use only lubricants approved by the cable manufacturer. Do not over cinch cables, or crush cables with staples. For UTP cable, bend radii shall not be less than four (4) times the cable diameter.

U. All communications cables shall be terminated. Segregate voice and data terminations. Provide service loops for all voice (telephone) backbone cables. Provide excess cable at both ends of horizontal cable to facilitate future re-termination.

1. All telephone/voice cabling shall be punched down on one hundred and ten (110) type punch down blocks located in enclosure. Height of highest punch down block shall not exceed 78 inches above floor. All cabling shall be punched down.

2. Terminate all copper data cabling on Category 6 type data patch panels with jacks. Patch panels and equipment shall be rack mounted. Racks shall have a minimum of 39 inches clearance at front and back. Racks shall be permanently bolt anchored to the floor per the manufacturer's recommendations.

V. Provide outlet box and jack(s) at each voice/data outlet. Depth of outlet boxes shall be sufficient to allow the manufacturer's recommended conductor bend radii.

1. Terminate UTP cable in accordance with ANSl/TIA/EIA-568-B and wiring configuration as specified.

W. Bond racks, conduits, raceways, cable trays, etc. in accordance with ANSI/TIA/EIA standards, NFPA 70 and Section 16060. Grounding conductors shall be compatible with raceways. Protect all grounding and bonding conductors from physical damage.

X. Provide identification and labeling of communications cables, outlets, and equipment per ANSI/TIA/EIA-606.

1. All cables shall be labeled at least at each end of each cable section, using SEPTA approved cable tags or labels. Inside plant cables shall be labeled using SEPTA approved

self-adhesive waterproof labels; outside plant cables shall be labeled using SEPTA approved waterproof cable tags.

2. A cable labeling table shall be developed based on this Contract. The table shall be submitted for approval prior to cable installation.

3. Cable Tags:
   a. Attach to cable using two (2) nylon cable ties through holes in the tag.
   b. Use pre-printed plastic tags marked with a durable, abrasion resistant, waterproof ink.

3.03 Cleaning

A. After wiring, vacuum out interior and wipe clean of all foreign material.

B. After painting in areas, remove all over paint, drips, and splashes.

C. Unpack all material and dispose of all trash and related material offsite. Keep work area clean.

3.04 Field Quality Control

A. Perform telecommunications cabling inspection, verification, and acceptance tests in accordance with ANSI/TIA/EIA-568-B.

B. Visually inspect cabling jacket materials for UL or third party certification markings. Inspect cabling terminations in telecommunications rooms and at workstations to confirm color code for tip and ring pin assignments and inspect cabling connections to confirm compliance with ANSI/TIA/EIA-568-B. Visually confirm Category 6 marking of outlets, wallplates, connectors, and patch panels.

C. Perform testing after cables are terminated, but not cross connected.

D. Verification Tests:

1. UTP backbone copper cabling shall be tested for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors, and between conductors and shield, if cable has overall shield. Test operation of shorting bars in connection blocks.

2. For UTP horizontal voice Category 6 cabling, test each pair for short circuit, continuity, short to ground, crosses and reversed polarity.

E. Acceptance Testing for Balance Twisted Pair Cabling:

1. Perform UTP permanent link tests in accordance with ANSI/TIA/EIA-568-B. Tests shall include wire map, length, insertion loss, Near-End Crosstalk (NEXT) loss, Equal-Level Far-End Crosstalk (ELFEXT), propagation delay and delay skew, return loss, Power Sum Near-End Crosstalk (PSNEXT) loss, and Power Sum Equal-Level Far-End Crosstalk (PSELFEXT). Each and every link shall be tested and shall pass the requirements of ANSI/TIA/EIA-568-B for Category 6 and IEEE 802.3ab for 1000BASE-T. Any failing link shall be diagnosed and corrected. The corrective action shall be followed by a new test to prove that the corrected link meets the performance requirements. The final and passing result of the tests for all links shall be provided in the test results documentation.

3.05 Protection

A. During painting, mask all nameplates, all plastic parts, and all items not to be painted.

B. Protect all items during work of other trades including welding and cutting.

END OF SECTION

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SECTION 16760

FIBER OPTIC NETWORK

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for furnishing all equipment and material necessary to complete the installation of fiber optic cables. Use industry standard construction practices so that Project management, Project coordination and construction techniques meet all federal, state, and local codes and regulations.

B. Furnish and Install the most recent version of equipment available at the time of installation.

C. Furnish and install all necessary equipment and materials identified in this Section and the Contract Drawings for the successful performance of the identified work.

D. Cabling shall be installed in such a manner so that SEPTA's normal day-to-day operations are not affected and that interruptions to SEPTA's normal workday activities are kept to a minimum.

E. Work along the right of way of this Section may require track outages and must be performed during the hours of 1:30 AM and 4:30 AM Monday thru Friday.

F. Terminate cables in replacement Traction Power Substation (TPSS). Prepare cable ends for termination to active circuits by SEPTA.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 07841 – Penetration Fire Stopping

C. Section 07842 – Joint Fire Stopping

D. Section 16075 – Electrical Identification

E. Section 16950 – Testing

1.03 Submittals

A. Submit proof of manufacturer's certification, within ten (10) business days of the Contract award, which you or your sub-contractor is manufacturer certified to install the specified cabling systems that includes and will provide a manufacturer's extended warranty of five (5) years (minimum).

B. Submit for approval to SEPTA's Project Manager, sets of catalog cut sheets for all materials to be used in this installation, in accordance with Section 01300. Each cut sheet shall be identified with the manufacturer's name, part number, acquisition lead time and date of submittal. SEPTA will not be responsible for any materials ordered prior to SEPTA's approval for the cut sheet item in question.

C. Failure to provide a complete cut sheet submittal for a specific item will result in rejection. Upon rejection, resubmit the specified documentation for re-approval.

D. Submit cut sheet submittals in a timely manner to permit proper consideration and approval. Coordinate the timing of each submission to assure adequate lead time for procuring items required by this Contract and inform SEPTA's Project Manager of any time constraints concerning submittal approvals that are critical to the completion of the Contract. Delays attributable to rejected cut sheet submittals shall not serve as a basis for extending time for Contract completion.

E. After an item has been approved, changes in make, manufacturer or part number shall not be permitted, unless:

1. Satisfactory written evidence is presented, and approved by SEPTA, that the manufacturer cannot make the scheduled delivery date of an approved item; or

2. Other conditions become apparent indicating approval of the item to be substituted will be in the best interest of SEPTA.

F. Submit a cable and outlet identification plan to SEPTA's Project Manager for approval before final cable and faceplate labels are installed.

G. Submit pulling calculations (tensions and side wall pressure).

H. Field monitored pulling tension forces during actual installation of the cable.

I. Submit copies of the completed test results, in accordance with Section 01300, within fifteen (15) working days of test completion, in both electronic and printed format. The submission shall include copies of the print-outs of all cables tested.

J. Submit copies of the marked-up "as-built" drawing(s) to SEPTA's Project Manager within fifteen (15) working days of completion of the work or each stage of the work. As a minimum, annotate on a clean set of prints, the following information:

1. The approximate routing of all cabling installed.

2. All other pertinent information concerning the performance of the work regarding "as-built" conditions that will provide a more accurate set of drawings

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. BICSI, Telecommunications Distribution Methods Manual.

2. NFPA 70, National Electric Code (NEC).

3. TIA/EIA 568-B.1, Commercial Building Telecommunications Cabling Standard - General Requirements.

4. TIA/EIA 568-B.2, Commercial Building Telecommunications Cabling Standard - 100 Ohm Twisted Pair Cabling Components.

5. TIA/EIA 568-B.3, Commercial Building Telecommunications Cabling Standard - Optical Fiber Standards.

6. TIA/EIA 569-A, Commercial Building Standards for Telecommunications Pathways and Spaces.

7. TIA/EIA 607, Commercial Building Grounding and Bonding Requirements for Telecommunications.

1.05 Performance Requirements

A. All work shall be performed in a professional manner using practices of good craftsmanship.

B. All cables shall have the specified connectors affixed using the tools specified by the manufacturer.

C. All cables shall be terminated using the tools specified by the manufacturer.

D. All cables and outlets shall be labeled in accordance with Article 3.08 in this Section.

E. Remove trash, debris, spent reels and all other refuse related to this installation, daily.

1.06 Qualifications

A. Provide the services of personnel having at least five (5) years of experience in the installation and termination of single mode optical fiber.

1.07 Operations and Maintenance Data

A. Certified factory test reports.

B. Pulling calculations.

C. Certified detailed field test reports that verify the total db losses.

1.08 Warranty

A. Provide the standard warranty. The warranty shall begin upon TPSS commissioning by SEPTA.

1.09 System Acceptance

A. Final acceptance will be made by SEPTA upon satisfactory completion of the work, including all cable testing and an integrated Supervisory Control and Data Acquisition (SCADA)/Communications systems test, that will insure that all equipment and cabling have been properly installed. Additionally, SEPTA's acceptance is based upon the submission and approval of all test records, cable run summaries and as-built drawings.

B. The work will not be considered complete until:

1. It has been inspected and accepted by SEPTA.

2. All discrepancies have been resolved.

3. All test records, cable run summaries and as-built documentation have been received.

PART 2 - PRODUCTS

2.01 General

A. Items not listed in this document or shown on the Contract Drawings, but necessary for the complete and proper performance of the work as specified, shall be considered part of the work. Verify exact types and quantities of all materials with SEPTA before purchase.

