BANDELIER NATIONAL MONUMENT
LOS ALAMOS, NEW MEXICO

BAND 266697
UNDERGROUND UTILITIES REHABILITATION

PROJECT SPECIFICATIONS

NATIONAL PARK SERVICE (NPS)
DENVER SERVICE CENTER (DSC)

NATIONAL PARK SERVICE

BANDELIER NATIONAL MONUMENT, NEW MEXICO

BANDELIER NATIONAL MONUMENT

CONTRACT DOCUMENTS

for the construction of the

BAND 266697
UNDERGROUND UTILITIES REHABILITATION

D3167658

****

FINAL CONSTRUCTION DOCUMENTS

****

JACOBS

Los Alamos

April 2025

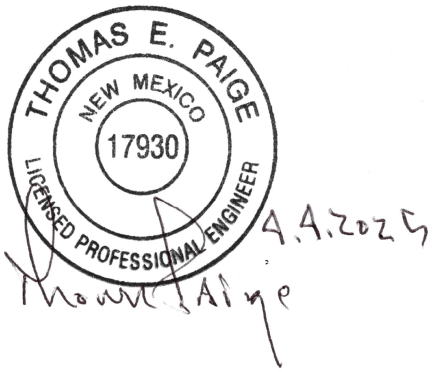
SECTION 00 01 07
SPECIFICATIONS SEALS PAGE
FOR
BAND 266697
UNDERGROUND UTILITIES REHABILITATION

See Table of Contents for author of each specification section, identified by author's initials as follows:

AUTHOR'S NAME = INITIALS

MICAH E. JOHNSON = MEJ
THOMAS E. PAIGE =TEP
GREGORY SCOTT HINTE = GSH
JONATHAN B. JAMES = JBJ
JAMES MILLS = ML
ROBERT W. MARTIN = RWM
BRYOR WAYNE PRICE = BWP

Micah E. Johnson

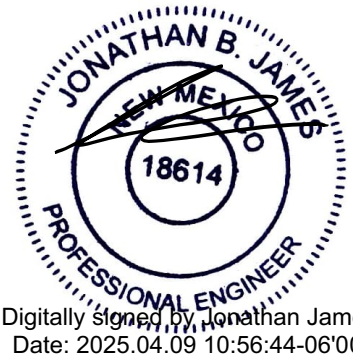


Thomas E. Paige

GREGORY SCOTT HINTE
NEW MEXICO
18049
PROFESSIONAL ENGINEER

Gregory Scott Hinte

Gregory Scott Hinte
2025.04.08
14:41:58-05'00'



Digitally signed by Jonathan James
Date: 2025.04.09 10:56:44-06'00'

Jonathan B. James

JAMES MILLS
NEW MEXICO
29711
PROFESSIONAL ENGINEER

Digitally signed by James Mills
James Mills Date: 2025.04.10 13:11:35-06'00'

James Mills

For roadway specification sections only

Robert W. Martin

04-09-2025

Bryor Wayne Price

END OF SECTION

TABLE OF CONTENTS

Section	Person Responsible	Title	Pages
SPECIFICATIONS			
DIVISION 01—GENERAL REQUIREMENTS			
01 11 00	MEJ	Summary of Work	1- 10
01 26 01	MEJ	Contract Modification Procedures	1- 7
01 27 00	MEJ	Definition of Contract Line Items	1- 16
01 31 00	MEJ	Project Management and Coordination	1- 13
01 32 16	MEJ	Construction Schedule	1- 12
01 32 33	MEJ	Photo Documentation	1- 3
01 33 23	MEJ	Submittal Procedures	1- 10
		Supplement:	
	MEJ	Submittal List	1- 27
01 35 13.22	MEJ	Archeological Protection	1- 3
01 35 23	MEJ	Safety Requirements	1- 6
01 35 91	MEJ	Historic Preservation Treatment Procedures	1- 10
01 40 00	MEJ	Quality Requirements	1- 9
		Supplement:	
	MEJ	Statement of Structural Tests and Special Inspections	1- 22
01 42 00	MEJ	Reference Standards	1- 15
01 45 33	TEP	Special Inspection, Observation, and Testing	1- 6
		Supplement:	
	TEP	Contractor's Statement of Responsibility	1- 2
01 50 00	MEJ	Temporary Facilities and Controls	1- 13
01 57 19.12	MEJ	Noise and Acoustics Management	1- 3
01 57 23	MEJ	Temporary Storm Water Pollution Prevention	1- 7
01 57 28	MEJ	Temporary Flow Control	1- 7
01 67 00	MEJ	Product Requirements	1- 7
		Supplements:	
	MEJ	Affirmative Procurement Reporting Form	1- 2
	MEJ	Manufacturer's Certificate of Proper Installation	1- 1
	MEJ	Manufacturer's Certificate of Compliance	1- 1
01 73 29	MEJ	Cutting and Patching	1- 4
01 73 40	MEJ	Execution	1- 9
01 74 19	MEJ	Construction Waste Management and Disposal	1- 11
		Supplement:	
	MEJ	Project Waste Management Plan Worksheet Sample	1- 1

Section	Person Responsible	Title	Pages
01 77 00	MEJ	Closeout Procedures	1- 6
		Supplement:	
	MEJ	Closeout and Operation & Maintenance (O&M) Requirements Template & Sample	1- 2
01 78 23	MEJ	Operation and Maintenance Data	1- 10
		Supplement:	
	MEJ	Equipment Data Sheet	1- 1
01 79 00	MEJ	Demonstration and Training	1- 4
01 81 13	MEJ	Sustainable Design Requirements for Non-LEED™ Projects	1- 3
01 88 15	TEP	Anchorage and Bracing	1- 6
01 91 14	MEJ	Total System Commissioning	1- 14

DIVISION 02—EXISTING CONDITIONS

02 41 00	MEJ	Demolition	1- 9
02 61 00	MEJ	Removal and Disposal of Contaminated Soil	1- 8
02 82 00	MEJ	Asbestos Remediation	1- 21

DIVISION 03—CONCRETE

03 01 32	TEP	Repair of Vertical and Overhead Concrete Surfaces	1- 12
03 01 33	TEP	Repair of Horizontal Concrete Surfaces	1- 12
03 10 00	TEP	Concrete Forming and Accessories	1- 6
03 15 00	TEP	Concrete Joints and Accessories	1- 11
03 21 00	TEP	Steel Reinforcement	1- 5
03 30 00	TEP	Cast-in-Place Concrete	1- 27
		Supplements:	
	TEP	Concrete Mix Design, Class 4500F2S1W1C1	1- 2
	TEP	Concrete Mix Design, Class 3500F1S1W1C1	1- 2
03 39 00	TEP	Concrete Curing	1- 5
03 40 00	TEP	Precast Concrete Structures	1- 4
03 62 00	TEP	Grouting	1- 10
		Supplement:	
	TEP	24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures	1- 3
03 63 00	TEP	Concrete Doweling	1- 4
03 64 23	TEP	Epoxy Resin Injection Grouting	1- 11
03 64 24	TEP	Polyurethane Injection Grouting	1- 9

Section	Person Responsible	Title	Pages
DIVISION 04—MASONRY			
04 03 43	TEP	Historic Stone Masonry Repointing	1- 9
DIVISION 05—METALS			
05 05 19	TEP	Post-Installed Anchors	1- 9
05 50 00	TEP	Metal Fabrications	1- 17
DIVISION 06 (NOT USED)			
DIVISION 07—THERMAL AND MOISTURE PROTECTION			
07 21 01	TEP	Thermal Insulation	1- 3
DIVISION 08—OPENINGS			
08 16 13	TEP	Fiberglass Doors	1- 4
08 71 00	TEP	Door Hardware	1- 8
DIVISION 09—FINIGSHES			
09 90 00	TEP	Painting and Coating	1- 29
		Supplements:	
	TEP	Paint System Data Sheet (PSDS)	1- 1
	TEP	Paint Product Data Sheet (PPDS)	1- 1
DIVISION 10—SPECIALTIES			
10 14 00	TEP	Signage	1- 6
10 44 00	TEP	Fire Protection Specialties and Safety Equipment	1- 3
DIVISION 11 AND DIVISION 12 (NOT USED)			
DIVISION 13—SPECIAL CONSTRUCTION			
13 34 20	TEP	Precast Concrete Building	1- 6
DIVISION 14 THROUGH DIVISION 21 (NOT USED)			

Section	Person Responsible	Title	Pages
DIVISION 22—PLUMBING			
22 07 00	GSH	Plumbing Piping Insulation	1- 4
22 10 01	MEJ	Plumbing Piping and Accessories	1- 22
		Supplements:	
	MEJ	Plumbing Piping Schedule	1- 2
22 10 01.12	MEJ	Polyethylene (PE) Pipe and Fittings—Natural Gas Service Data Sheet	1- 2
22 10 01.15	MEJ	Carbon Steel Pipe and Fittings—Gas Service Data Sheet	1- 4
22 30 00	MEJ	Plumbing Equipment	1- 5
		Supplement:	
	MEJ	Backflow Preventers Data Sheet	1- 1
22 40 00	GSH	Plumbing Fixtures	1- 3
DIVISION 23—HEATING, VENTILATING, AND AIR-CONDITIONING (HVAC)			
23 05 48	GSH	Vibration Isolation for HVAC Piping and Equipment	1- 5
		Supplement:	
	GSH	Vibration Isolation Schedule for HVAC Piping and Equipment	1- 1
23 81 00	GSH	Unitary Air-Conditioning Equipment	1- 11
		Supplements:	
	GSH	Ductless Split System DX Indoor Units Data Sheet	1- 1
	GSH	Split System DX Outdoor Units Data Sheet	1- 1
23 82 00	GSH	Terminal Heating and Cooling Units	1- 5
		Supplement:	
	GSH	Unit Heaters Schedule	1- 2
DIVISION 24 AND DIVISION 25 (NOT USED)			
DIVISION 26—ELECTRICAL			
26 05 02	JBJ	Basic Electrical Requirements	1- 7
26 05 04	JBJ	Basic Electrical Materials and Methods	1- 10
26 05 05	JBJ	Conductors	1- 18
26 05 26	JBJ	Grounding and Bonding for Electrical Systems	1- 6
26 05 33	JBJ	Raceway and Boxes for Electrical Systems	1- 23
26 05 70	JBJ	Electrical Systems Analysis	1- 9
		Supplements:	
	JBJ	Figure 1: Example Arc Flash Label – Warning	1- 1
	JBJ	Figure 2: Example Arc Flash Label – Danger	1- 1
26 08 00	JBJ	Commissioning of Electrical Systems	1- 23

Section	Person Responsible	Title	Pages
26 12 02	JBJ	Oil-Filled Pad Mounted Transformers	1- 7
26 13.16.02	JBJ	Pad-Mounted Switchgear	1- 12
26 20 00	JBJ	Low-Voltage AC Induction Motors	1- 6
26 22 00	JBJ	Low-Voltage Transformers	1- 3
26 24 16	JBJ	Panelboards	1- 7
26 27 26	JBJ	Wiring Devices	1- 8
26 32 13.16	JBJ	Natural Gas Engine Generator Set	1- 13
26 43 00	JBJ	Surge Protective Devices	1- 5
26 50 00	JBJ	Lighting	1- 9

DIVISION 27 THROUGH DIVISION 30 (NOT USED)

DIVISION 31—EARTHWORK

31 10 00	MEJ	Site Clearing	1- 4
31 23 13	JM	Subgrade Preparation	1- 3
31 23 16	MEJ	Excavation	1- 5
31 23 19.01	MEJ	Dewatering	1- 3
31 23 23	MEJ	Fill and Backfill	1- 9
31 23 23.15	MEJ	Trench Backfill	1- 10
31 32 19.16	MEJ	Geotextile	1- 7
31 37 00	RWM	Riprap	1- 3
31 40 00	RWM	Tunneled Crossings	1- 7
31 41 00	RWM	Shoring	1- 3
31 42 00	RWM	Horizontal Auger Boring	1- 11
31 43 00	RWM	Steel Casing Pipe	1- 3
31 44 00	RWM	Settlement Monitoring	1- 6
31 45 00	RWM	Installation of Carrier Pipe in Steel Casing	1- 5
31 46 00	RWM	Backfill Grouting	1- 11

DIVISION 32—EXTERIOR IMPROVEMENTS

32 11 23	JM	Aggregate Base Course(s)	1- 7
32 12 16	JM	Asphalt Paving	1- 15
32 13 13	JM	Concrete Paving	1- 16
32 16 00	JM	Curbs and Gutters	1- 4
32 17 23	JM	Pavement Markings	1- 5
32 31 13	MEJ	Chain Link Fences and Gates	1- 8
32 91 13	MEJ	Soil Preparation	1- 3
32 93 00	MEJ	Plants	1- 5

Section	Person Responsible	Title	Pages
DIVISION 33—UTILITIES			
33 05 01	MEJ	Conveyance Piping—General	1- 11
33 05 01.02	MEJ	Ductile Iron Pipe and Fittings	1- 12
33 05 01.09	MEJ	Polyvinyl Chloride (PVC) Pressure Pipe and Fittings	1- 6
33 05 01.12	MEJ	Gravity Sewer Pipe and Fittings	1- 17
33 05 13	MEJ	Manholes	1- 15
33 05 23.13	MEJ	Utility Horizontal Directional Drilling	1- 6
33 12 13	MEJ	Water Service Connections	1- 9
33 12 16	MEJ	Water Utility Distribution Valves	1- 4
33 12 16.29	MEJ	Air and Vacuum Release Valve Assemblies	1- 6
33 12 19	MEJ	Water Utility Distribution Fire Hydrants	1- 5
33 13 00	BWP	Disinfection of Water Utility Distribution Facilities	1- 6
DIVISION 34 THROUGH DIVISION 39 (NOT USED)			
DIVISION 40—PROCESS INTERCONNECTIONS			
40 05 15	BWP	Piping Support Systems	1- 9
		Supplement:	
	BWP	Table 1: Nonchemical Areas	1- 1
40 27 00	BWP	Process Piping—General	1- 20
40 27 00.01	BWP	Fusion Bonded-Epoxy-Lined Ductile Iron Pipe and Fittings Data Sheet	1- 5
40 27 00.03	BWP	Carbon Steel Pipe and Fittings—Water Service Data Sheet	1- 7
40 27 00.10	BWP	Polyvinyl Chloride (PVC) Pipe and Fittings Data Sheet	1- 4
40 27 00.13	BWP	Copper and Copper Alloy Pipe, Tubing, and Fittings Data Sheet	1- 2
40 27 02	BWP	Process Valves and Operators	1- 17
40 80 01	BWP	Process Piping Leakage Testing	1- 5
40 90 00	JBJ	Instrumentation and Control for Process Systems	1- 38
		Supplements:	
	JBJ	Process Control Narratives – Loop Specific	1- 3
	JBJ	Control Panel Schedule	1- 1
	JBJ	Instrument List	1- 1
	JBJ	PLC Input/Output List	1- 1
	JBJ	Preparation for Testing and Functional Test Forms	1- 3
	JBJ	Performance Test Sheet - Example	1- 1
40 91 00	JBJ	Instrumentation and Control Components	1- 33
40 95 60	JBJ	Telemetry System	1- 6

Section	Person Responsible	Title	Pages
40 95 80	JBJ	Fiber Optic Communication System	1- 18
		Supplements:	
	JBJ	On-Reel Fiber Optic Cable Test Summary Form	1- 1
	JBJ	Fiber Optic Attenuation Performance Test Form	1- 1
	JBJ	Post-Installation Fiber Optic Cable Test Summary Form	1- 2

DIVISION 41 THROUGH DIVISION 49 (NOT USED)

DRAWINGS

END OF SECTION

SPECIFICATIONS

SECTION 01 11 00
SUMMARY OF WORK

PART 1 GENERAL

1.1 SUMMARY

A. Section includes the following:

1. Work Covered by Contract Documents.
2. Work Phases.
3. Construction Contractor Use of Site.
4. Public Use of Site.
5. Occupancy Requirements for Buildings.
6. Conduct of Operations.
7. Work Restrictions.
8. Special Construction Requirements.
9. Soils Investigation Report.
10. Additional Reports.

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Location: Bandelier National Monument, Los Alamos, New Mexico. The Project will be located at the following developed areas within NPS park-owned land: Mesa Top, Entrance Road, and Frijoles Canyon; and Los Alamos National Lab (LANL) right-of-way across Highway-4 from Bandelier. The Mesa Top area consists of Entrance Station, Juniper Campground, Mesa Housing (Residential Area), and Field Operations Center (FOC). Entrance Road consists of Entrance Road and Fire Tower Lane. The Canyon Area consists of Agoyo Lane, Stone House Road, Visitor Center, and Other Buildings.

B. The Work consists of:

1. The Work required in the scope as described in Section 01 27 00, Definition of Contract Line Items, includes the following at Bandelier National Monument developed areas, as described herein but not limited to:

   a. General Conditions. Include General Requirements, Mobilization/ Demobilization, Erosion and Sediment Control, Traffic Control, Non-vegetative Surface Restoration, and Protection and Preservation of historic buildings and features as required to complete the Work per Contract Specifications and Drawings.
   b. The Work is to be completed within two National Register of Historic Places districts, the Civilian Conservation Corps (CCC) Historic District in the Canyon Area, and Mission 66 Historic District in the Mesa Top Area.

c. Replace utility systems at the major distribution and collection systems to address deferred maintenance and code deficiencies on 60 plus year old systems utilizing existing utility corridors and road shoulders and/or under roads to maintain code required separation horizontally and vertically while mitigating impact to sensitive natural and cultural resource areas. Utilities include underground potable water, primary electrical, fiber-optic, natural gas, and sanitary sewer.

d. The main park water system consists of replacing primary distribution mains and laterals, connecting to a new 24,000-gallon belowgrade water storage tank at Entrance Road (referred as Entrance Road Water Tank) and adjacent new Canyon mechanical building, abandoning the existing Canyon 20,000-gallon belowgrade water storage tank (referred as Existing Canyon Underground Concrete Water Tank), removing water main hanging from the Canyon cliff, and providing hydropneumatic tanks with pumps as water pressure boosters at Juniper Campground comfort stations.

e. The primary electrical distribution system consists of replacing Mesa Top single-phase feed with a new three-phase primary electrical service, facilitate future interconnection tie between the Mesa Top and the Frijoles Canyon distribution systems, and replacing aging electrical feeders, equipment, and conductors for the three main areas at Mesa Top, Entrance Road, and Frijoles Canyon.

f. The fiber-optic network consists of extending existing fiber-optic from the Frijoles Canyon to Mesa Top areas including FOC and Entrance Station.

g. The remote monitoring system consists of a cellular modem and antenna for a cloud based monitoring. A remote monitoring system will be installed at the Main Blue Water Tank, Abert's Squirrel Loop, PRV vaults, and Main Lift Station. The existing 35,000-gallon above-grade Existing Main Blue Water Tank level sensor will be wired to Mesa Top Abert's Squirrel Loop.

h. The natural gas system consists of replacing existing natural gas distribution lines and service lines for Mesa Top (Mesa housing, FOC, and Fire Tower Lane) and Frijoles Canyon areas (Visitor Center and other buildings).

i. The wastewater system consists of replacing existing sewer pipes, manholes, and laterals at Mesa Top, Juniper Campground, and Frijoles Canyon developed areas. It also consists of providing new gravity sewer from the Frijoles Canyon Comfort Station Building #1 (also known as Cottonwood Comfort Station) to a manhole near the Visitor Center and installing new electric utility under the pedestrian bridge to re-activate the existing comfort station.

C. Project will be constructed under a single prime contract.

1.3 WORK PHASES

A. Refer to Section 01 32 16, Construction Schedule, for additional sequencing requirements.

1.4 CONSTRUCTION CONTRACTOR USE OF SITE

A. General: Construction Contractor shall have limited use of site for construction operations. Limit use of premises to work in areas indicated on the Drawings. Do not disturb portions of Project Site beyond areas in which the Work is indicated. Bandelier National Monument will remain open during construction project. See Article Public Use of Site, for additional requirements.

1. Limits: Confine construction and disturbance operations to the Limits of Disturbance (LOD) boundary shown on the Drawings. Coordinate with the requirements of Section 31 10 00, Site Clearing.

B. Storage of Materials: Confine storage of materials to staging areas indicated on the Drawings, or allowable work area next to utility trenches. Use of temporary barriers and signage is not exclusive to locations shown on the Drawings. It is the responsibility of the Construction Contractor to provide protection to any trees, historic buildings and features that may be harmed by equipment during construction.

C. Staging areas shall be located within areas that are already compacted, graded, gravel or paved surface as indicated on Drawing No. 00G004.

D. Parking: Confine parking to areas as shown on Drawing No. 00G004. During busy visitor seasons, preference is for parking at the Bone Yard and carpooling to the active worksites. Contractor is prohibited from parking on the main visitor parking loop by the Visitors Center.

E. Stockpiling: Unless otherwise approved by Contracting Officer, all excess excavated material must be disposed offsite. Temporary stockpiles within approved work areas may be allowed by Contracting Officer in consultation with Bandelier operations, and with appropriate protection of visitors. Contractor may be allowed to reuse material from the existing stockpiles at the Bone Yard for certain project activities, such as filling in the demolished water tank in Contract Line Item Option B. When suitable material is available at the Bone Yard, preference is to use those onsite materials instead of offsite materials.

F. Protection of Cultural Resources: Bandelier National Monument is listed as a National Historic Landmark on the Register of Historic Places. The Contractor must undertake operations with sensitivity to preserve the historic integrity of the Park.

1. Unless approved by Bandelier staff, construction vehicles and equipment must stay on pavement or gravel surfaces. Equipment will avoid known

archeological resources. Coordinate offroad work in advance in accordance with Section 01 32 16, Construction Schedule.

2. Items identified as significant resources, intrinsic features and elements of the property that are not specifically named, as well as archeological remains and artifacts are valued and important.
3. Construction activity must demonstrate treatment approaches that protect Park cultural resources. Construction means and methods must comply with the Secretary of the Interior (SOI) Standards for Rehabilitation and SOI Guidelines for Treatment of Cultural Landscapes and Archeological Protection.
4. Excavation requires archeological monitoring provided by NPS staff.
5. Construction methods that are considered radical, unproven, or have the potential to adversely alter or cause irreversible loss of the fabric, character defining qualities or appearance, must not be attempted.
6. Construction deviating from approved Contract Documents require review and approval by the Contracting Officer in advance of commencing work.
7. Historic Preservation Treatment Plan (HPTP) must be submitted in advance of mobilization, highlighting means and methods for accomplishing critical tasks when and where an elevated risk of damage to resources exists.
8. If previously unknown archeological resources are discovered during construction, all work in the immediate vicinity of the discovery shall be halted until the resources are identified and documented and an appropriate mitigation strategy developed, if necessary, in accordance with pertinent laws and regulations. Contracting Officer shall be called immediately.