2.02 Composite Copper/Fiber Optic Cable

A. Provide one (1) composite cable consisting of twenty-five (25) pair CAT-3, No. 22 AWG solid copper cable and twelve (12) 8.3/125 single mode fiber under one (1) jacket for voice and data applications.

B. Manufacturers:

1. Superior-Essex Part No. 70-062-12.

2. Or Approved Equal.

C. Within one (1) empty 4 inch duct of existing and new communications duct banks to be used for this Contract, provide two (2) 1 1/4 inch diameter inner ducts and one (1) 1 inch diameter inner duct. Utilize one (1) of the 1 1/4 inch diameter inner ducts for this Contract's composite cable system. Inner duct shall be rated for placement in an outside plant environment and shall be in accordance with Table 16760-1; Or Approved Equal.

Table 16760-1 Inner Duct Data

Diameter	Manufacturer	Part Number
1 inch	Pyramid	4404-04T
1 1/4 inch	Pyramid	4404-05T

2.03 Cable Terminations

A. Terminations for Fiber Optic Elements:

1. Single mode fiber optic elements of the composite copper/fiber optic cable shall be terminated on SC connectors installed within fiber optic patch panels.

2. Fiber optic terminations shall be in accordance with Table 16760-2; Or Approved Equal.

Table 16760-2 Fiber Optic Cable Terminations

Description	Manufacturer	Anixter Part No.
SC connector to be single mode	Corning	515987
Buffer tube fan-out kit, twelve (12) fiber	Corning	152286
Wall mounted patch panel to be two (2) insert	Corning	180542
Connector panel, w/(3) SM duplex SC adapters	Corning	180435

B. Terminations for Voice Cabling:

1. Copper pairs (No. 22 AWG) of the composite copper/fiber optic cable shall be terminated on wall mounted protector blocks designed to facilitate cross connection and interconnection using patch cords or cross connect wire.

2. Protector blocks shall be twenty-five (25) pair, one hundred and ten (110) type connector input and output. Protector blocks to be Underwriter's Laboratories (UL) listed. Protector blocks to be equipped with a cover and external ground connector that will accept between No. 6 AWG and No. 14 AWG ground wire.

3. The twenty-five (25) pair protector block manufacturer:
   a. Anixter Part No. 195420.
   b. Or Approved Equal.
4. Protector modules shall be five (5) pin, solid state with heat coils. Protector module manufacturer:
   a. Anixter Part No. 106805.
   b. Or Approved Equal.

2.04 Audio Repeaters with Power Supply

A. Part numbers shall be in accordance with Table 16760-3; Or Approved Equal.

Table 16760-3 Audio Repeaters

Description	Manufacturer	Part No.
IFS audio repeater (single mode, for use on 120 V AC 60 Hz power supply)	International Fiber Systems	A2125

2.05 Fire Stop

A. Provide UL-listed fire stopping for all conduits, sleeves, floor openings and wall penetrations used for this cable installation.

B. Submit for approval the method(s) and material(s) to be used to fire stop all wall, floor, and ceiling penetrations, and all conduits and sleeves used as a part of the cabling installation.

C. Refer to Sections 07841 and 07842 for additional information on fire stopping materials.

PART 3 - EXECUTION

3.01 General

A. Do not exceed the recommended pulling tension of the cable manufacturer. Assume responsibility to pay all costs associated with the replacement of any cable that exhibits evidence of cuts, crimps, severe abrasions and damage due to exceeding the manufacturer's specified pulling tension.

B. Install, dress and terminate cabling in a professional manner, using practices of good craftsmanship. Where communications cabling must cross power cables/conduits, they shall cross at right angles (90 degrees) to the power runs. A minimum of 12 inches separation from power cables/conduits shall be maintained where communications and power cabling follow the same route.

C. Place all new sleeves and penetrations required for successful cable installation.

D. Upon completion of the cable installation, install fire stopping/sealing material in all sleeves and penetrations used during this installation.

E. Ground equipment racks and cabling in accordance with all manufacturer's specifications and recommendations, the NEC and accepted industry standards for grounding communications cable and ancillary devices.

3.02 Backbone Cable Installation

A. Furnish and install the specified composite copper/fiber optic cable as shown on the Contract Drawings.

B. Furnish and install the specified inner ducts.

3.03 Cable Termination

A. Terminate unshielded twisted pair voice backbone on the specified protector blocks.

B. Each element of the specified fiber optic cabling installed shall be connectorized using the specified SC connectors, and shall be mounted into the specified fiber optic patch panels and SC insert panels.

C. Furnish and install all termination equipment according to the manufacturer's instructions using the required tooling and materials.

3.04 Floor and Wall Penetrations

A. Install all required floor, wall and building penetrations.

B. Submit to SEPTA's Project Manager for approval, all required floor, wall and building penetrations before proceeding with this portion of the work.

3.05 Fire-Stop

A. Furnish and install fire-stop material in all floor, wall and building penetrations after all cabling has been installed.

B. Save all fire stopping containers, tubes, jars, boxes, etc., all vendor/distributor packing slips, and all SDS sheets as a part of the end of Contract submittals. These shall be available for inspection by SEPTA's Project Manager as part of the system acceptance for this installation.

3.06 Splices

A. SEPTA's intend that cabling shall be installed in one (1) continuous run between termination locations. However, should the SEPTA approved pulling calculations by the Contractor indicate the need to construct a splice or splices, assume all costs for and provide the required splices and enclosures.

3.07 Damage

A. Any cuts, abrasions, burns, stretched segments and/or other damage that will be detrimental to the performance of that cable shall be cause for replacement of that entire segment of cable.

B. Incidental damage to cables and connectors shall be corrected at the Contractor's expense before testing and final acceptance of cables.

3.08 Cable Labeling and Identification

A. Submit a cable and outlet identification plan to SEPTA for approval before final cable labels are installed.

B. Each cable, patch panel port and termination block position shall be labeled individually with a unique cable number using machine printed labels.

C. Each outlet shall be labeled individually with a unique identification number, using machine printed labels.

D. Cable labels that are cut off during the installation process shall be replaced with new labels after final dress and termination in such a position that permits the label to be easily read.

3.09 Testing

A. Factory and field testing shall be performed in accordance with the requirements of Section 16950.

END OF SECTION

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SECTION 16772

CCTV SYSTEM

PART 1 - GENERAL

1.01 Description

A. Section includes:

1. Closed Circuit Television (CCTV) system; complete, including all wiring, cables, raceways, terminal cabinets, pull boxes, outlet and mounting boxes, cameras, Power Over Ethernet (POE) management hardware, network switches, mounting hardware, testing, and all other accessories and miscellaneous items required for a complete operating system even though each item is not specifically mentioned or described.
2. Place SEPTA approved labels on each camera to uniquely identify the camera.
3. Refer to the Contract Drawings for specific quantity, location and type of equipment.

1.02 Related Sections

A. Section 01810 – Commissioning of Systems

B. Section 16050 – Basic Electrical Materials and Methods

1.03 Submittals

A. Submit to SEPTA the following information in accordance with the requirements of general conditions of the Contract:

1. Manufacturer's product data, user, and installation manuals for all equipment and software programs including computer equipment and other equipment required for complete video management system.
2. Shop drawings including system device locations on architectural floor plans; full schematic of system, including wiring information for all devices.

B. Submit complete submittals, which shall include schematic wiring drawings and specification sheets for all equipment. Partial submittals will not be accepted.

1.04 Quality Assurance

A. General:

1. All equipment and software provided shall be standard components that are regularly manufactured and utilized in the manufacturer's system.
2. All systems and components shall have been thoroughly tested and proven in actual use.
3. All systems and components shall be provided with the availability of technical support from the manufacturer during normal business hours at no charge.
4. Confirm the compatibility of all new equipment being provided on this Contract with SEPTA standards.

5. All systems and components shall be listed by UL and FCC specifically for the required application. Provide evidence of compliance upon request.

B. Manufacturer with a minimum of ten (10) years of experience in the manufacture and design of video surveillance devices. Registered to ISO 9001 quality standard.

C. An experienced installer with a minimum of five (5) years of experience in the installation of CCTV systems of similar type, size, and scope; who is an authorized representative of the manufacturer for installation.

D. As part of this Contract, the Contractor shall secure and fund the services of SEPTA's CCTV Maintenance Contract Provider, for the installation of the local Genetec Head End, Storage and Peripheral Devices within each Traction Power Substation (TPSS).

1. The Contractor shall provide for SEPTA's review and concurrence prior to installation, the full scope of services and related costs associated with SEPTA' CCTV Maintenance Contract Provider, for the installation of the local Genetec Head End, Storage and Peripheral Devices with each TPSS.

2. The Contractor shall not permit the installation of local Genetec, Head End, Storage and Peripheral Devices within each TPSS without first attaining scope and cost approvals from SEPTA.

E. Meet the applicable provisions of the most recent issues of the following references:

1. FCC Part 15, Radio Frequency Devices.

2. ICES-003, Information Technology Equipment (Including Digital Apparatus) - Limits and Methods of Measurement.

3. IEC 61000-4, Electromagnetic Compatibility (EMC).

4. ISO 9001, Quality Management Systems – Requirements.

5. MIL-STD-810(e), Environmental Test Methods and Engineering Guidelines.

6. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

7. NFPA 70, National Electrical Code (NEC).

8. UL 294, Standard for Access Control System Units.

9. UL 864, Control Units and Accessories for Fire Alarm Systems.

10. UL 1076, Proprietary Burglar Alarm Units and Systems.

11. UL 60950, Information Technology Equipment.

12. All applicable Federal, State, and Local laws, regulations and codes.

1.05 Operations and Maintenance Data

A. Submit to SEPTA the following operation and maintenance information in accordance with the requirements of general conditions of the Contract:

1. Instruction books and/or leaflets.

2. Focus aid.

3. Recommended renewal parts list.

4. Maintenance requirements.
5. Final as-built drawings.
6. Complete wiring diagrams.
7. CCTV camera field of view definitions spreadsheet.
8. CD-ROM with manual, software and tools.

1.06 Acceptance of Systems

A. Total acceptance of the system will only be made after the required tests, complete record document package and the instruction period have been provided.

1.07 Guarantee

A. The Contractor shall guarantee labor, materials and equipment provided under this Contract against system defects for a period of one (1) year after the date of final acceptance of this work by the SEPTA.

B. Provide manufacturer's three (3) year warranty for CCTV products, covering replacement and repair of defective equipment.

1.08 Maintenance

A. Make ordering of new equipment for expansions, replacements, and spare parts available to dealers and end users.

B. Provide live factory direct technical support minimum 8:00am to 8:00pm (EST/EDST) via telephone and email.

C. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents. Deliver extra materials to SEPTA.

1. One (1) fully operational camera per TPSS.
2. One (1) fully operational display console, recording device and media converter.

1.09 Environmental Requirements

A. Temperature:

1. Equipment/Communication Room Equipment:
   a. Hardware installed in equipment cabinet shall be designed, fabricated, and environmentally tested to operate in the temperature range between minus 13°F and plus 122°F with a relative humidity range of 5 to 95 percent, non-condensing.
2. Interior Equipment:
   a. Interior equipment to be installed within SEPTA TPSSs shall be designed and certified by the manufacturer to operate in a range of between minus 13°F and plus 122°F with a relative humidity of 20 to 80 percent, non-condensing. The Contractor shall make clear in the technical proposal any additional heating or air conditioning that may be required.
3. Equipment Storage and Start-up:

a. All exterior and equipment room products shall be designed to avoid damage due to thermal shock during normal operation or start-up during low temperature conditions.

b. All equipment shall be designed for dry storage in temperatures that range from minus 13°F to plus 145°F.

B. Weather and Elements:

1. All interior, exterior and communication room equipment and any other potentially exposed units, shall be designed and tested to operate continuously and reliably in varying conditions of humidity, rain, salt, dust, cleaning detergents, water spray, roadway chemicals, exhaust emissions and other contaminants found in the transportation areas. This means that appropriate rain/corrosion/tightness testing shall be conducted for all transit equipment. All exterior components shall be designed and finished to resist adverse effects from solar radiation.

C. Electromagnetic and Electrostatic Susceptibility:

1. System equipment shall not be adversely affected by radiated or conducted electromagnetic or electrostatic interference from other onboard or fixed site equipment. Certain tests for Electromagnetic Interference (EMI) and Electrostatic Discharge (ESD) susceptibility are required. These conditions shall include, but not be limited to fixed site, portable and mobile radio interference, incidental (spurious) radiation, ignition noise, lighting fixture (static) interference, electrical power system transients and electrostatic discharge (air or contact).

2. The Contractor shall investigate all environmental factors that may affect equipment operations both before and after installation of the equipment, including shock and vibration. Environmental deficiencies uncovered during installation testing, on-line demonstration, or final tests may be cause for additional design adjustments and additional environmental testing by the Contractor. SEPTA shall retain the exclusive right to judge the environmental acceptability of the components before final acceptance.

D. Electrical Power:

1. All components shall be certified via testing to operate with normal outputs when the input voltage varies as much as plus or minus 10 percent.

E. Shock and Vibration:

1. All interior, exterior and communication room equipment, when in their fully assembled configuration, shall not be damaged, nor shall the operational performance be degraded, after subjection to vibration of 1G at 10 Hz to 500 Hz or shocks of 20G for eleven (11) plus or minus one (1) millisecond.

2. Vibration isolation for equipment housings shall be provided (if applicable) to protect electronic components within the cabinets from long term low frequency events resulting from continual train operations through the TPSSs. The Contractor shall coordinate with the electronic equipment and cabinet manufacturers to determine proper vibration isolation hardware to meet the manufacturer’s electronic equipment environmental test specifications.

1.10 Test and Waivers

A. The Contractor may request a waiver of environmental testing for any component previously tested and certified. In such an event, fully certified technical test data shall be submitted to SEPTA with the waiver request. SEPTA shall retain the exclusive right to require representative environmental testing or to waive such testing after reviewing the Contractor's waiver request.

B. The Contractor may request; where applicable; representative and or sample testing to be provided. In such an event, fully certified technical test data shall be submitted to SEPTA with the representative or sample request. SEPTA shall retain the exclusive right to require testing or to waive such testing after reviewing the Contractor's request.

C. All environmental testing in accordance with these Specifications shall require written test procedures prepared by the Contractor and approved by SEPTA. All environmental test procedures shall be submitted for SEPTA review and approval before the testing.

D. All environmental tests shall be completed, and the results submitted to SEPTA for approval prior to installation of equipment at any SEPTA site or sites outlined in this Section.

E. All environmental tests shall be conducted by an independent test facility that has been previously approved by SEPTA. The Contractor may use appropriate subcontracting to achieve environmental testing at the approved facility.

PART 2 - PRODUCTS

2.01 Manufacturers

A. Manufacturers:

1. Cameras:
    a. Panasonic.
    b. Or Approved Equal.
2. Media Converter:
    a. Antaira FCU-RACK16-DC with FCU-100SC (Communication Rooms), IMP-100A-M-T in NEMA Enclosure (at the camera), for Pan/Tilt/Zoom, ILNP-0501.
    b. Or Approved Equal.
3. Network Switch:
    a. N70 OTN Node, N7024CF (twenty-four (24) copper ports and twenty-four (24) fiber), Part No. N7024CF-SEPTA-01.
    b. Or Approved Equal.
4. Power Supplies:
    a. OTN ETS Switch for PoE.
    b. Or Approved Equal.
5. Copper Camera Cabling:
    a. Belden.
    b. Or Approved Equal.

6. Refer to the Contract Drawings material list.

B. Manufacturers submitted by the Contractor as equal shall meet the requirements for substitutions in Section 16050, and the following:

1. The equipment to be supplied will be considered only if it meets all Sections of the performance Specification. Any deviations of system performance outlined in this Section will only be considered when the following requirements have been met.

a. The supplier shall furnish evidence that the proposed or alternate system performance is equal or superior to the system operation stated in this Section.

b. The supplier shall submit a point by point statement of compliance for all Articles in this Section. The statement of compliance shall consist of a list of all paragraphs within these Articles. Where the proposed system complies fully with the paragraph as written, placing the word "comply" opposite the paragraph number shall indicate such. Where the proposed system does not comply with the paragraph as written, and the supplier feels the proposed system will accomplish the intent of the paragraph, a full description of the function as well as a full narrative description of how its proposal will meet its intent shall be provided. Any submission that does not include a point by point statement of compliance as described herein shall be disqualified. Where a full description is not provided, it shall be assumed that the proposed system does not comply.

c. The acceptability of any alternate proposed system shall be the sole decision of SEPTA.

2.02 System Description

A. The intent of these Specifications is to provide a new CCTV system with the following features and capabilities:

1. Provide color cameras monitoring selected interior and exterior areas of the TPSS as directed.

2. Provide hardware, software and all other required components to view and record locally as well as remotely at a location to be determined by SEPTA.

3. Provide all required components, accessories, hardware, cabling, terminations, etc. for a complete and operable system, in accordance with the intent of the Contract Drawings and these Specifications, whether enumerated herein or not.

4. The Contractor shall design, provide, configure and install all the cameras and any and all required software to allow proper communication/connection between the TPSS and SEPTA's head end video viewing and recording equipment.

2.03 Fixed Camera

A. Provide 4K cameras per the following:

1. The manufacturer of the specified color dome camera shall provide optional hardware to allow the camera to be mounted per the camera schedule located on the Contract Drawings. Coordinate ceiling types and mounting hardware required.

2. The lens coverage for each camera shall be no less than 180 degrees.

3. The basis of design for indoor and outdoor 4K color camera shall be the Panasonic WV-SFV781L or the PNV-9080R.

4. Provided tinted/smoked bubble.

2.04 IP Video Recorder PC

A. The Contractor shall design, provide, configure and install all the cameras and any and all required software to allow proper communication connection between the TPSS and SEPTA's head end video viewing and recording equipment.

2.05 Copper Cable

A. The Contractor shall utilize Cat 6E cable for camera feeds. When cameras are located indoors, orange plenum rated PVC jackets shall be utilized.

B. When cameras are located outdoors, black outdoor rated jackets apply. Outdoor cables may not run within building exceeding 50 feet.

C. Each camera shall receive two (2) CAT 6E cables, (1) active, (1) spare. Coil spare inside junction box by camera. Do not plug horizontal cable directly into camera. Provide UL listed disconnect in a watertight junction box. Utilize patch cord installed in Liquidtight Flexible Metal Conduit (LFMC) to connect to camera. LFMC shall not exceed 3 feet.