G. Preservation of Natural Features:

1. Unless approved by Bandelier staff, construction vehicles and equipment must stay on pavement or gravel surfaces. Coordinate offroad work in advance in accordance with Section 01 32 16, Construction Schedule.
2. Prevent damage to natural surroundings. Limit disturbance to boundaries shown on Drawings. Replace removed and damaged trees at no additional expense to the Government at the location determined by the Bandelier National Monument Integrated Resources Program Manager in accordance with Section 32 93 00, Plants.
3. Provide temporary barriers in accordance with Section 01 50 00, Temporary Facilities and Controls, to protect existing trees and plants and root zones.
4. Do not remove, injure, or destroy trees or other plants without prior approval from the Bandelier National Monument Integrated Resources Program Manager .
5. Do not fasten ropes, cables, or guys to existing trees.
6. Carefully supervise excavating, grading, filling, and other construction operations near trees to prevent damage.
7. Prior to vehicles entering Bandelier National Monument, power wash all vehicles and equipment that will travel off paved surfaces into the construction corridor. Washing shall be sufficient to remove all visible plant material and soil from prior locations where vehicles and equipment have been used. NPS

shall inspect vehicles and equipment for adequacy of cleaning before they are used within the Park. Any equipment leaving the Park must be recleaned before re-entry to the Park and Project Site.

8. Subsequent to project completion, Park staff will monitor the Park for the presence of invasive species. The Contractor will be responsible for the removal of any invasive species observed.
9. All introduced fill material coming from outside the Park shall be certified sterile, weed-free soil.
10. Do not paint rocks for subsurface utility marking, temporary benchmarks, or any other reason.
11. Care will be taken not to disturb any wildlife species (reptiles, migratory birds, raptors, or bats) found nesting, hibernating, estivating, or otherwise living in, or immediately nearby, worksites. Follow time of year restrictions for tree removal. Coordinate construction dates with Section 01 32 16, Construction Schedule.
12. All machinery containing fuels and oils shall have a spill kit available immediately in the event of a spill. In the event of a fuel or oil leak/spill, the work shall cease immediately, spill containment deployed, Contracting Officer and other jurisdictional authorities shall be called immediately, as designated.

H. Driveways and Entrances: Keep driveways and entrances serving premises clear and available to Government employees, residents, and emergency vehicles at all times. Do not use these areas for parking or storage of materials.

1. Schedule deliveries to minimize use of driveways and entrances.
2. Schedule deliveries to minimize space and time requirements for storage of materials and equipment on-site.

I. Construction Camp: Establishment of a camp within the Park will not be permitted.

J. Hauling Restrictions: Comply with legal load restrictions in hauling of materials. Load restrictions on park roads are identical to state load restrictions with such additional regulations as may be imposed by the Park Superintendent. Information regarding rules and regulations for vehicular traffic on park roads may be obtained from the Office of the Park Superintendent. A special permit will not relieve Construction Contractor of liability for damage which may result from moving of equipment.

K. Bridge Restrictions: Identify jurisdictions, load restrictions, permit requirements, time and calendar restrictions as outlined.

1.5 PUBLIC USE OF SITE

A. Construction Contractor shall conduct operations to ensure the least inconvenience to the public.

B. Coordinate with Section 01 32 16, Construction Schedule. Pause construction and ensure park is fully accessible during the first 2 weeks of October, and second week of March. Coordinate with park staff on other special events.

C. Single lane closures are permitted during visitor hours. See Paragraph Extended Hours with Coordination, for additional requirements. Building and Road closures may be permitted, when required, upon specific approval of Contracting Officer. The maximum allowable full road closure in Entrance Road is 15 minutes during visitor hours.

1. The Construction Contractor will be responsible for traffic control during road closures and shall provide routing around the work being performed, unless a full road closure is specifically approved. All traffic control methods are to be performed in accordance with all federal, state, and local codes.

D. Construction Contractor to maintain the same number of Architectural Barriers Act (ABA) existing or temporary spaces during construction.

E. Provide continuity for visitor seasonal (May – October) shuttle operations, including pickup and dropoff points, and access past active construction zones.

F. Phase work to keep at least one road loop of the campground available at all times. Coordinate timing of campground work per Section 01 32 16, Construction Schedule, in advance with the Contracting Officer to allow Bandelier staff to have predictability with their online camping space reservation system.

G. Coordinate in advance with Bandelier staff for any trail detours necessitated by construction activities. Reference Section 01 50 00, Temporary Facilities and Controls.

1.6 OCCUPANCY REQUIREMENTS FOR BUILIDINGS

A. Existing Buildings:

1. Partial Government Occupancy: Government will occupy premises during entire construction period, with exception of areas under construction. Cooperate with Government during construction operations to minimize conflicts and facilitate Government usage. Perform Work so as not to interfere with Government's operations. Maintain existing exits, unless otherwise indicated.

a. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Contracting Officer.
b. The Construction Contractor is responsible for maintaining and providing power, water, gas, and sewer to existing buildings at all times.

B. New Buildings:

1. Government Occupancy of Completed Areas of Construction: Government reserves right to occupy and to place and install equipment in completed areas of building, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the entire Project.

   a. Contracting Officer will prepare a Beneficial Occupancy letter for each specific portion of the Work to be occupied before Government occupancy.
   b. Obtain a Certificate of Occupancy from National Park Service (NPS) before Government occupancy.
   c. Before partial Government occupancy, mechanical and electrical systems shall be fully operational, and required tests and inspections shall be successfully completed. On occupancy, Government will operate and maintain mechanical and electrical systems serving occupied portions of building.
   d. On occupancy, Government will assume responsibility for maintenance and custodial service for occupied portions of building.

1.7 CONDUCT OF OPERATIONS

A. Construction Contractor shall conduct operations in conformance with rules and regulations promulgated by the Secretary of the Interior for the National Park Service, and applicable park rules and regulations prescribed by Park Superintendent. The Contractor shall contact the Contracting Officer to obtain the current Park rules and regulations.

B. Work on Saturdays, Sundays, Federal holidays or at night may not be performed unless stated in the Work Restrictions below or without prior consent from the Contracting Officer. Submit requests 3 business days in advance of the work to the Contracting Officer for approval.

C. No signs or advertisements (except those specified herein) shall be displayed on the construction site or within the park unless approved by the Contracting Officer.

1.8 WORK RESTRICTIONS

A. Typical On-Site Work Hours: Work shall be generally performed during normal business working hours of 7:00 a.m. to dusk, Monday through Friday, except when otherwise indicated.

1. Weekend Hours and Federal Holidays: No work shall be performed without the approval of the Contracting Officer.
2. Early Morning Hours: No work shall be performed without the approval of the Contracting Officer.

3. Quiet Hours: Juniper Campground and staff housing area quiet hours are from 10:00 p.m. to 6:00 a.m.
4. Coordinate with the requirements of Section 01 57 19.12, Noise and Acoustics Management.

B. Extended Hours with Coordination:

1. Extended work hours until 10:00 p.m. may be approved for Entrance Road utility and pavement rehabilitation and canyon utility work, with full coordination with Bandelier operations.
2. Night work may be approved for Entrance Road utility installation and pavement rehabilitation between the Campground Road and Agoyo Lane with full coordination of Bandelier operations.

    a. Emergency access must remain available past work areas at all times, or be able to be re-established during the interval first responders are traveling to the site.
    b. Excavation requires archaeological monitoring and is allowable only between 8:00 a.m. and 10:00 p.m.
    c. Full road closure outside of normal park visitor hours is acceptable in January and February. 90 day advance notification is a prerequisite for a full road closure request.

3. Temporary lights must be full cutoff luminaires with an International Dark Sky Association / Illuminating Engineering Society BUG rating uplight value of U0 to protect bats and birds. Use of temporary lights is not allowed between April and August.
4. Project shall comply with NPS and park lighting guidelines to reduce impacts to the night sky and wildlife. This will include, but is not limited to, low-level lighting, minimized glare, downward focused light fixtures, and energy efficient light sources such as low-pressure sodium lamps. If night work is permitted, lights need to be shielded from the sky to minimize impact to migratory birds and bats.

C. Existing Utilities:

1. Existing Utilities: Notify Contracting Officer and utility companies of proposed locations and times for excavation.
2. Construction Contractor shall be responsible for locating and preventing damage to known utilities. If damage occurs, repair utility at no additional expense to the Government.
3. If damage occurs to an unknown utility, repair utility. An equitable adjustment will be made in accordance with the Changes clause of the Contract.

D. Existing Utility Interruptions:

1. Do not interrupt utilities serving facilities occupied by Government or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

a. Notify Contracting Officer not less than seven business days in advance of proposed utility interruptions.
b. Do not proceed with utility interruptions without Contracting Officer's written permission.
c. Hours and Length of Utility Shutdowns: Maximum of 4 hours.

1) Gas system outages are allowed only between 5:00 p.m. and 10:00 p.m.

E. Nonsmoking Building/Tobacco Use/Vaping: Smoking is not permitted within buildings or within 25 feet of entrances, operable windows, or outdoor air intakes, or at locations where smoking would be a nuisance to Park visitors as determined by the Contracting Officer.

1.9 SPECIAL CONSTRUCTION REQUIREMENTS

A. Project Management and Communication Software: Software administered by NPS shall be used to manage communication and document sharing during construction.

1. See Section 01 31 00, Project Management and Coordination, for requirements on using NPS project management and communication software.

B. Coordinate with the requirements in Section 01 50 00, Temporary Facilities and Controls.

C. Equipment is prohibited within the channel of Rito de los Frijoles. Cross-reference to CLIN Option M Cottonwood Comfort Station (Building #1) Utilities Connections.

D. Backfill within the demolished water tank of CLIN Option H Demolition of Existing Canyon Underground Concrete Water Tank and Exposed Suspended Utilities must be delivered by helicopter.

E. When the park closes for snow removal, the Park is also closed to Contractor. Use of steel plates for trenches in roadways is prohibited when there is a risk of snow.

F. Comply with the Migratory Bird Act of 1918.

1. Ensure that the nest of migratory birds are not damaged by timing the construction activities outside of nesting period and/or visual inspection of vegetation before it is treated or removed. Complete all tree/brush removal outside of nesting season (April-July). No construction may occur from

STA 115+25 to STA 123+00 (Drawing 02C029) between April-July due to an active Peregrine Falcon nest in that area.

2. The regulatory risk to LANL is from the destruction of active bird nests, which are defined as nests with eggs or nestlings. Prioritize tree and shrub removal outside of the peak bird breeding season, May 15 to July 31. If tree or shrub removal must be conducted during breeding season, you must contact and schedule LANL EPC-ES biologists (Brent Thompson or Milu Velardi) to survey smaller trees and shrubs immediately prior to removal. Large trees often cannot be adequately cleared and may not be approved for removal during breeding season. Active nests built within structures or equipment are also protected and must not be disturbed. If active nests are discovered any time of year, then work must be paused and the Contracting Officer and LANL EPC-ES biologists must be notified.

1.10 SOILS INVESTIGATION REPORT

A. The report *Preliminary Geotechnical Report NPS Bandelier National Monument Utility Rehabilitation*, February 2022, prepared by Shannon & Wilson is available to all plan holders with this package.

B. The report *Geotechnical Report NPS Bandelier National Monument Utility Rehabilitation*, September 26, 2024, prepared by Shannon & Wilson is available to all plan holders with this package.

C. In case of conflict between report and the Drawings or Specifications, the Drawings and Specifications govern.

1.11 ADDITIONAL REPORTS

A. The report Limited Discrete Soil Sampling Results from the Entrance Road near the Frijoles Canyon Visitor Center Maintenance Area, February 23, 2022, prepared by Jacobs is available to all plan holders with this package.

B. In case of conflict between report and the Drawings or Specifications, the Drawings and Specifications govern.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 26 01
CONTRACT MODIFICATION PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section consists of administrative and procedural requirements for contract modifications.

1.2 DEFINITIONS AND ALLOWANCES

A. Home Office Overhead:

1. Costs incurred in support of all of a contractor's projects and not attributable to a specific job. The cost for home office overhead is only allowed as a percentage of all direct work excluding profit. The following items represent allowable home office overhead costs identified in Part 31 of the Federal Acquisition Regulation (FAR):

   a. Rent.
   b. Utilities.
   c. Furnishings.
   d. Office equipment.
   e. Executive and management staff not exclusively assigned to the Project.
   f. Support, accounting, and administrative staff.
   g. Preparation of cost proposals, estimating, and schedule analyses connected with Modifications.
   h. Estimating and preconstruction services.
   i. Mortgage costs.
   j. Real estate and corporate taxes.
   k. Automobile maintenance and travel costs for home office personnel.
   l. Home office insurances i.e., structure, automotive, umbrella, flood, etc.
   m. Depreciation of equipment and other assets.
   n. Home office supplies (paper, staples, etc.).
   o. Legal services.
   p. Accounting and data processing.
   q. Professional fees/registration.

B. General Conditions (Field Office Overhead):

1. Management and administrative costs incurred on site for the designated project. Costs associated with preparation of modifications will not be allowed. Costs for these items are to be included only in the general conditions of the modification estimate. Only in the case of a contract time extension are additional general conditions included in modifications. The following items, if applicable, are considered allowable costs for calculating General Conditions:

   a. Project Manager (PM), Assistant Project Manager.
   b. Superintendent, Assistant Superintendent.
   c. Quality Control, Safety Officer, Environmental Manager, etc.
   d. Engineers.
   e. Travel, lodging, and per diem (as established by Federal Travel Regulations).
   f. Scheduling.
   g. Field Office Trailers and associated temporary utilities.
   h. Field office supplies.

      1) Mailing and couriers.
      2) Reproduction costs.
      3) Storage.
      4) Phones.
      5) Computers.
      6) Copiers.

   i. Personnel vehicles i.e., Superintendent Pickup trucks.

C. General Requirements:

1. Costs directly associated with the Project and are necessary to perform the actual work of the modification. These costs shall be shown as direct costs in the estimate. The following items, if applicable, are considered allowable costs for calculating General Requirements:

   a. Hosiery heating and power.

D. Personnel Costs: Costs included in the modification must only be for General Conditions staff and workers actually present and working on project site. Modification costs for salaried workers are only allowed within the structure of a 40-hour week and no overtime or holiday pay will be allowed.

1. Worker Hourly Rates are costs directly associated with the individual worker and consist of the following:

a. Base Rate: The hourly rate paid directly to the worker.
b. Labor Burden:

1) Employer payments of all applicable burdens; includes insurance and taxes the business must pay on behalf of the worker to government entities and educational forums, such as:

a) Social Security.
b) Medicare.
c) Workers Compensation: Policy and company calculation to be made available.
d) Federal Unemployment Tax Act (FUTA): Cap Rate and percentage to be proportionally allocated over 1 year.
e) State Unemployment Tax Act (SUTA): Cap Rate and percentage to be proportionally allocated over 1 year.
f) Union Agreement Costs: Other costs required under an enforceable collective bargaining agreement.

c. Fringe Benefits:

1) Various non-wage compensations provided to employees such as:

a) Health Care Insurance Premiums.
b) Cell Phone.
c) Clothing.
d) 401K and Pensions.
e) Vehicle allowances.
f) Gas allowance.
g) Life insurance premiums.
h) Disability insurance.
i) Other Fringe Benefits required under an enforceable collective bargaining agreement.

E. Bonuses or Deferred Compensation: No Bonus or Deferred Compensation will be allowed within any components of pricing including Home Office Overhead, General Conditions, General Requirements, Hourly Worker Rates, or the direct costs of work.

F. General Liability Insurance: An insurance policy that protects Contractor from claims resulting from bodily injury or property damage to a third party. Include as a separate line item within all modification proposals and provide a current insurance quote upon request.

G. Performance and Payment Bonds: A performance bond is a surety bond issued by an insurance company or bank to guarantee satisfactory completion of a project. The Payment Bond guarantees the Contractor will pay the labor and material costs incurred. Banks and Insurance companies charge a premium for individual project based on a sliding scale related to the size of the Project. Include as a separate line item in modification proposals and provide current company bonding rates upon request.

H. Builder's Risk Insurance: Covers the contractor's loss due to fire, high winds, or other natural forces. Not reimbursed by the National Park Service (NPS) and shall not be included in modification proposals.

1.3 MODIFICATION PROPOSAL PRICING REQUIREMENTS

A. General:

1. Proposal be received in the format and within the time frame specified in the Request for Proposal (RFP) letter. Costs or delays resulting from failure of contractor to submit within the time frame specified will not be compensable.
2. Proposal shall be detailed with itemized lists of equipment, materials, labor, production rates, overhead, profit, and bond markup for each item. Labor costs must be itemized by craft and hourly rate, including Fringe Benefits and Labor Burden. If the costs of Fringe Benefits and Labor Burden are not itemized, it is assumed they are included in the hourly rate shown, or contractor is not requesting reimbursement. Contractor may utilize the government provided Contractor Estimate Form, or their own form, provided that it contains the same information and level of detail as the Government's form.
3. Requests for extensions of contract time as a result of change must be justified with a Time Impact Analysis (TIA). Refer to Section 01 32 16, Construction Schedule, for time impact analysis requirements. TIA and associated costs shall be received with the proposal by the date shown within the Request for Proposal letter. Contractor's failure to submit within the specified time frame will be construed as the Contractor waiving right for additional time and no time extension will be allowed.
4. All supporting documentation used to justify the proposed modification will be made available to the Contracting Officer (CO) upon request.
5. Contractor shall review and approve all subcontractor/supplier pricing in detail for proper format, scope, production rates, and pricing prior to submission to NPS. All delay costs associated with not reviewing and approving subcontractor/supplier pricing will be borne by the Contractor.

6. All pricing and production rates within the estimate must be based on fair and reasonable pricing and cannot include built-in contingency.

B. Labor:

1. Contractor shall estimate cost of labor by itemizing each craft involved, indicating worker hourly rate (base rate + labor burden + fringe benefits) for each and itemizing hours required for each craft directly engaged in modification work. Any work proposed requiring overtime work or premium pay shall be itemized separately. Rates shall be in accordance with the Davis-Bacon Act as incorporated herein. Labor Burden may include payroll taxes, Social Security, unemployment insurances, workers compensation insurance, Federal Insurance Contributions Act (FICA), FUTA, and other direct costs resulting from Federal, State, or local laws.
2. Itemize labor costs for equipment operators separate from equipment costs.
3. Labor cost for foremen shall only be costs for related work required for the modification.

C. Materials:

1. Estimated cost for materials shall include quotes from multiple sources. Material prices shall include applicable fees and credits, including but not limited to, sales tax, freight and delivery charges, and tax rebates.
2. No markup shall be applied to any material provided by NPS.

D. Equipment:

1. Equipment used for the Project must be appropriately sized for work being performed.
2. Do not include costs for “miscellaneous tools and equipment”, in your proposal for a replacement value of $500 or less. Costs shown in excess of $500 shall be broken out separately.
3. Regardless of ownership, rates to be used in determining equipment rental costs shall be the lowest cost from one of the following sources:

    a. United States (U.S.) Army Corps of Engineers, Ownership and Operating Expense Schedule (use latest edition and applicable region).
    b. Construction Blue Book.
    c. Local equipment rental rates, documented by actual invoice charges, or itemized vendor quotes.

4. Estimated equipment rates shall include operating costs of all fuel, oil, lubrication, supplies, small tools, necessary attachments, ground engaging components, tires and tracks, routine repairs, and maintenance (cost of major repair and overhaul is not allowed per Federal Acquisition Regulation (FAR) 31.105(d)(2)), depreciation, storage, insurance, and all incidentals.

Mobilization, if applicable, may be included for equipment solely used on the modification work but must be listed separately.

5. Estimate full rate for equipment only for duration that equipment will be utilized to accomplish work of the modification.
6. Standby unit rates used in accordance with Paragraph 1.3.D.3, above. If the U.S. Army Corp of Engineers is utilized then their standby rates prevail. If Bluebook or local equipment pricing is accepted, then 1/2 of equipment costs minus any operating costs, major repair and overhaul will be accepted.
7. If equipment is in standby mode due solely to a documented NPS delay, established standby rate shall apply from the first day of the delay.
8. Equipment not used and on job site for up to 5 consecutive days may be classified at standby rates, provided the equipment is or has been used solely to perform work on the modification and will be necessary to complete additional modification work. Equipment still on the jobsite but not in use after 5 consecutive days will not be considered in the modification pricing.
9. Requests for compensation for equipment stand by time must be justified, documented and itemized separately.
10. The estimated timeframe (daily, weekly, monthly) for use of the equipment must reflect the lowest cost to the Government.

E. Establishment and Application of Overhead and Profit Percentages:

1. Home Office Overhead and Profit (OH&P) shall be applied to direct costs only. Profit shall not be applied to overhead amounts; and overhead shall not be applied to profit. Home office overhead shall contain only allowable, allocable, and reasonable costs per the contract documents and FAR Part 31. Profit percentages are based on risk factors found in FAR Part 31 which have been applied to the specific type of work included in this Project. Negotiated rates shall not exceed the following percentages for OH&P for contractor self-performed work:

   d. Overhead: 10 percent.
   e. Profit: 8.20 percent.

2. Total aggregate limit of markup (OH&P) for Contractor and Subcontractors on modification work shall not exceed 25 percent. The NPS will not be responsible for allocation of percentages between contractor and subcontractors at any tier.
3. If Contractors form a partnership, partnership may only receive home office overhead and profit in same amount as an individual Contractor (refer to Paragraph 1.3.E.1 above). It is the responsibility of the partners to decide on division of revenue.
4. Combined Increases and Decreases: On proposals involving both increases and decreases in the Contract Price, overhead and profit mark-ups are required on net increases and deducted on net decreases.
5. At no time can profit be calculated on Overhead or itself, it must be calculated on direct costs of work only.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 27 00
DEFINITION OF CONTRACT LINE ITEMS

PART 1 GENERAL

1.1 SUMMARY

A. Section explains in general, what is and is not included in a Contract line item, and limits or cut-off points where one item ends and another begins.

B. If no Contract line item exists for a portion of work, include costs in a related item.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 LIST OF CONTRACT LINE ITEMS

A. Contract Line Item Number 0001 Main Park Water System:

1. This item consists of:

a. Provide new pressure reducing valves, gate valves, and meter at the inter-tie connection with Los Alamos National Lab (LANL) distribution system prior to the existing 35,000-gallon above-grade water storage tank (referred as Existing Main Blue Water Tank). Install meter to be provided by Los Alamos County. Remove and replace 4-inch and 6-inch gate valves, and 6-inch cast iron and ductile iron yard piping. Provide and install 4-inch altitude valve.

b. NPS Existing Main Blue Water Tank to remain.

c. Replace all existing distribution waterlines, service lines, fire hydrants, water meters, pressure reducing valves, and rate of flow control valves.

1) Install new 10-inch Schedule C900 PVC water mains from the Existing Main Blue Water Tank to Abert's Squirrel Loop inter-tie connection. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.

2) Install new 8-inch Schedule C900 PVC water mains along Abert's Squirrel Loop, Campground Road to the Entrance Road inter-tie connection. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while

mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.

3) Install new 6-inch Schedule C900 PVC water mains from Entrance Road to the Entrance Road Water Tank, and Stone House Road ending at the Canyon Maintenance inter-tie connection. Provide 6-inch taps for future connections at inter-tie connections between Campground Road with Coopers Hawk Road and Entrance Road with Fire Tower Lane. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.
4) Install new HDPE water service lines ranging from 3/4-inch to 2 inches at Stone House Road. Abandon-in-place existing service lines.
5) Replace existing water meters at Stone House Road. If a meter can does not have a meter, install a new one.
6) Remove and dispose of existing fire and yard hydrants. Provide new fire and yard hydrants as shown on the Drawings.
7) Provide temporary traffic control as needed for all construction activities.

d. Entrance Road Water Tank:

1) Construct new below-grade effective water volume of 24,000-gallon cast-in-place concrete water storage tank serving the Frijoles Canyon Area divided into two 12,000-gallon water basins by an interior wall including butterfly valves, with integrated concrete sump pits, vents, level indicator sensors, and passive mixing system.
2) Install access hatches in the top slab with wall-mounted ladders.
3) Install new 8-inch ductile iron overflow drain line from the Entrance Road Water Tank to Entrance Road.

e. Canyon Mechanical Building:

1) Construct new prefabricated Canyon mechanical building with precast faux metal standing seam roof, precast board and batten finished walls, and associated mechanical and electrical systems per applicable building codes. Foundation consists of a concrete floor slab.
2) Install hose bibs, floor drains, and domestic connection with back flow preventer valve.
3) Install new unit heaters, exhaust fan, louvre, and A/C unit.