D. All outdoor cable must first land on lightning/surge protection.

2.06 Copper/Fiber Cable

A. The Contractor shall utilize Cat 6E cable for camera feeds. When maximum Cat 6E cable distances are exceeded, multi-mode fiber with PoE media converters shall be utilized.

B. The Contractor shall utilize AFL Copper/Fiber Composite Cable, two (2) 62.5/125 multi-mode GIGA-Link 300 fibers and two (2) No. 18 AWG copper for camera feeds when maximum Cat 6E distances are exceeded.

2.07 Cable, Wires and Miscellaneous Accessories

A. Provide all necessary parts and accessories, including but not limited to adapters, connectors, plugs, transformers, switches, relays, lamps, splitters, and power supplies required to guarantee a complete and fully functional CCTV system.

B. The CCTV installation shall require configuration of storage, firewalls and network equipment.

C. The Contractor shall rack mount all equipment in server grade cabinets. All cabling shall be secured using industry standards for cable management. Patch cords shall be a minimum of Cat 6E and have factory molded connectors. No crimp connections will be accepted.

PART 3 - EXECUTION

3.01 General

A. Examine areas to receive devices and notify SEPTA of adverse conditions affecting installation and/or subsequent operation prior to proceeding. Do not begin installation until unacceptable conditions are corrected.

B. Protect devices from damage during construction. Ensure operating temperature and humidity are within range accepted and recommended by the manufacturer.

3.02 Installation

A. The Contractor shall visit each fixed camera installation location identified on the Contract Drawings with SEPTA prior to ordering camera equipment for those locations and prior to performing any installation work, and shall perform the following with SEPTA witnessing and approving each planned installation:

1. Bring the one (1) spare camera of each type used on the Project.
2. Bring a suitable ladder or ladders, safety items, portable video monitor, portable power supply, and all other necessary cables, accessories, supplies and manpower.
3. Temporarily but steadily, position a camera equipped with the design proposed lens into the proposed installation location. The SEPTA representative shall view the image at ground level on the portable monitor.
4. The Contractor shall adjust the lens as necessary as directed by SEPTA such that SEPTA can determine if the view in that camera location will be acceptable.
5. The proposed camera location may need to be moved in any direction in order to obtain the desired view. The Contractor shall relocate the camera and adjust the lens to test the view in the new location.
6. If the design proposed lens does not provide the desired result, another spare camera with a different lens will be tested.
7. The Contractor will continue the test process with SEPTA until the optimal lens and location is determined for each camera installation location. Once a camera distance, height and lens are determined, it will likely be the same for many camera locations. When parameters such as the camera height, distance and width of field of view vary, additional testing will be required. Testing shall be conducted for as many locations as required by SEPTA.
8. A digital photo will be taken for each tested location and the lens and camera location information shall be documented.
9. The exact position for each camera location will be identified by careful measurements and will be documented along with a printed copy of the digital photo and all parameters and signed by both the Contractor's and SEPTA's representative. The Contractor and SEPTA shall each receive a copy of the approved installation plan documentation.
10. The Contractor shall configure the lens setting after the above testing has been conducted and approved by SEPTA.

B. Installation shall be performed by qualified service personnel.

C. All cabling shall be installed in rigid galvanized steel conduit.

3.03 Tests

A. Test snugness of mounting screws of all installed equipment. Test proper operation of all video system devices. Determine and report all problems to the manufacturer's customer service department.

B. Demonstrate that the video management system and devices function properly. Demonstrate camera's functionality and video recording capabilities.

C. SEPTA acceptance test will only be made after the above inspection, testing and adjusting of the complete CCTV system is performed, and the test report results are turned over to SEPTA for evaluation. SEPTA's test will be the same as the above Contractor's tests. The Contractor shall perform these tests in the presence of SEPTA or SEPTA's representative.

3.04 Field Adjustments

A. The Contractor shall repair or replace; at his expense; any defective devices, equipment or wiring and shall again perform any and all testing required to demonstrate that the system is in full compliance with the Contract Drawings and Specifications.

B. Make proper adjustments to video system devices for correct operation. Make any adjustment of camera settings to meet specific customer needs.

3.05 Training

A. The Contractor shall provide technical training and system administrator training. Technical training shall consist of one (1) session at each TPSS; each session shall be four (4) hours long and accommodate ten (10) students. The Contractor shall supply all training material and documentation in the form of system drawings, system configuration and setting, user documentation, manufacturer OEM manuals and all custom configurations done by the CCTV system contractor during installation. All training shall be onsite at a SEPTA designated facility. All system software and hardware configuration options shall be documented and provided to SEPTA in the form of CAD files, excel spread sheets, screen capture and Word documents. The Contractor shall provide all as-built single line diagrams, system interconnection and wiring details in the form of .PDF and CAD files. This documentation shall be included in all the OEM documentation.

B. Upon the completion of all work and of all tests, the Contractor shall furnish the necessary skilled labor for providing operating and maintenance instructions of all systems and equipment for a minimum period of eight (8) hours per Contract of documented formalized instruction for SEPTA, detailing the proper operation and maintenance of the installed system.

C. The instruction shall be presented in an organized and professional manner by a person factory trained in the operation and maintenance of the equipment and who is also thoroughly familiar with the installation.

3.06 Environmental Test Procedures

A. The environmental requirements described herein shall be in effect for all components unless specifically excluded by other specification sheets of this procurement document.

B. All test procedures related to environmental testing for temperature, rain, humidity, salt, fog, dust, vibration and shock which are prepared by the Contractor for SEPTA approval shall be formulated in accordance with the requirements of MIL-STD-810(e). Testing for ESD shall be formulated in accordance with IEC 61000-4. No exceptions shall be made to this requirement without prior written approval by SEPTA.

END OF SECTION

SECTION 16910

ELECTRICAL SYSTEMS CONTROL SCADA, REMOTE TERMINAL UNIT – INCLUDING HMI

PART 1 - GENERAL

1.01 Description

A. The Traction Power Substations (TPSSs) included in this Contract are normally monitored and controlled remotely from the SEPTA Power Department Control Center located at 1234 Market Street. The existing master station of the supervisory system is located at the SEPTA Power Department Control Center. Existing Remote Terminal Units (RTUs) at all four (4) TPSSs are supplied by QEI. The RTUs are connected to the SEPTA Power Department Control Center existing master station via combination of fiber optic and copper cables.

B. The Contractor shall design a complete end-to-end supervisory remote control system for control and supervision of each of the TPSSs. The system shall include sensors, transducers, coordination of contacts for status and alarms of all equipment and security system, RTU, and cabling from the communication cabinet. The system shall be compatible with the new equipment supplied by SEPTA or designed and procured by the Contractor and the SEPTA Power Department Control Center existing master station.

C. The design will include development of final Supervisory Control and Data Acquisition (SCADA) point assignment list to include all control, status, analog, alarm, and self-diagnostic points based on the equipment selected. Include points for the building security and fire alarm systems. Identify the status points which require dry contacts.

D. The Contractor is also responsible for the design, execution and testing of the modifications required at the SEPTA Power Department Control Center existing master control stations located at 1234 Market Street. The Contractor shall utilize services of a firm experienced and licensed to work with the existing equipment and software installed at the SEPTA Power Department Control Center existing master control stations. The Contractor shall obtain SEPTA approval of the firm before commencement of the work. The Contractor or its subcontractor shall submit necessary information in the form of database, drawings, screen shots and charts for updating the SEPTA Power Department Control Center existing master control stations for SEPTA review and approval. Coordinate the work with the SEPTA Project Manager and SEPTA Operating Department. The Contractor to replace existing servers A, B, and C located at 1234 Market Street prior to any new RTU installation for this Contract.

E. The system shall be tested for end-to-end operation from each TPSS to the SEPTA Power Department Control Center existing master control stations for each function and point. The Contractor is responsible for performing the end-to-end operational testing. SEPTA will not provide support for this testing phase. The Contractor will need to coordinate with SEPTA on days and times for when this work can be done. SEPTA may direct the Contractor to perform this work during overnight hours 1:30am - 4:30am Monday thru Friday to ensure that interruptions to the system do not adversely affect daily transit operations.

F. The RTU shall be a free standing cabinet. I/Os that are for the status, operation, and control of the TPSS in its entirety shall be landed in the RTU cabinet. An alternate secondary cabinet may be proposed if necessary, for SEPTA approval. Other I/Os comprise status indication of battery charger alarms, hydrogen detection system, and fire and intrusion detection

systems points shall be connected directly to the RTU and their point status annunciated to the SEPTA Power Department Control Center existing master control stations.

G. Make the necessary connections to the new RTU and to the new equipment in step with the construction staging to maintain the status and remote indication and controls for all devices and functions.

H. Furnish and install control and indication cable(s) from each piece of TPSS equipment that requires I/O to the SCADA/RTU cabinet.

I. Integrate the RTU to function with the relay communications network. The status of the relay communication network shall be accessible via a panel mounted Human Machine Interface (HMI), which shall be used for TPSS relay status viewing, troubleshooting and complete control of all TPSS equipment within the TPSS.

J. HMI shall be installed on to the SCADA/RTU network and shall mimic operations and annunciation of the SEPTA Power Department Control Center existing master SCADA workstations.

K. HMI shall be a touchscreen type with a minimum of 2TB of local file storage space above the necessary storage space for all required resident programs to run the HMI for everyday use in the TPSS environment and a minimum of two (2) USB ports.

L. Each HMI shall have software resident that will allow the viewing of PDF, MsWord and MsExcel files including all required Licensing for unlimited use.