4) Install new 3-inch magnetic flowmeter, air release valve, 6-inch pressure reducing valve, combination rate of flow and pressure reducing valve with solenoid shutoff valve, butterfly and ball valves.
5) Install blowoff line with isolation valves.
6) Provide a PLC control panel with an operator interface touchscreen (OIT) for monitoring the Entrance Road Water Tank. The PLC panel will include a remote monitoring system.

f. Abandon in-place existing 20,000-gallon concrete water tank at the Frijoles Canyon (referred as Existing Canyon Underground Concrete Water Tank). Access to the tank is by foot only.
g. Provide hydropneumatic tanks with pumps as water pressure booster at Coyote Loop comfort station. Remove and replace existing hydropneumatic tanks with pumps as water pressure boosters at Abert's Squirrel Loop and Black Bear Loop comfort stations. The three comfort stations are historic buildings.
h. All cavates and native vegetation are to be protected and not disturbed.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

B. Contract Line Item Number 0002 Mesa Housing and Field Operations Center (FOC) Water Mains and Service Lines:

1. This item consists of:

a. Replace all existing distribution waterlines, service lines, fire hydrants, water meters, pressure reducing valves, and rate of flow control valves.

1) Install new 6-inch Schedule C900 PVC water mains from Campground Road and Coopers Hawk Road inter-tie connection to the FOC. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.
2) Install new 6-inch Schedule C900 PVC water lines at Mesa Top Housing area including Saltbrush Court and Paintbrush Court. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.

3) Install new HDPE water service lines ranging from 3/4-inch to 2 inches. Abandon-in-place existing service lines.
4) Install new water service line from the FOC to the unserved paint building adjacent to the generator.
5) Remove and replace existing water meters. If a meter can does not have a meter, install a new one.
6) Remove and dispose of existing fire and yard hydrants. Provide new fire and yard hydrants as per the Drawings.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

C. Contract Line Item Number 0003 Primary Electrical Distribution:

1. This item consists of:

a. New primary service from Los Alamos National Lab (LANL) to the Mesa Top System.

1) Provide new three-phase primary electrical service from LANL distribution system to Bandelier National Monument.
2) Coordinate with LANL for new riser pole location approximately 20 feet from existing pole #2604.
3) Provide new primary meter cabinet with ground sleeve meeting LANL and Los Alamos County Electric Utility requirements.
4) Provide new primary service disconnect switchgear with ground sleeve.
5) Demolish overhead H-structure, overhead primary metering, and disconnects. LANL electrical will remove slack span between H-structure and overhead distribution.
6) Remove single-phase feed, slack span, pole-mounted transformer and disconnect, and supporting pole.

b. The existing primary service from LANL to the Frijoles Canyon System, located near Fire Tower Lane, to remain.
c. Mesa Top Primary Electrical Distribution System:

1) Provide new primary system in the Mesa Top areas: Entrance Station, Juniper Campground, Mesa Top Housing, and Field Operations Center (FOC).
2) The Mesa Top primary electrical system will begin at the service disconnect switch on the LANL side of Highway-4, route underground across Highway-4 onto Monument property.
3) Provide new three-phase underground primary distribution system including electrical duct banks, loop-feed transformers, primary switchgear, sectionalizing cabinets, medium voltage conductors, and electrical and communication handholes and manholes.

4) Primary duct banks will be generally routed along the existing roadways.

5) Electrical Demolition, Mesa Area:

   a) Cut, remove, and dispose of existing above ground electrical equipment.
   b) Cut, remove, and dispose of existing underground electrical conductors from accessible vaults and from conduit.
   c) Abandon in place direct buried underground electrical conductors and conductors which cannot be reasonably removed because of crushed or damaged conduit.

6) Entrance Station:

   a) Provide new Entrance Station secondary service fed from the new three-phase primary distribution system.
   b) Provide a new transformer and service entrance rated fused disconnect switches and above-grade support structure.
   c) Refeed the existing low-voltage panelboard inside the Entrance Station.
   d) Refeed the existing motorized gate. Provide low-voltage duct bank and handholes along Entrance Road to motorized gate near the intersection with Campground Road.
   e) Demolish accessible low-voltage conductors and conduit feeding the entrance station and motorized gate. Direct buried conductors and inaccessible conductors will be abandoned in place.

7) Juniper Campground:

   a) Provide new secondary services fed from the new three-phase primary distribution system for each campground comfort station, campground pay station, and the campground amphitheater.
   b) Provide new transformers for comfort stations.
   c) Refeed existing low-voltage panelboards in the comfort stations and amphitheater.
   d) Provide new RV pedestal for the new Abert's Squirrel campground host site fed from the comfort station. Existing campground host RV pedestal and feed shall remain as is.

8) Mesa Top Housing:

   a) Housing area primary distribution and services shall comply with Los Alamos County Electric Utility requirements for residential installation.

b) Provide new single-phase primary feeds and transformers in the housing area.
c) Refeed existing secondary service entrance and metering equipment at Saltbrush housing units.
d) Provide new secondary service to Paintbrush housing units including outdoor wall-mounted meter, service disconnect, and low-voltage distribution panelboard. Subfeed existing housing panelboards from new panelboards.
e) Refeed secondary service to Triplex housing unit.
f) Provide new service entrance rated metered RV pedestals in Saltbrush and Paintbrush housing areas.
g) Provide secondary stub-outs for future expansion from transformers for future services as shown.

9) Field Operations Center (FOC):

a) Provide new three-phase primary feeder.
b) Provide new switchgear with ground sleeve. Provide primary conduit stub out for future EV and solar system connection.
c) Refeed the existing three-phase transformer.

d. Canyon Area Electrical Distribution System:

1) The existing primary distribution in the Canyon Area was replaced by a LIC project in 2017 in which most of the distribution system in Frijoles Canyon was replaced. The existing system consists of three-phase medium voltage conductors, handholes, sectionalizing cabinets, and transformers. Most of the existing primary distribution system will remain in service as is.
2) Scope in the Canyon area consists of Agoyo Lane (CLIN Option K) and Cottonwood Comfort Station Building 1 (CLIN Option M) only.

e. Fiber-Optic Conduits

1) Provide dedicated conduits and handholes for fiber optic communications cabling in common trench with three-phase primary distribution system.
2) Fiber-optic cables and installation is included under CLIN Option E.

f. Provide temporary traffic control as needed for all construction activities.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

D. Contract Line Item Number 0004 Cellular Network:

1. This item consists of:

a. Remote Monitoring Systems: Remote monitoring system to include a cell modem and antenna for cloud based monitoring that also will make call out via text messaging, emailing, or phone calls.

1) Main Blue Tank:

a) Provide new remote monitoring system at Abert's Squirrel Comfort Station.
b) Provide a pressure transmitter to be installed in the valve vault at the Main Blue Water Tank. Pressure transmitter will be used to monitor the level.
c) Provide wiring from the pressure transmitter to Abert's Squirrel Loop.

2) PRV Vault:

a) Provide new remote monitoring system at the PRV Vault near the entrance to Agoyo Lane.
b) Provide a pressure transmitter to be installed in the PRV vault.

3) Main Lift Station: Provide new remote monitoring system to be installed inside the Main Lift Station vault. Remote monitoring system will replace the existing installed Sensaphone.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

E. Contract Line Item Number 0005 Rock Excavation:

1. This item consists of:

a. Provide unit cost for rock excavation per cubic yard.

2. Payment will be made at the contract price per cubic yard.
3. Measurement for payment will be based on percent completion agreed upon.

F. Contract Line Item Number 0006 Roadway:

1. This item consists of:

a. Remove, dispose, and replace asphalt pavement on roads and parking to match existing curbs at Entrance Road and Frijoles Canyon Visitor Center area. Protect historic curbs, stone drainage, and retaining walls.

b. Pulverize pavement in place and provide full depth asphalt pavement reclamation for other roads and parking areas. Transition pavement to meet grades at all driveways, campground slips, and adjacent roads. Protect historic curbs, stone drainage, and retaining walls.
c. Asphalt pavement patching of utility trench locations and around manholes, valves, and other flush utility features within paved roadways and parking areas.
d. Install pavement markings and ABA features as per the Drawings.
e. Include all awarded roadway and parking area pavement work covered in CLINs 1-6.This CLIN is also inclusive of the roadway work in the Frijoles Canyon covered in CLIN Options A to D and CLIN Option F.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

G. Contract Line Item Number Option A Primary Electrical Inter-Connection between Frijoles Canyon and Mesa Top systems:

1. This item consists of:

a. Provide new electrical duct banks and access vaults to facilitate future interconnection tie between the Mesa Top and the Frijoles Canyon distribution systems.
b. Provide interlocks on new and existing primary switchgear to prevent parallel connection to both LANL primary services.
c. Install duct banks in the shared utility corridor parallel to the water and gas lines between Campground Road and the Fire Tower Lane. Terminate conduits at the existing primary switchgear at the Frijoles Canyon service from LANL near Fire Tower Lane.
d. Interconnecting primary conductors is not part of this Project Scope.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

H. Contract Line Item Number Option B Frijoles Canyon Water and Natural Gas Main Loop:

1. This item consists of:

a. Replace all existing distribution waterlines, service lines, fire hydrants, and water meters.

1) Install new 6-inch Schedule C900 PVC water mains from the Stone House Road inter-tie at the Canyon Maintenance Center area and loop around the Canyon administration buildings, casitas and Visitor Center and through the Visitor Center parking lot. Integrated utility corridor utilizing existing utility corridors and

road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas. Include non-vegetative surface restoration of disturbed areas.

2) Install new HDPE water service lines ranging from 3/4-inch to 2 inches to the existing meter cans. Abandon-in-place existing service lines.
3) Provide bottle filling / water fountain by the Visitors Center at the telescopic viewing area.
4) Remove and replace existing water meters. If a meter can does not have a meter, install a new one.
5) Remove and dispose of existing fire and yard hydrants. Provide new fire and yard hydrants where shown on the Drawings.

b. Replacement of all existing natural gas distribution lines and service lines for Frijoles Canyon areas (Visitor Center and Buildings).

1) Install new 1-inch to 2-inch MDPE gas mains and plug valves. Gas mains to be installed in integrated utility corridor at Frijoles Canyon. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.
2) Mains will be re-routed under the pavement. Some rerouting of mains will be required to avoid conflicts with other utilities and historic features.
3) Limit excavated disturbances to open areas and flat paths that can be restored to original conditions with minimal impacts.
4) Canyon Building service line replacement included under CLIN Option D.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

I. Contract Line Item Number Option C Frijoles Canyon Wastewater System:

1. This item consists of:

a. Replace vitrified clay sewers and associated receiving manholes and install new 4-inch through 8-inch Schedule C900 PVC pipes.
b. Remove and dispose of sections of ductile iron and PVC mains with critical offset joints or heavily sagging as identified from CCTV results and install new 4-inch through 8-inch Schedule C900 PVC pipes.

c. Removal and disposal (only if needed) of DDT contaminated soil in accordance with specification Section 02 61 00, Removal and Disposal of Contaminated Soil.
d. Remove and dispose sewer laterals and associated receiving manholes and install new Schedule C900 PVC laterals to cleanout. If there is no cleanout, install a new cleanout to the edge of the building as per the Drawings.
e. No work at the existing wastewater treatment lagoons.
f. Provide temporary traffic control as needed for all construction activities.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

J. Contract Line Item Number Option D Frijoles Canyon Natural Gas Laterals:

1. This item consists of:

a. Replace service lines for each building within the Frijoles Canyon Loop up to the regulator for buildings where the regulator and meter are adjacent to the building. For individual buildings in the Canyon area where regulators/meter assemblies are not collocated with the building, the service laterals from the assemblies to the first connection outside the building wall will also be replaced.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

K. Contract Line Item Number Option E Fiber-Optic Cable from Existing Fiber Handhole near the Entrance Road Microwave Tower to FOC and Entrance Station:

1. This item consists of:

a. Provide 12-strand fiber-optic cables from Frijoles Canyon IT room in Building #15 to FOC, and from FOC to Entrance Station. Existing duct bank conduits and innerduct will be utilized from the Canyon IT room to an existing communications handhole near Fire Tower Lane. New underground dedicated fiber-optic duct bank conduits from the existing handhole to the FOC and Entrance Station are included under CLINs 0003 and Option A.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

L. Contract Line Item Number Option F Frijoles Canyon Visitor Center Fiber Pathway:

1. This item consists of:

   a. Provide underground conduit pathway between the Building 15 IT room and the Visitor Center Server Room.
   b. Provide building penetrations for new conduits.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

M. Contract Line Item Number Option G Demolition of Utility Features:

1. This item consists of:

   a. After new utility systems are active and functional, remove above ground features and underground valves of abandoned utility systems under CLINs 0001 to Option D.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

N. Contract Line Item Number Option H Demolition of Existing Canyon Underground Concrete Water Tank and Exposed Suspended Utilities:

1. This item consists of:

   a. Demolish roof, electrical panels, and valves of the existing 20,000-gallon concrete water tank at the Frijoles Canyon (referred as Existing Canyon Underground Concrete Water Tank). Drill 4-inch diameter holes at the bottom of the concrete tank. Fill with native soil materials from the bone yard via helicopter and provide non-vegetative surface restoration. Worker access to the tank is by foot only. Demolition concrete material can remain inside the emptied tank. Demolition metal materials to be recycled. Reference Section 01 11 00, Summary of Work, Article Special Construction Requirements.
   b. Demolish and dispose exposed water and natural gas pipes, and electrical conduit suspended over the cliff from the Existing Canyon Underground Concrete Water Tank to the Frijoles Canyon. Access is by foot only. After all utilities have been removed, demolish the rock façade. Avoid impacts to nearby archeological cavates.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

O. Contract Line Item Number Option I Juniper Campground Water Mains and Service Lines:

1. This item consists of:

a. Install new 4-inch Schedule C900 PVC water lines at Juniper Campground from Campground Road inter-tie connection to Abert's Squirrel Loop, Black Bear Loop, and Coyote Loop. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water and electrical.

b. Install new HDPE water service lines ranging from 3/4-inch to 2 inches to the comfort stations, existing Camp Host site, and new Camp Host site. Abandon-in-place existing service lines.

c. Remove and dispose of existing fire and yard hydrants. Provide new fire and yard hydrants.

d. After new utility systems are active and functional, remove above ground features and underground valves of abandoned utility systems.

e. Asphalt pavement patching of utility trench locations and around manholes, valves, and other flush utility features within paved roadways and parking areas impacted by this Option and installation of pavement markings and ABA features as per the Drawings.

2. Payment will be made at the contract lump sum price.

3. Measurement for payment will be based on percent completion agreed upon.

P. Contract Line Item Number Option J Mesa Top Wastewater System:

1. This item consists of:

a. Mesa Housing and FOC:

1) Remove and dispose of all vitrified clay sewers and associated receiving manholes and install new 4-inch to 8-inch Schedule C900 PVC pipes.

2) Remove and dispose of sections of ductile iron and PVC mains with critical offset joints or heavily sagging as identified from CCTV results and install new 4-inch to 8-inch Schedule C900 PVC pipes.

3) Open cut and replace asbestos cement pipes and install new 4-inch to 8-inch Schedule C900 PVC pipes.

4) Asbestos cement pipe demolition requires hazardous material PPE and disposal at hazardous material landfill.

5) Remove and dispose sewer laterals and associated receiving manholes and install new Schedule C900 PVC laterals to cleanout. If there is no cleanout, install a new cleanout per the Drawings.

6) No work at the existing wastewater treatment lagoons.
7) Pulverize pavement in place and provide full depth asphalt pavement reclamation in all other roads and parking areas outside of the integrated utility corridor. Transition pavement to meet grades at all driveways, campground slips, and adjacent roads. Protect historic curbs, stone drainage, and retaining walls.
8) Provide temporary traffic control as needed for all construction activities.

b. Juniper Campground:

1) Remove and dispose identified sewer laterals. Install new laterals Schedule C900 PVC pipes to cleanout at comfort stations, existing Camp Host, and new Camp Host site. If there is no cleanout, install a new cleanout per the Drawings.
2) Remove and dispose of identified sewer manholes. Install new manholes as per the Drawings.
3) Point repairs on segments of sewer pipes identified by CCTV.
4) Provide temporary traffic control as needed for all construction activities.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

Q. Contract Line Item Number Option K Agoyo Lane Electrical System:

1. This item consists of:

a. Provide new single-phase buried electrical duct banks. Intercept the single-phase circuit near Building 25 transformer and extend to new sectionalizing cabinet. Provide single-phase primary circuit for Agoyo Lane.
b. Provide a new transformer near the existing storage building and refeed secondary service to existing pole-mounted panelboard near RV Site #1.
c. Provide new transformer near the existing Bunkhouse and refeed secondary service to the existing pole-mounted panelboard near the Bunkhouse.
d. Demolish and dispose of the existing single-phase overhead primary conductors from the Stable to the Agoyo Lane pump station. Demolish and dispose of the existing overhead secondary conductors serving the storage building. Demolish wood poles above existing panelboard mounting.
e. Existing secondary feeders to the stables, storage building, staff RV sites, and the Bunkhouse will remain.
f. Asphalt pavement patching of utility trench locations and around manholes, valves, and other flush utility features within paved roadways

and parking areas impacted by this Option and installation of pavement markings and ABA features as per the Drawings.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

R. Contract Line Item Number Option L Fire Tower Lane Water and Natural Gas Line Replacement:

1. This item consists of:

a. Install new 2-inch HDPE water service lateral from Entrance Road inter-tie connection to Fire Tower Lane. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.
b. Install new 1-inch gas service line along Fire Tower Lane up to the regulator for the Fire Tower building where the regulator and meter are adjacent to the building.
c. Asphalt pavement patching of utility trench locations and around manholes, valves, and other flush utility features within paved roadways and parking areas impacted by this Option and installation of pavement markings and ABA features as per the Drawings.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

S. Contract Line Item Number Option M Cottonwood Comfort Station (Building #1) Utility Connections:

1. This item consists of:

a. Install new 4-inch Schedule C900 PVC sewer lateral from the comfort station to the manhole at the Canyon Visitor Center, electric to reactivate existing Building 1 Comfort Station. Install utilities in integrated utility corridor under the pedestrian bridge across the Frijoles Creek near the Canyon Visitor Center.
b. Install new NEMA 4X enclosed control panel, 208V, single-phase.
c. Provide a new secondary electrical feed from the Visitor Center to serve the comfort station.
d. Asphalt pavement patching of utility trench locations and around manholes, valves, and other flush utility features within paved roadways and parking areas impacted by this Option and installation of pavement markings and ABA features as per the Drawings.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

T. Contract Line Item Number Option N Natural Gas System:

1. This item consists of:

a. Replacement of all existing natural gas distribution lines and service lines for Mesa Top (Mesa housing and FOC) and Frijoles Canyon areas (Stone House Road).

1) Remove and replace main line piping downstream of the existing meter at the inter-tie connection with Los Alamos National Laboratory.
2) Increase the main line pressure supply to Bandelier National Monument.
3) Install new 1-inch to 4-inch MDPE gas mains and plug valves. Gas mains to be installed in integrated utility corridor at Mesa Top, Entrance Road, and Stone House Road. Integrated utility corridor utilizing existing utility corridors and road prisms shoulders and/or under roads to maintain code required separation horizontally and vertically, while mitigating impact to sensitive natural and cultural resource areas. Integrated utility corridor may include water, electrical, fiber-optic, and gas.
4) Replace service lines for Mesa Top Housing and FOC for each building up to the regulator for buildings where the regulator and meter are adjacent to the building. For individual buildings in the Canyon area Stone House Road where regulators/meter assemblies are not collocated with the building, the service laterals from the assemblies to the first connection outside the building wall will also be replaced. Remaining Canyon Building service line replacement included under CLIN Option D.
5) Mains will be re-routed under the pavement. Some rerouting of mains will be required to avoid conflicts with other utilities and historic features.
6) Limit excavated disturbances to open areas and flat paths that can be restored to original conditions with minimal impacts.
7) Asphalt pavement patching of utility trench locations and around manholes, valves, and other flush utility features within paved roadways and parking areas impacted by this Option and installation of pavement markings and ABA features as per the Drawings.

b. Remove existing diesel fueled generator and fuel tank. Replace with new natural gas fueled, spark ignited generator. Existing transfer switch will be reused.

2. Payment will be made at the contract lump sum price.
3. Measurement for payment will be based on percent completion agreed upon.

END OF SECTION

SECTION 01 31 00
PROJECT MANAGEMENT AND COORDINATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

1. Definitions.
2. Construction Coordination.
3. Submittals.
4. Coordination Drawings.
5. Requests for Information (RFIs).
6. NPS Project Management and Communication Software.
7. Project Meetings.
8. Environmental Coordination.
9. Permits.

B. Related Requirements:

1. Section 01 32 16, Construction Schedule, for preparing and submitting Construction Contractor's construction schedule.
2. Section 01 73 40, Execution, for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
3. Section 01 77 00, Closeout Procedures, for coordinating closeout of the Contract.
4. Section 01 91 14, Total System Commissioning, for coordinating the work with Owner's Commissioning Authority.

1.2 DEFINITIONS

A. Agency with Jurisdiction.

B. Construction Permits: Contractor Provided.

C. Government-Furnished Permits.

1.3 CONSTRUCTION COORDINATION

A. Coordination: Coordinate construction operations included in different sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different sections, which depend on each other for proper installation, connection, and operation.

1. Schedule construction operations in sequence required to obtain best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
2. Coordinate installation of different components with other Construction Contractors to ensure maximum accessibility for required maintenance, service, and repair.
3. Make provisions to accommodate items scheduled for later installation.
4. Where availability of space is limited, coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair of components, including mechanical and electrical.
5. Properly plan construction operations to include permit requirements. Allow enough time to execute permit provisions to maintain work schedule, site visits, inspections, and reporting deadlines.

B. Prepare memoranda for distribution to each party involved, outlining special procedures required for coordination. Include such items as required notices, reports, and list of attendees at meetings.

C. Administrative Procedures:

1. Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other Construction Contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to:

   a. Preparation of Construction Contractor Construction Schedule.
   b. Preparation of the Schedule of Values.
   c. Installation and removal of temporary facilities and controls.
   d. Delivery and processing of submittals.
   e. Progress meetings.
   f. Permit requirements.
   g. Pre-installation conferences.
   h. Project closeout activities.
   i. Commissioning activities.

1.4 SUBMITTALS

A. Coordination Drawings: Prepare Coordination Drawings if limited space availability necessitates maximum utilization of space for efficient installation of different components or if coordination is required for installation of products and materials fabricated by separate entities.