M. Route all hardwire control, alarm, status, and telemetry functions from the traction power equipment to the SCADA/RTU. Coordinate the routing method with the traction power equipment manufacturers. Protective relay functions to trip the traction power equipment shall remain independent of the RTU and SCADA.

N. The new RTU shall be installed and commissioned while the existing RTU continues to remain in service. New traction power equipment will be connected to the new RTU. Existing traction power equipment will continue to be monitored and/or controlled via the existing RTU. Once RTU commissioning is complete, the existing RTU shall then be removed.

O. The required controls and indications for supervisory control are listed in the SCADA points list, which is provided in the Contract Drawings. Please note that these points listed are not all inclusive of the total SCADA points that will be required for this Contract. The Contractor shall work with the SEPTA Project Manager and SEPTA substation maintenance personnel to develop the all-inclusive final points list for this Contract in a format to be approved by SEPTA. This effort will be completed very early in the Contract.

P. Provide and test end-to-end control, supervisory and data acquisition functions from all new field equipment to the new RTU.

1.02 Related Sections

A. All the requirements as described in Division 1.

B. Section 16010 – Basic Electrical Requirements

C. Section 16050 – Basic Electrical Materials and Methods

D. Section 16060 – Grounding and Bonding

E. Section 16075 – Electrical Identification

F. Section 16120 – Conductors and Cables

G. Section 16240 – Battery Equipment

H. Section 16344 – DC Traction Power Switchgear Assemblies

I. Section 16953 – Electrical Testing – Traction Power Equipment (CTD)

1.03 Submittals

A. Submit shop drawings including product description, catalog data, wiring details, interconnection diagrams, microprocessor details, instructions manual, operating and maintenance manuals, details of interface with existing systems, software documentation, test programs for detailed testing, and database preparation and completion.

B. Submit step-by-step installation instructions.

C. Submit recommended list of test equipment and spare parts.

D. Submit database, drawings and any/all other information required for updating the SEPTA Power Department Control Center existing master control stations.

E. Submit operation and maintenance manual.

F. Submit test plans and procedures for the field, and end-to-end tests.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. American National Standards Institute (ANSI).
2. IEEE C37.90, IEEE Standard for Relays and Relay Systems Associated with Electric Power Apparatus.
3. IEEE C37.90.1, IEEE Standard for Surge Withstand Capability (SWC) Tests for Relays And Relay Systems Associated With Electric Power Apparatus.
4. IEEE C37.90.2, IEEE Standard for Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
5. IEEE C37.90.3, IEEE Standard Electrostatic Discharge Tests for Protective Relays.
6. National Electrical Manufacturers Association (NEMA).
7. NFPA 70, National Electrical Code (NEC).

B. The installation shall be performed by workmen with established skills in the type of work covered by this Section.

1.05 Inspection

A. Inspection of the material/equipment will be made via factory acceptance tests, at the point of delivery and via field tests.

1.06 Warranty

A. Provide standard warranty against defective materials and workmanship for two (2) years from the date of TPSS acceptance by SEPTA.

1.07 Maintenance Service and Extra Material

A. Spare Parts:

1. To ensure inclusion with Contract orders, submit for approval, a recommended list of spare parts.
2. Furnish, prior to the system being placed in service, two (2) each of the active printed circuit boards that are utilized on this Contract, as required by SEPTA (latest board revisions should be provided).
3. The intent of this clause is that a complete set of spare material is furnished to ensure the continued operation of the system, considering the long delays which may be inherent in future replacement and predicted usage rates.
4. Specifically highlight any equipment which has unduly long delivery time exceeding twelve (12) weeks and/or where there is likelihood that spares may become unavailable within the next ten (10) years.

PART 2 - PRODUCTS

2.01 Basic Architecture

A. All functions of SCADA and RTU pertaining to the circuit breakers, rectifier transformers, auxiliary transformers and rectifiers shall be routed to the equipment from the RTU cabinet.

B. Functions as stated below shall be routed directly from the equipment to the RTU.

1. Battery and battery charger alarms and indications.
2. Intrusion and smoke alarms.
3. Satellite clock (time shall be displayed on the HMI).
4. Status indication of manually operated DC disconnect switches.

C. All status and alarms shall be annunciated on the HMI annunciator. This HMI annunciator shall be provided and installed in the RTU door. Coordinate with SEPTA during detailed design.

D. “Close” commands from RTU shall be executable only if the master local/remote selector is in “Remote” mode. “Trip” or “Open” commands from the RTU shall be executable in both modes of the master local/remote selector.

E. “Close” commands from the HMI and the physical control switches located at the traction power equipment shall be executable only if the master local/remote switch is in “Local” mode. “Trip” or “Open” commands from the HMI shall be executable in both modes of the master local/remote selector.

F. Protective relays commands to trip the traction power equipment shall be independent of the HMI, RTU and/or SCADA.

G. Failure of communication with the SEPTA Power Department Control Center existing master control stations, RTU or relay communication network shall not prevent the following functions:

1. Local operation of the TPSS via control switches located on the traction power equipment.
2. Operation of protective relays to trip the circuit breakers.

2.02 Materials and Equipment

A. Provide all the necessary relays, indication contacts, interface cables and transducers, in the various power equipment enclosures, and in the TPSS, for connection to the supervisory system, as described herein.

1. Supervisory "indication" power shall be 130 V DC positive from the supervisory RTU cabinet through normally open or normally closed contacts in the equipment, then back to the supervisory device point.
2. Control power to operate circuit breakers shall be 130 V DC from the device being operated to the supervisory interposing relay then back to the device point.
3. Supervisory interposing relays for control of circuit breakers shall be rated 130 V DC, 20 A continuous with closing pulse duration of five hundred (500) milliseconds. If the equipment current requirements are greater than 20 A or if the pulse required is longer than five hundred (500) milliseconds, provide interposing relays in the equipment to accomplish the desired close or trip operation.
4. Analog inputs for AC and DC voltage and current shall be 0-1 mA from transducers. The Contractor shall verify the compatibility of the transducers with the SEPTA Power Department Control Center existing master control stations during detail design and shall design, provide, and install any/all required equipment to ensure these signals are made compatible with the SCAD/RTU.
    a. Transducers Manufacturers:
        1) AC Voltage and Current Transducers:
            a) Ametek Power Instruments Electronic Models.
            b) Or Approved Equal.
        2) DC Voltage Transducers:
            a) Ametek Power Instruments.
            b) Or Approved Equal.
5. Name plates shall be 1 inch by 3 inch laminated black plastic and shall be engraved with 1/2 inch white lettering “Remote Terminal Unit”. Name plate shall be mounted on surface of the RTU.

B. Provide 20 percent spare wires in each cable with a minimum of two (2) spares per cable.

C. Control cables shall be as specified in Section 16120.

D. Wire terminals shall be insulated, compression type, ring tongue lugs such as manufactured by the following:

1. T & B.

2. Sta-Kon.
3. Or Approved Equal.

2.03 SCADA Points Table

A. The sample control, supervisory and data acquisition points, with minimum requirements, are shown on the Contract Drawings. The Contractor shall develop the points table in the SEPTA approved format to include all the points for the equipment. This effort shall be completed within thirty (30) days of the NTP of the Contract in order to order the RTU in a timely manner.

2.04 Supervisory RTU

A. Supervisory RTU shall be of a micro-processor based design. The RTU shall contain all necessary subsystem equipment to provide a complete operating system. Subsystems shall include, but not be limited to, the following:

1. Power supply unit to convert 130 V DC to the voltage required by RTU.
2. Communications subsystem.
3. Micro-processor subsystem.
4. Status input subsystem.
5. Control output subsystem.
6. Interposing relay subsystem.
7. Digital to analog subsystem for four (4) wire analog data transmission.
8. Multiport data modems to be manufactured by the following:
   a. Universal Data Systems.
   b. Or Approved Equal.
9. Ihrig B clock with a one (1) millisecond time stamp, or synchronized time system to ensure identical time with the SEPTA Power Department Control Center existing master control stations and other TPSSs. Coordinate with SEPTA during detail design.
10. This style RTU requires external voltage and current transducers.

B. All input and output terminals shall be capable of meeting and withstanding the requirements of the IEEE C37.90.

C. The RTU shall be totally enclosed in a NEMA 4, twist handle, three (3) point latch, gasketed, natural vented, free standing enclosure, UL listed and pad lockable (3/8 inch shank minimum). The enclosure shall be front accessible only, allowing placement of enclosure against a wall. Color shall be ANSI 61 gray.

D. A touch screen HMI shall be provided on the RTU door for all control and annunciation functions.

E. Communications between the RTU and the SEPTA Power Department Control Center existing master control station equipment shall be over SEPTA's existing fiber optics communication system. The RTU shall also be capable of communicating over Ethernet LAN using IP transport protocol. Termination options for Ethernet connections shall include

10/100 BaseT as well as single mode and multi-mode fiber optics. Communication at Castor TPSS is via a cellular modem.

F. A micro-processor with programmable read only memories shall be provided in each RTU for future changes in the TPSS.

1. Operating software shall be proven to be resistant to malware. Provide data of past five (5) years to demonstrate that the selected software is not prone to malware attacks.
2. All programs shall be stored in programmable read only memory that is not electrically erasable.
3. Program reloading shall not be required due to power surges, dips or outages.
4. Random access memory may be used to store temporary raw data prior to transmission.

G. Optical isolators shall be provided on all status or alarm inputs. A digital filter shall be employed on all inputs to eliminate contact bounce. All optical isolator components shall be installed in optoisolator sockets.

H. All status, alarm, potential, etc., indications from the TPSS equipment to the RTU shall be digital type from electrically isolated normally open or normally closed contacts. All status contacts will be energized with 130 V DC.

I. Interposing relays for control of TPSS equipment shall have two (2) form-C, heavy duty contacts. Contacts shall be rated for a 20 A (resistive) load at 130 V DC and have adjustable close time up to five hundred (500) milliseconds. All control and status circuit boards shall include Light Emitting Diode (LED) indications on every point. The circuit boards shall be installed via board sockets. Interposing relays to be manufactured by the following:

1. Potter & Brumfield (P&B) catalog number PRD11DJ0-24V.
2. Or Approved Equal.

J. Make all connections from external equipment that are connected to the RTU, shall be made to terminal blocks provided in the SCADA Interface Cabinet (SIC).

K. All connections from the RTU to external equipment shall be made to terminal blocks provided in the SIC.

L. All connections from I/O relays on circuit boards shall be made to terminal blocks in the SIC. Direct connections to circuit board relay I/O are not permitted.

M. The RTU shall contain a DC/DC converter which obtains power from the TPSS 130 V DC battery. The DC/DC converter to be manufactured by the following:

1. Lambda Power Supply.
2. Or Approved Equal.

N. Provide a sealed 12 V DC maintenance free battery back-up to sustain remote operation for minimum of one (1) hour.

O. Design the RTU with as small of a footprint as possible due to space limitations. Limit the footprint to 60 inches wide, 24 inches deep as far as possible. Larger footprints up to 72 inches wide by 24 inches deep will be considered if space permits.

P. The RTU shall have a proven service record and shall be based upon the 6CPP6 Central Processor Panel architecture and shall operate from and be thoroughly and fully compatible with an existing TPSS master supervisory system, TDMS-Plus, manufactured by QEI, Inc., Springfield, New Jersey. The unit shall be programmed to respond to the QEI QUICS IV system communication protocol. No modification to the QEI, TDMS-Plus Alpha SEPTA Power Department Control Center existing master control station servers will be accepted. Licensing agreement fee for QEI, QUICS IV protocol must be included in the bid. In addition, the proposed RTU shall support multiple protocols and be capable of DNP3 communications with Intelligent Electronic Devices (IEDs) over RS232 serial port, RS485 or Ethernet link. The number of serial communications ports shall be expandable up to no less than eight (8) usable ports. One (1) serial port shall also be provided for RTU configuration and testing purposes. RTU configuration shall be accomplished via software. The configuration software shall provide a simple, logical, user-friendly graphical interface. The unit shall be sized for the required status points, control points and analog points as per the Contract Drawings. Provide all equipment required for full interface of the RTU with the SEPTA Power Department Control Center existing master control stations at no additional cost to SEPTA. The RTU to be manufactured by the following:

1. QUICS Model 4150.
2. ePAQ-9100 Gateway.
3. Or Approved Equal.

Q. Communications between the SCADA network server and the RTU shall be accomplished using single mode fiber optic cable which shall be connected to Port No. 2 of the RTU. The Contractor shall propose suitable cable.

R. Each RTU shall have an adequate number of analog boards compatible with the transducers on the equipment including 0-1mA.

S. Provide 20 percent spare control and indication points, completely wired to terminal blocks in the RTU.

T. Amperage reading displayed on the SEPTA Power Department Control Center existing master control station screens shall have a minimum of 10 A resolution values unless SEPTA directs otherwise.

U. Resolution of the voltage readings displayed on the SEPTA Power Department Control Center existing master control stations shall be determined and approved by SEPTA.

V. In addition to any control system indications mentioned earlier in this Section or listed in the final approved points list; the SCADA/RTU system shall transmit all points and indication values to the SEPTA Power Department Control Center existing master control stations in a SEPTA approved format.

2.05 SEPTA Power Department Control Center Existing Master Control Stations

A. SEPTA shall design the modifications required at the SEPTA Power Department Control Center existing master control stations. Note that the existing RTU will continue to be in service during first stage of construction.

PART 3 - EXECUTION

3.01 Preparation

A. Thoroughly review the Contract Drawings and Specifications in preparation for installation of the materials and equipment. Materials shall be procured, stored and planned for use which minimizes waste, and substitutions, and maximizes installation efficiency and quality of end product.

B. Examine all Contract and Reference Drawings to verify and properly coordinate the work; check all relevant drawings including civil; mechanical drawings and shop drawings.

C. Prepare all databases required for the SCADA system.

3.02 Shipment

A. Ship the RTU and other components only after successful completion of the factory tests and approval of the factory test report by SEPTA.

B. Ship the RTU and other delicate components by special air-ride equipped trucks if required by the supplier.

3.03 Installation

A. Following all repairs to the TPSS building, install the new RTU at the location indicated on the Contract Drawings. Maintain all other existing control equipment in the building in revenue service. Exercise caution to ensure that the existing equipment is not damaged. Note that the existing RTU will continue to be in service simultaneously with the new RTU for a period of time.

B. Install control cable in cable tray or conduit.

C. Install fiber optic cable in cable tray or conduit.

D. SCADA Interface Cabinet and RTU:

1. Connect all wires from the TPSS equipment terminal blocks to the supervisory RTU terminal blocks.
2. Provide tape pothead where cable jacket is removed on both ends of each cable. Bundle and tie neatly all wiring inside equipment.
3. Neatly bundle spare wires inside equipment.
4. Identify each cable by device name and number and destination.
5. Identify each wire including spares with wire markers.

E. Install 130 V DC power circuits to the RTU cabinet.

F. Install a 120 V AC receptacle in the RTU cabinet, and supply power to the receptacle from the AC distribution panel.

G. Connect the new RTU to the communication cable in coordination with SEPTA staff.

H. Provide, install and configure/program a central GPS clock to connect to the RTU and/or the relay communications system ring to distribute the clock signal to all connected equipment (i.e., RTU, relays, etc.).

3.04 Testing and Acceptance

A. Perform and successfully pass factory tests and field commissioning tests prior to the equipment being accepted by SEPTA.

B. Factory Tests:

1. Refer to Section 16953. Submit factory test procedure to SEPTA for review and approval at least twenty-one (21) days in advance. SEPTA has the right to request any revision to the testing plan to ensure that the equipment performs as expected.

2. Furnish SEPTA with certified copies of the results of all tests and measurements made to determine the quality and serviceability of the equipment manufactured in accordance with this Section. Such results shall show compliance with all the requirements of this Section. SEPTA approval at actual acceptance test shall be contingent upon prior receipt and approval of these certified tests. During the actual acceptance test, minimum of 10 percent of all points shall be tested. If problems arise, SEPTA may specify that more or all points within the questionable RTU be re-tested.

3. The factory acceptance test will be witnessed by a minimum of one (1) representative of SEPTA.

C. Field Tests:

1. Perform the field testing according to the SEPTA approved SCADA system test plan.

2. Test all points from all locations not limited to HMI, remote SCADA workstations or via local connected commissioning computer, for both proper indication of status and control.

3. Perform the specified field tests including end-to-end tests from the SEPTA Power Department Control Center on all functions and points to the satisfaction of SEPTA. Tests shall be performed in two (2) or more stages per construction staging and schedule.

4. Submit the test results to SEPTA.

5. Upon successful completion of tests, place the RTU in revenue service.

END OF SECTION

SECTION 16920

STRAY CURRENT MONITORING

PART 1 - GENERAL

1.01 Description

A. Provide professional services to set up stray current surveys, analyze data and prepare and submit reports for each Traction Power Substation (TPSS) being rehabilitated as part of the Contract.

1. In close coordination with SEPTA forces, work with SEPTA in the field at the TPSS and along the DC distribution system, either overhead or third rail and running rail types.
2. Make and submit written recommendations about products installed under Article 1.02 in this Section and carry out the recommendations once approved by SEPTA.

B. The objective of stray current monitoring is for the Contractor to quantify any correlation between SEPTA DC powered transit operations and stray currents at and around each TPSS before and after being rehabilitated. If the newly rehabilitated TPSS exhibits increased levels of stray current associated with DC traction power delivery, notify the SEPTA Project Manager.

1.02 Related Sections

A. Section 01810 – Commissioning of Systems

B. Section 16348 – Negative and Drainage Switchboard

1.03 Submittals

A. Submit the following for approval:

1. Written site specific work plans for each stray current survey.
2. Field report for each stray current survey that documents the methods and equipment used, personnel present and analytical results.
3. Recommendations report.
4. Report on implementation of stray current control products with analyses of results.
5. Credentials of key personnel for the analysis and the field team leader.

1.04 Quality Assurance

A. Utilize National Association of Corrosion Engineers International (NACE) certified personnel for certifying studies, recommendations, and implementation of recommendations reports.

1.05 System Requirements

A. Provide stray current monitoring services that cover an area around each TPSS that covers the land within 20 yards in each direction along the perimeter of each TPSS and along the path of the DC distribution to both sides of the transit right-of-way.

1.06 Reports

A. Deliver each report on electronic media and in hard copy (paper) format, complete with cover letter and submittal documentation.

1.07 Coordination

A. Provide services that include notification of SEPTA and consider transit operations in a manner to prevent transit disruptions.