1. Content:

a. Project-specific information, drawn accurately to scale. Do not base Coordination Drawings on reproductions of Contract Documents or standard printed data. Include-following information, as applicable:

1) Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
2) Indicate dimensions shown on the Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment and minimum clearance requirements. Provide alternate sketches to Contracting Officer (CO) for resolution of such conflicts.
3) Indicate space requirements for routine maintenance and anticipated replacement of components during the life of the installation.
4) Show location and size of access doors required for access to concealed dampers, valves, and controls.
5) Indicate required installation sequences.

2. Refer to individual sections for Coordination Drawing requirements for Work in those sections.
3. Follow NPS DSC Electronic Drawing Standards. See CAD/BIM (Computer Aided Design/Building Information Modeling) & Drafting Standards page > DSC Requirements section.

B. Coordination Drawing Organization:

1. Organize coordination drawings as follows:

a. Floor Plans and Reflected Ceiling Plans: Show architectural, structural, mechanical, plumbing, fire-protection, fire-alarm, and electrical elements. Show locations of visible ceiling-mounted devices relative to acoustical ceiling grid. Supplement plan drawings with section drawings where required to adequately represent the Work.
b. Plenum Space: Indicate sub-framing for support of ceiling and wall systems, mechanical and electrical equipment, and related Work. Locate components within ceiling plenum to accommodate layout of light fixtures indicated on the Drawings. Indicate areas of conflict between light fixtures and other components.

c. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
d. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
e. Slab Edge and Embedded Items: Indicate slab edge locations and sizes and locations of embedded items for metal fabrications, sleeves, anchor bolts, bearing plates, angles, door floor closers, slab depressions for floor finishes, curbs and housekeeping pads, and similar items.
f. Mechanical and Plumbing Work:

1) Sizes and bottom elevations of ductwork, piping, and conduit runs, including insulation, bracing, flanges, and support systems.
2) Dimensions of major components, such as dampers, valves, diffusers, access doors, cleanouts and electrical distribution equipment.
3) Fire-rated enclosures around ductwork.

g. Electrical Work:

1) Runs of vertical and horizontal conduit 1-1/4 inches (32 millimeters) in diameter and larger.
2) Light fixture, exit light, emergency battery pack, smoke detector, and other fire-alarm locations.
3) Panel board, switch board, switchgear, transformer, busway, generator, and motor control center locations.
4) Location of pull boxes and junction boxes, dimensioned from column center lines.

h. Fire-Protection System: Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.
i. Review: Contracting Officer will review coordination drawings to confirm Work is being coordinated; details of coordination are Construction Contractor's responsibility. If Contracting Officer determines coordination drawings are not prepared in scope or detail, or are otherwise deficient, Contracting Officer will inform Construction Contractor, who shall make changes and resubmit.
j. Coordination Drawing Prints: Prepare coordination drawing prints according to requirements in Section 01 33 23, Submittal Procedures.

C. Coordination Digital Data Files:

1. Prepare coordination digital data files according to:

a. File Preparation Format: Same digital data software program, version, and operating system as original Drawings.

b. File Submittal Format: Submit or post coordination drawing files using Portable Document Format (PDF) file format.
c. Contracting Officer will furnish Construction Contractor one set of digital data files (AutoCad.dwg) of the Drawings for use in preparing coordination digital data files.

1) Contracting Officer makes no representations as to accuracy or completeness of digital data files as they relate to the Drawings.
2) Digital Data Software Program: Drawings are available in AutoCad.dwg.

D. Division 01, General Requirements Documents:

1. Letter designating Project Superintendent.
2. Construction Schedule.
3. A Comprehensive Schedule of Values.
4. Accident Prevention Plan.
5. A List of Subcontractors for this Project.
6. Written statements from Subcontractors certifying compliance with applicable labor standard clauses.
7. Certificates of Insurance and Standard Form SF1413 for Contactor and all Subcontractors.
8. Waste Management Plan.
9. Quality Control Plan.
10. Temporary Storm Water Pollution Prevention Plan (SWPPP).
11. Indoor Air Quality (IAQ) Management Plan.
12. Construction Contractor Commissioning Plan.
13. Historic Preservation Treatment Plan (HPTP).
14. List of Required Construction Permits. Include the following information for each permit:

a. Name of Permit.
b. Agency(ies) with Jurisdiction issuing the permit.
c. Information required from Government to complete permit application.

E. Provide items listed to Contracting Officer at least 1 week prior to Pre-Construction Conference, or as directed by Contracting Officer.

1. Failure to submit items may result in:

a. Construction conference may be cancelled, Notice to Proceed may not be issued, and Contracting Officer will consider other contractual remedies.
b. Work shall not commence until written Notice to Proceed has been issued and Certificates of Insurance and SF1413 documents are received for Construction Contractor and all Subcontractors.

1.5 REQUESTS FOR INFORMATION (RFI)

A. General: Immediately on discovery of the need for additional information or interpretation of Contract Documents, Construction Contractor shall prepare and submit an RFI utilizing form created on NPS project management and communication software.

1. Contracting Officer will not respond to RFIs submitted by other entities controlled by Construction Contractor.
2. Coordinate and submit RFIs in a prompt manner to avoid delays in the work.

B. Content of RFI:

1. Include detailed, legible description of item needing information or interpretation and the following:

a. RFI number, numbered sequentially.
b. Date.
c. RFI subject.
d. Specification section number and title and related paragraphs, as appropriate.
e. Drawing number and detail references, as appropriate.
f. Field dimensions and conditions, as appropriate.
g. Construction Contractor's suggested resolution: If suggested resolution impacts Contract Time or Contract Sum, Construction Contractor shall state impact in RFI.
h. Construction Contractor's signature.
i. Requested date for response.
j. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

1) Include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

C. RFI Form: Complete and submit on NPS project management and communication software.

D. Contracting Officer's Action: Contracting Officer will review each RFI, determine action required, and respond. Contracting Officer will determine critical nature of each RFI and issue response accordingly.

1. The following are not considered to be RFIs and will receive no action:

a. Requests for approval of submittals.
b. Requests for approval of substitutions.

c. Requests for approval of Construction Contractor's means and methods.
d. Requests for coordination information already indicated in Contract Documents.
e. Requests for adjustments in Contract Time or Contract Sum.
f. Requests for interpretation of Architect's actions on submittals.
g. Incomplete RFIs or inaccurately prepared RFIs.

2. Contracting Officer's action may include a request for additional information; time for response will date from time of receipt of additional information.
3. Contracting Officer's action on RFIs may result in need for a change to Contract Time or Contract Sum. All contract changes will be processed following terms and Conditions of Contract.

1.6 PROJECT MANAGEMENT AND COMMUNICATION SOFTWARE

A. Use to manage project communication and document sharing during contract period on:

1. Project directory.
2. Project correspondence.
3. Meeting agendas and minutes.
4. Contract modifications forms and logs.
5. RFI form and processing.
6. Task and issue management.
7. Photo documentation.
8. Baseline schedule, schedule updates and calendar management.
9. Submittal form and processing.
10. Payment coordination documentation.
11. Reminder and tracking functions.
12. Archiving functions.
13. Notification of submittal and RFI statuses and current responsible party.
14. Permits and addendums.

B. Some documents are not suitable to be shared using NPS project management and communication software. Documents containing Personal Identifying Information (PII) (i.e., certified payrolls) shall not be shared and shall be coordinated with project team as appropriate.

1.7 PROJECT MEETINGS

A. Preconstruction Conference:

1. Before start of construction, Contracting Officer will arrange an on-site meeting with Construction Contractor. Meeting agenda will include the following as a minimum:

   a. Roles & Responsibilities / Lines of Authority.
   b. Park rules and regulations.
   c. Jobsite Safety.
   d. Resolution of comments on required Division 01, General Requirements documents.
   e. Coordination of Subcontractors.
   f. Labor law application.
   g. Modifications.
   h. Payments to Construction Contractor.
   i. Payroll reports.
   j. Contract time.
   k. Liquidated damages.
   l. Construction Contractor Performance Evaluation.
   m. Display of Hotline posters.
   n. Notice to proceed.
   o. Correspondence procedures.
   p. NPS project management and communication software.
   q. Acceptance/rejection of work.
   r. Progress meetings.
   s. Submittal procedures.
   t. NPS Final Accessibility Inspection.
   u. Environmental requirements.
   v. Permit requirements.
   w. Historic properties protection requirements.
   x. Archeological resources protection requirements.
   y. As-constructed drawings/operation and maintenance (O&M) manuals.
   z. Saturday, Sunday, holiday and night work.
   aa. Reference materials.
   bb. Value engineering.
   cc. Schedule of Values.

B. Progress Meetings: Contracting Officer will schedule weekly meetings with Construction Contractor.

1. Attendees: In addition to Government Representatives, each Construction Contractor, Subcontractor, supplier, and other entity concerned with current progress or involved in planning, coordination, or performance of future

activities shall be represented. Participants at meeting shall be familiar with Project and authorized to conclude matters relating to the Work.

2. Agenda:

    a. Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Meeting agenda will include:

        1) Approval of minutes of previous meetings.
        2) Submittal status.
        3) Review of off-site fabrication and delivery schedules.
        4) Requests for information (RFI) and other issues.
        5) Modifications.
        6) Work in progress and projected.

            a) Status of required inspections (Special Inspections, Accessibility, etc.).

        7) Inspections of work in progress and projected (Special inspections, Accessibility, etc.).
        8) Construction Schedule update (provide updated Critical Path Method (CPM)).
        9) Status of Project Record Drawings and O&M manuals.
        10) Other business relating to work.
        11) Permit requirements.

C. Preinstallation Conferences: Conduct at Project Site before each construction activity that requires coordination with other construction.

1. Attendees: Installer and representatives of manufacturers and fabricators involved in or affected by installation and its coordination or integration with other materials and installations that have preceded or will follow, shall attend meeting. Advise Contracting Officer of scheduled meeting dates.

2. Agenda:

    a. Review progress of other construction activities and preparations for particular activity under consideration, including requirements for:

        1) Contract Documents.
        2) Options.
        3) Related RFIs.
        4) Related Change Orders.
        5) Purchases.
        6) Deliveries.
        7) Submittals.

b. Review of mockups.
c. Possible conflicts.
d. Compatibility requirements.
e. Time schedules.
f. Weather limitations.
g. Manufacturer's written instructions.
h. Warranty requirements.
i. Compatibility of materials.
j. Acceptability of substrates.
k. Temporary facilities and controls.
l. Space and access limitations.
m. Regulations of agency(ies) with jurisdiction.
n. Testing and inspecting requirements.
o. Installation procedures.
p. Coordination with other work.
q. Required performance results.
r. Protection of adjacent work.
s. Protection of construction and personnel.

3. Record significant conference discussions, agreements, and disagreements, including required corrective measures and actions.
4. Reporting: Distribute minutes of meeting to each party present and to other parties requiring information.
5. Do not proceed with installation if conference cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of Work and reconvene conference at earliest feasible date.

1.8 ENVIRONMENTAL COORDINATION

A. Construction Contractor's Environmental Manager: Designate onsite party responsible for overseeing Construction Contractor's conformance to environmental goals for project and implementing procedures for environmental protection.

1. Qualifications: Minimum 3 years Construction experience on projects of similar size and scope; with environmental procedures similar to this Project; familiarity with Environmental Management Systems (EMSs) such as International Organization for Standardization (ISO) 14001; familiar with environmental regulations applicable to construction operations.
2. Responsibilities:

a. Responsibilities shall include:

1) Compliance with applicable federal, state, and local environmental regulations, including maintaining required documentation.
2) Coordination with Archeological Monitor in accordance with Section 01 35 13.22, Archeological Protection.

3) Implementation of Waste Management Plan (WMP).
4) Implementation of Indoor Air Quality (IAQ) Management Plan.
5) Implementation of Storm Water Pollution Prevention Plan (SWPPP).
6) Present overview of environmental issues and summarize site specific procedures relating to management plans at Preconstruction conference.
7) Training for Construction Contractor personnel in accordance with position requirements.
8) Monitoring and documentation of environmental procedures.