B. Coordinate the work with the other Contractor efforts and trades involved in the rehabilitation of each TPSS in the Contract.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Preparation

A. A site specific work plan (SSWP) compliant with SEPTA general requirements is required before each site visit.

3.02 Testing

A. For each TPSS in the Contract provide one (1) stray current monitoring test over a full twenty-four (24) hour period on a weekday:

1. Before each TPSS is rehabilitated, and
2. Upon energization of DC traction power products installed as part of the rehabilitation, under normal train operations.

B. Only those tests identified in a SSWP may be performed at the time of a field visit or test.

C. The SEPTA approved Contractor field team leader is required to be present at each field visit or test.

D. The Contractor shall return the site to its original or better condition after each field test, making sure no equipment used in the test is left behind as litter or that would present a hazard.

3.03 Documentation

A. Submit reports on the stray current monitoring tests within two (2) weeks of the completion of the field activities of that test.

END OF SECTION

SECTION 16950

TESTING

PART 1 - GENERAL

1.01 Description

A. This Section specifies the requirements for factory and field testing on electrical equipment furnished and installed under this Contract.

B. The following equipment and/or material shall be tested in accordance with the requirements of this Section:

1. Supervisory Control and Data Acquisition (SCADA) system.
2. Medium voltage cables.
3. Composite copper/fiber optic cable.
4. Battery, battery charger and DC distribution system.
5. Dropping resistors.
6. Auxiliary power transformers.
7. Automatic transfer switches as integrated with the indoor switchboards.
8. Panelboards.
9. Fuse cutouts.
10. Receptacles.
11. Motor starters.
12. Enclosed switches.
13. Lighting system.
14. Fire alarm.
15. Intrusion detection and alarm.
16. Thermo-graphic testing of the auxiliary power equipment.

1.02 Related Sections

A. Section 01300 – Submittals

B. Section 01810 – Commissioning of Systems

C. Section 13850 – Fire Alarm and Detection System

1.03 Submittals

A. Submit a detailed testing program for the equipment in accordance with the test procedures described in Section 01300 and the referenced industry standards organizations.

B. Submit a factory test plan and a field test plan to SEPTA sixty (60) days prior to performing the tests. Describe the overall test process, including the responsibilities of individuals and documentation of the test results. Demonstrate that a complete, safe and operable power system has been provided and that as a minimum the following data has been submitted:

1. A flow diagram indicating the logical sequence of tests starting with material receiving tests and inspections and concluding with system demonstration tests.
2. Test schedules.
3. Record keeping assignments, procedures and forms.
4. Procedures for monitoring, correcting and re-testing variances.
5. Procedures for controlling and documenting all changes made to the hardware after the start of testing.
6. Block diagrams for the hardware test configuration including external data transmission interfaces, and detailed descriptions of any and all test and/or simulation equipment.
7. Estimated duration of each test.
8. Software version numbers, CRC check sums, date and time for every module.
9. Calibration and the traceability to known standards of hardware, software, simulation tools and test equipment to be used for testing.

C. Submit test procedures and reports, for tests specified, to meet the requirements herein.

1. Detailed test procedures will not be required if such procedures are adequately described in ANSI, IEEE or NEMA Standards, or standards reviewed by SEPTA, and copies of the standards are submitted with the related test. Include the following in all detailed test procedures; minimum requirement:
   a. Test purpose.
   b. Applicable standards or code including specific paragraph or section reference.
   c. Equipment to be tested.
   d. Test set up.
   e. Chronological step-by-step test sequence.
   f. Pass/fail acceptance criteria.
   g. Test data form for recording and documenting test information.
   h. Pass/fail test conclusions.
   i. Signature of personnel.
   j. Date of testing.
   k. Test duration and schedule.
2. No testing shall commence until SEPTA's Project Manager or designated representative reviews and approves the test procedures.
3. No testing shall commence until all control equipment, keypads, alarms, detectors and switches have been checked as an integrated system in accordance with the manufacturer's recommendations.

D. Submit two (2) copies of the test report to SEPTA's Project Manager for review and comments. After acceptance, six (6) final copies of the certified test report shall be submitted to SEPTA's Project Manager.

1.04 Quality Assurance

A. Meet the applicable provisions of the most recent issues of the following references:

1. Association of Edison Illuminating Companies (AEIC).
2. ANSI C37.54, American National Standard for Indoor AC High-Voltage Circuit Breakers Applied as Removable Elements in Metal-Enclosed Switchgear - Conformance Test Procedures.
3. ANSI C37.55, American National Standard for Switchgear - Medium-Voltage Metal-Clad Assemblies - Conformance Test Procedures.
4. ICEA S-93-639/NEMA WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. IEEE 450, IEEE Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
6. IEEE C37.09, IEEE Standard Test Procedure for AC High-Voltage Circuit Breakers Rated on a Symmetrical Current Basis.
7. IEEE C37.20.2, IEEE Standard for Metal-Clad Switchgear.
8. ISO 9001, Quality Management Systems - Requirements.
9. NEMA PE 5, Utility-Type Battery Chargers.
10. National Fire Protection Association (NFPA).

B. Perform the testing described herein, according to the referenced standards and this Section.

C. Factory Testing Witness Program:

1. In case of a design or manufacturing failure during factory testing, design tests need to be performed on all similarly designed equipment that are included in this Contract. Perform such tests on replacement equipment until, and unless, a satisfactory resolution of the problem is accepted by SEPTA. In the event of such a failure, assume all costs of replacement and retesting, including the cost for SEPTA's representatives to witness the testing.
2. In the event that equipment provided for this Contract fails during field commissioning, assume complete costs for shipping the equipment to the manufacturer, replacement equipment, complete factory testing, SEPTA witness of factory testing, return shipment to the Project site, installation and commissioning.
3. In the event that equipment provided for this Contract fails during warranty, after Project acceptance; all warranties begin with final acceptance; SEPTA will follow standard warranty procedures.

D. Field Testing:

1. Provide the services of a certified National Electrical Testing Agency independent testing company to perform the field testing work covered in this Section.

1.05 Deliverables

A. Six (6) hard copies and one (1) CD-ROM of the certified test reports for all field tests in Adobe Acrobat (PDF) format.

PART 2 - PRODUCTS

2.01 Not Used

PART 3 - EXECUTION

3.01 Factory Testing

A. General Requirements:

1. The purpose of the factory test is to demonstrate that each of the systems meet or exceed the functionality and performance requirements specified in the Specifications.
   a. Perform all factory tests according to the applicable standard whether such tests are specified herein or not.
   b. Provide the services of an independent testing laboratory to perform design tests of the equipment manufactured for Specification compliance. Submit copies of certified results from prior design testing for all items of equipment that are being furnished without any modification from the item of equipment originally tested. Design tests are required if certified test results from prior article testing are not available.
   c. In addition to the specific design tests, the testing shall include items such as:
      1) Verification of all mechanical Specifications.
      2) Verification of all operating, control and indicating functions.
      3) Electromagnetic compatibility, temperature, humidity, shock and vibration testing.
   d. The test data for each unit shall be certified by the testing laboratory. The equipment shall be fully operational during electromagnetic compatibility, temperature, humidity, shock and vibration testing.
   e. Submit the certified test data reports to SEPTA's Project Manager for approval. Do not withhold any certified test data from SEPTA's Project Manager even though the certified test data may indicate that a unit of equipment has failed the test. If any single unit of equipment fails to meet the Specifications, or fails to provide the correct control or indication functions, then the unit of equipment will be inspected by SEPTA's Project Manager, who shall determine whether the equipment shall be repaired, redesigned or shall be replaced and completely retested. In order to pass the test, the test report must indicate that each unit of equipment meets or exceeds the functionality and performance requirements of the tested equipment.
2. Require that, at designated stages of the production process, the materials, components, assembly, subsystems and systems under test meet the Contract Drawings and Specifications. The proof of verification shall be submitted to SEPTA's Project Manager.

3. SEPTA's Project Manager reserves the right to witness all factory testing. Within forty-five (45) days prior to the start of all factory testing, notify SEPTA's Project Manager in writing. A detailed bar chart schedule of the tests and inspections and sample test reports shall be included. Equipment or material that fails factory testing or malfunctions during the testing shall be replaced with new equipment and retested until the requirements are met. The equipment or material will not be accepted until the test reports are submitted to SEPTA's Project Manager for approval.

3.02 Thermo-Graphic Testing of Auxiliary Power Equipment

A. Perform thermo-graphic testing and record circuit parameters for the following auxiliary power equipment:

1. All electrical equipment cable terminations whose conductor size is No. 4 AWG or larger.
2. Panelboards.
3. Vacuum switches.
4. Transformers.
5. Transfer switches, motor starters and contactors.

3.03 Factory Tests of Equipment and Materials

A. SCADA Remote Terminal Unit (RTU):

1. Factory Tests:
   a. Perform SCADA RTU mainframe operational and functional tests that exercise all I/O and their associated control, supervisory and indications.
2. Field Tests:
   a. After the installation of the system has been completed, conduct a test of the system similar to the witnessed factory acceptance test to verify that the system has been properly installed and is properly operating.
   b. Assume responsibility for the SCADA system and the communications system performing as an integrated system. Assume responsibility for any and all equipment and cabling failures that prevent full SCADA operation.
   c. Submit copies of test reports to SEPTA within five (5) days after completion of testing in accordance with Section 01300.
3. Test Equipment:
   a. Provide all necessary test equipment and instruments to perform the required tests.
4. Site Tests:
   a. SEPTA and the manufacturer's Field Engineer will test the supervisory system from the Power Dispatcher's location of the SEPTA Power Department Control Center, 1234 Market Street, Philadelphia, Pennsylvania, for correct operation. Supervisory master unit and telephone line failures will be SEPTA's responsibility. Assume responsibility to require all other failures and deficiencies be corrected under this Contract, by the SCADA RTU manufacturer's Field Engineer.

B. Cables and Conductors:

1. Medium Voltage Power Cables:
    a. Factory tests to meet ICEA S-93-639/NEMA WC 74:
        1) Unaged and accelerated aging tests.
        2) Conductor DC resistance.
        3) Conductor diameter measurement.
        4) Tensile, elongation and set.
        5) Cold bend.
        6) Electrical accelerated water absorption.
        7) AC voltage withstand.
        8) Partial Discharge Test:
            a) Each reel of shielded power cable shall meet the partial discharge test requirements of AEIC.
        9) Insulation resistance.
        10) Dielectric constant and dissipation factor.
        11) Sunlight resistance test.
        12) Cable tray flame test.
        13) Spark test.
        14) Insulation corona discharge.
        15) Resistance for Class IV EPR.
    b. Field Tests:
        1) Megger test.
        2) Hi-Pot test using DC voltage level as recommended by the manufacturer.

C. Composite Copper/Fiber Optic Cable:

1. Procure and provide all necessary test equipment, test cables, adapters, load boxes, light sources and any other hardware required to perform cable testing.
2. Before beginning testing, submit a list of all test equipment to be used to SEPTA for their approval.
3. Schedule all testing with SEPTA's Project Manager in advance of testing. Additionally, SEPTA reserves the right to witness testing of all installed cabling.
4. Submit each test report to SEPTA for approval. Approval is based upon the expected results for the cable being tested and upon the corrective actions taken by the Contractor when specific tests fail.
5. Each optical fiber shall be tested from end-to-end at each patch panel to determine end-to-end attenuation, including connector and splice loss.
6. Each element of all new single mode fiber optic cabling shall be tested for continuity and attenuation in both directions at both 1310nm and 1500nm, with a fiber optic light source and power meter. Before beginning testing, the Contractor shall submit a design fiber optic loss budget for the segment to be tested, based upon the length of fiber optic cable installed. When tested at both windows in both directions, the measured attenuation of each fiber optic cable segment shall be less than or equal to the design attenuation of the segment being tested. Until this condition has been met, the installation shall not be considered complete and will not be accepted.

7. Each and every multi-pair copper conductor shall be tested for shorts, opens, continuity and grounds. These test results for the cable shall be furnished to SEPTA's Project Manager.
8. Corrective Action:
    a. If a cable test fails for any reason, the Contractor shall determine the cause of the failure. If a defective cable, outlet insert, wiring block and/or patch panel is found to be the cause of failure, replace the material in the question and assume responsibility for all costs associated with its replacement.
    b. Perform the tests at both 1310nm and 1550nm wavelength. If any fiber testing reveals an abnormal test result, outside of the manufacturer's normal parameters, then conduct a test of all fiber strands in the affected sheath with an Optical Time Domain Reflectometer (OTDR) to identify the source and location of the problem.

D. Battery:

1. Perform the following field test in the Traction Power Substation (TPSS) during the commissioning of the battery system:
    a. Constant current capacity discharge test in accordance with IEEE 450. The test shall verify the capacity discharge rate of the battery system for eight (8) hours. Provide computer plots and tabular data of the cell voltage taken before and after installation of the "Cell Voltage Equalizers", to SEPTA's Project Manager.
    b. Upon completion of the testing, the float voltage, equalizing voltage, specific gravity and temperature basis shall be set and maintained in accordance with the manufacturer's recommendations.

E. Battery Chargers:

1. Factory Tests:
    a. The following factory tests shall be performed on one (1) battery charger per NEMA PE5 as follows:
        1) Dielectric.
        2) Voltage adjustment.
        3) Temperature rise.
        4) Current limit.
        5) Short circuit.
        6) Static voltage deviation.
        7) Efficiency measurement.
        8) Power factor measurement.
        9) Ripple voltage measurement.
        10) Audible noise.
        11) Stability and response.
        12) Transient voltage withstand.
        13) No load.
    b. Additional factory tests shall be performed on all battery chargers per NEMA PE5 as follows:
        1) Dielectric.
        2) Full load tests with a 270 ampere-hour, sixty (60) cell.

3) Lead acid battery, running in parallel with, and without a battery, with momentary overload. The full load test shall show output ripple voltage lies within 0.06 percent of normal output voltage.
4) Voltage.
5) Current limit.
6) Ripple voltage measurement.
7) Charging capability within twelve (12) hours of a battery already discharged to 105 V DC from its nominal 130 V DC value.
8) Float voltage tests.
9) Detection of positive and negative grounds circuit and system, overload protection and "low battery voltage" status indications.
10) Temperature compensation.
11) Automatic "Equalizing Charge" capability.

F. Dropping Resistors:

1. Factory Tests:
   a. The following factory tests shall be performed on one (1) dropping resistor as follows:
      1) Dielectric.
      2) Voltage adjustment.
      3) Temperature rise.
      4) Current limit.
      5) Short circuit.
      6) Static voltage deviation.
      7) Efficiency measurement.
      8) Ripple voltage measurement.
      9) Audible noise.
      10) Stability and response.
      11) No load.

G. Automatic Transfer Switch (ATS):

1. The complete ATS shall be factory tested to ensure proper operation of the individual components and correct overall sequence of operation and to ensure that the operating transfer time, voltage, frequency and time delay settings meet the Specification requirements.
2. Upon request, the manufacturer shall provide a notarized letter certifying compliance with all of the requirements of this Section including compliance with the above codes and standards and withstand and closing ratings. The certification shall identify, by serial number(s), the equipment involved. No exceptions to the Specifications, other than those stipulated at the time of the submittal, shall be included in the certification.
3. The ATS manufacturer shall be certified to ISO 9001 International Quality Standard and the manufacturer shall have third party certification verifying quality assurance in design/development, production, installation, and servicing in accordance with ISO 9001.

H. Panelboards:

1. Field Tests:
    a. Cable lug mechanical torque; all lugs.
    b. Continuity test.
    c. Megger test.

I. Battery/Battery Charger System:

1. Develop test procedures for function tests of the battery systems and submit to SEPTA's Project Manager for approval prior to testing. Include the following test values in the testing plan:
    a. Specific gravity.
    b. Cell voltage.
    c. Equalize charge.

J. Fuse Cutout:

1. Field Tests:
    a. Visual inspection of fuse type and rating.
    b. Function test; Close – Open.
    c. Megger test.

K. Receptacles:

1. Field Tests:
    a. Continuity test.
    b. Polarity / ground configuration.
    c. Visual inspection of receptacle.

L. Motor Starters:

1. Field Test:
    a. Visual inspection of starter and enclosure.
    b. Continuity test.
    c. Function tests and control circuit.
    d. Megger test.
    e. Confirm proper overload units are installed.

M. Enclosed Switches:

1. Field Tests:
    a. Visual inspection of enclosure and switch mechanism.
    b. Functional tests; Close – Open or Close 'A'-Open-Close 'B'.
    c. Continuity.
    d. Megger test.
    e. Confirm proper fuse type and ratings of fusible switches.

N. Lighting System:

1. Field Tests:
    a. Submit an illumination level report performed by a qualified independent testing agency after final installation/construction of the lighting system.

b. The report shall include normal lighting and emergency lighting.

c. Submit an illumination level report for the emergency lighting system as follows:

1) Measure lighting levels on all egress paths, at each stair landing, at middle of stairs, at changes in direction, at doorways and every 25 feet along path.

2) In areas where daylight contributes to the total illumination, measure lighting levels at night.

O. Fire Alarm System:

1. All fire alarm system testing requirements including acceptance testing shall be conducted per specification section 13850.

2. Field Tests:

a. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

b. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity and insulation.

c. Open initiating device circuits and verify that the trouble signal actuates.

d. Open and short notification appliance circuits and verify that the trouble signal actuates.

e. Ground initiating device circuits and verify response of trouble signals.

f. Check all alarm notification devices.

g. Check installation, supervision and operation of smoke detectors.

h. Verify that each initiating device alarm signal is properly received and processed by the fire alarm control panel; Walk Test.

i. Conduct tests to verify trouble indications for common mode failures, such as alternating current power failure. Consult the manufacturer's manual for other common mode failures and conduct the described testing procedures.

j. At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

P. Intrusion Detection and Alarm System:

1. Field Tests:

a. Provide the service of a competent, factory trained engineer or technician authorized by the manufacturer of the intrusion alarm equipment to technically supervise and participate during all of the adjustments and tests for the system.

b. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity and insulation.

c. Open initiating device circuits and verify that the trouble signal actuates.

d. Open and short notification appliance circuits and verify that the trouble signal actuates.

e. Ground initiating device circuits and verify response of trouble signals.

f. Check all alarm notification devices.

g. Verify that each initiating device alarm signal is properly received and processed by the intrusion alarm control panel; Walk Test.

h. Conduct tests to verify trouble indications for common mode failures, such as alternating current power failure. Consult the manufacturer's manual for other common mode failures and conduct the described testing procedures.

i. At the final inspection, a factory trained representative of the manufacturer of the major equipment shall demonstrate that the system functions properly in every respect.

END OF SECTION

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