B. Perform project quality control in accordance with requirements specified in Paragraph Related Requirements, including:

1. Quality Requirements.
2. Regulatory Requirements.
3. Indoor Air Quality (IAQ) Management.
4. Noise and Acoustics Management.
5. Temporary Storm Water Pollution Prevention Environmental Management.
6. Construction Waste Management.

C. Construction Contractor's Environmental Training Program:

1. Construction Contractor shall provide environmental training for workers performing work on Project Site. Training shall include:

a. Overview of environmental issues related to building industry.
b. Overview of environmental issues related to Project.
c. Review of Site-specific Procedures and Management Plans:

1) Construction Waste Management.
2) Indoor Air Quality (IAQ) Management.
3) Noise and Acoustics Management.
4) Temporary Storm Water Pollution Prevention.

d. Pollution Prevention (P2) Practices: Submit evidence of P2 training.
e. Compliance with environmental regulations: As specified in Regulatory Requirements. Submit Construction Contractor 40 CFR (Code of Federal Regulations) employee training records upon request of Contracting Officer.

D. Provide documentation for environmental procedures as specified herein and in accordance with approved Waste Management Plan, IAQ Management Plan, and Storm Water Pollution Prevention Plan.

1.9 PERMITS

A. General:

1. Permits and Responsibilities: Construction Contractor shall, without additional expense to the Government, be responsible for obtaining necessary licenses and permits, and for complying with federal, state, and municipal laws, codes, and regulations applicable to the performance of the work. Construction Contractor shall also be responsible for damages to persons or property that occur as a result of Construction Contractor's fault or negligence; and for materials delivered and work performed until completion and acceptance of the work.
2. For the purpose of this contract, Construction Contractor will not be considered an agent of the Government. Construction Contractor shall comply with appropriate federal, state and local laws.

B. Government Furnished Permits: The following permits will be received by the Government prior to bid award. Terms and provisions of these permits shall be adhered to for the duration specified in each permit.

1. New Mexico Department of Transportation (NMDOT) Environmental Clearance for Undertakings within NMDOT Right-of-Ways
2. NMDOT Application for Permit to Install Utility Facilities in Public Rights-of-Way
3. Utility Easements Right-of-Way from Los Alamos National Laboratories
4. A construction notification will be sent to Los Alamos County Department of Public Utilities GWS Operations 2 weeks prior to mobilization.

C. Potential Permits: Permits listed below were identified during the design process as likely to be required based on typical means and methods of construction. The list is provided to assist Construction Contractor in determining which permits will be required for contract's chosen means and methods. The list shall not be considered complete; it is the Construction Contractors' responsibility to determine means and methods and obtain required permits. Construction Contractor shall obtain all permits required to legally conduct work.

1. Electrical Utility Connection to Service Provider: Los Alamos National Laboratories.
2. Gas Utility Connection to Service Provider: Los Alamos National Laboratories.
3. Water Utility Connection to Service Provider: Los Alamos National Laboratories.
4. New Water Meter: Los Alamos County.
5. Highway 4 Right-of-Way Permit: New Mexico Department of Transportation.
6. Traffic Control/Roadway Work Permit for Highway 4 Utility Crossings: New Mexico Department of Transportation.

7. National Pollution Discharge Elimination System (NPDES) Permit: General Permit for Discharges of Stormwater (Storm Water Pollution Prevention Plan): New Mexico Environmental Department.
8. Required Excavation/Fill/Soil Disturbance (EXID) Excavation Permit (for utility work on Los Alamos National Laboratories property): Los Alamos National Laboratories. Permit will require a routine 7 business day review.

    a. Excavation activities may not commence on this project until the Excavation/Fill/Soil Disturbance permit has been approved and issued by OSH-ISH. Requests may be submitted by accessing the excavation permit url: http://eswebapps/irt/login.aspx.
    b. All changes, deviations in the proposed scope (length, depth, width, location etc.) of the activity will need to be resubmitted for appropriate review and approval.
    c. Requester of an excavation permit review or anyone who is listed as a Person in Charge (PIC)/Alt PIC/STR must take the online Excavation Soil Disturbance self-study (Course 31419) and LANL Excavation/ Fill/ Soil Disturbance (EXID) Permit Process Using the EXID Request System (Course 47420) prior to requesting the review.
    d. If there are questions, contact Carrie Atencio at (505) 695-5343 or carriea@lanl.gov.
    e. Access the IRT policy at https://int.lanl.gov/policy/documents/P351.pdf.
    f. Access the Excavation/Fill/Soil Disturbance Procedure P101-17 at: http://int.lanl.gov/policy/documents/P101-17.pdf.

9. Dewatering Permit: New Mexico Environmental Department.
10. Digging/Excavation: New Mexico OneCall.
11. Air Quality Permit Hot Mix Asphalt Plant General Construction Permit 3 (GCP-3).

D. Construction Contractor Utility Coordination within Bandelier National Monument:

1. Coordinate in accordance with Section 01 32 16, Construction Schedule.

    a. Water, sanitary sewer, electric, natural gas, communications.
    b. Construction Trailer, Utilities Hookup Permit: Bandelier National Monument.
    c. Traffic Control/Street Closure: Bandelier National Monument.
    d. Hydrostatic Testing Approval: National Park Service.
    e. Waterline Flushing and Disinfection Approval: National Park Service.

E. Coordination with Agency(ies) with Jurisdiction Issuing Permits:

1. Coordination:

a. Contact the Agency(ies) with Jurisdiction as needed and sufficiently in advance to avoid delaying work: Coordinate meetings, reporting requirements, inspections, and other requirements.

F. Administrative Procedures:

1. Coordinate scheduling and timing of required administrative provisions of project permits with Agency(ies) with Jurisdiction, Construction Manager, and Park to avoid conflicts.
2. Supply needed information to Agency(ies) with Jurisdiction issuing permits, pay fees required and provide material needed to comply with permit's conditions and provisions.
3. Upload permits to NPS project management and communication software when permits are obtained.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 32 16
CONSTRUCTION SCHEDULE

PART 1 GENERAL

1.1 SUMMARY

A. Section consists of Construction Schedule requirements including:

1. Schedule of Values.
2. Construction Schedule Requirements.
3. Construction Schedule Updates.
4. Time Impact Analysis.
5. Submittal Schedule.

B. Purpose: The Construction Schedule ensures adequate planning, coordination, scheduling, and reporting during execution of the work by the Construction Contractor. It shall assist the Construction Contractor and Contracting Officer (CO) in monitoring the progress of the work, evaluating proposed changes, and processing Construction Contractor's monthly progress payments. It shall include the dates in the contract, phases, milestones, occupancies, holidays, weather consideration, a critical path, and the requirements of this section.

1.2 DEFINITIONS

A. Activity: A discrete part of a project identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources.

1. Critical activities are activities on the critical path. They start and finish on the planned early start and finish times.
2. Predecessor Activity: An activity that precedes another activity in the network.
3. Successor Activity: An activity that follows another activity in the network.

B. Cost Loading: Allocation of the Schedule of Values for completion of an activity as scheduled. The sum of costs for all activities must equal the total Contract Sum, unless otherwise approved by the Contracting Officer.

C. Critical Path Method (CPM): Method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

D. Critical Path: Longest connected chain of interdependent activities through the network schedule that establishes minimum overall Project duration and contains no float.

E. Float: Measure of leeway in starting and completing an activity.

1. Float: Not for the exclusive use or benefit of the Government or Construction Contractor but is jointly owned.
2. Free Float: Amount of time an activity can be delayed without adversely affecting the early start of the successor activity.
3. Total Float: Measure of leeway in starting or completing an activity without adversely affecting planned Project completion date.

F. Resource Loading: Allocation of manpower and equipment necessary for completion of an activity as scheduled.

G. Fragnet: A partial or fragmentary network that breaks down activities into smaller activities for greater detail.

1.3 SUBMITTALS

A. Electronic Copies: Schedules and reports submitted shall be posted on the NPS project management and communication software as PDF (portable document format) files. The intent of the Government is to limit the number of printed reports to those determined by the project team as essential.

B. Schedule of Values: After contract award and before Pre-Construction conference, submit schedule of dollar values based on Contract Price Schedule.

C. Construction Baseline Schedule: After contract award and before Pre-Construction conference, submit two paper copies of baseline schedule, large enough to show entire schedule for entire construction period. Utilize Schedule of Values in preparation of Construction Baseline Schedule.

D. Critical Path Method (CPM) Reports: Concurrent with CPM schedule, submit three paper copies of the following computer-generated reports. For each activity, include activity number, activity description, cost and resource loading, original duration, remaining duration, early start date, early finish date, late start date, late finish date, and total float in calendar days.

1. Activity Report: List of activities sorted by activity number and then early start date, or actual start date if known.
2. Logic Report: List of predecessor and successor tasks for activities sorted in ascending order by activity number and then early start date, or actual start date if known.
3. Total Float Report: List of activities sorted in ascending order of total float.

E. Construction Schedule Updates: On or before 7th day preceding progress payment request date, submit estimates of percent completion of each schedule activity and necessary supporting data. Provide two paper copies.

F. Construction Schedule Revisions and Time Impact Analysis: For each Construction Schedule revision, submit two paper copies of a Time Impact Analysis. Incorporate a Fragmentary Network (Fragnet) into currently accepted Construction Schedule demonstrating proposal to incorporate a modification, change, delay, or Construction Contractor request.

1.4 QUALITY ASSURANCE

A. Construction Contractor shall meet with Contracting Officer on day of the preconstruction conference to go over:

1. Review software limitations, content and format for reports.
2. Verify availability of qualified personnel needed to develop and update schedule.
3. Discuss constraints, including phasing, work stages, area separations, interim milestones, and partial Government occupancy/substantial completions. Refer to Section 01 11 00, Summary of Work, for list of constraints identified by NPS.
4. Review delivery dates for Government-furnished products.
5. Review schedule for work of separate Government contracts.
6. Review time required for review of submittals and re-submittals.
7. Review requirements for tests and inspections by independent testing and inspecting agencies.
8. Review time required for completion and startup procedures.
9. Review time required for obtaining and activating permits.
10. Review and finalize list of construction activities to be included in schedule.
11. Review baseline schedule comments, resolve issues and progress on incorporating them.
12. Review procedures for updating schedule.
13. Discuss reporting requirements and establish protocol for naming and transmitting electronic schedules.

B. Construction Contractor’s Schedule Representative: Before the preconstruction conference, designate an authorized representative to be responsible for preparing and maintaining the Construction Schedule. Submit resume outlining qualifications of Scheduler to Contracting Officer for acceptance. Scheduler shall have prepared and maintained at least five previous schedules of similar size and complexity similar to this Contract, demonstrating proficiency of using scheduling software. Authorized representative will be responsible for preparing the Baseline Schedule, required updates, revisions, Time Impact Analyses, and reports.

1.5 COORDINATION

A. Coordinate preparation and processing of schedules and reports with performance of construction activities and with scheduling and reporting of separate Construction Contractors.

B. Coordinate Construction Baseline Schedule with Schedule of Values, list of subcontracts, Submittals Schedule, progress reports, payment requests, and other required schedules and reports.

1. In developing Construction Baseline Schedule, ensure Subcontractor's work at all tiers, and prime Construction Contractor's work, is included and coordinated.
2. Secure time commitments for performing critical elements of work from parties involved.
3. Coordinate each construction activity in network with other activities and schedule in proper sequence.

PART 2 PRODUCTS

2.1 SCHEDULE OF VALUES

A. Breakdown each lump-sum item into component work activities used in the schedule for which progress payments may be requested. Work activities broken out within schedule of values shall be integrated into and made a logical part of the construction baseline schedule. Total costs for the component work activities shall equal Contract Price for that lump-sum item. Contracting Officer may request data to verify accuracy of dollar values. Include mobilization, general condition costs, overhead and profit in the total dollar value of unit price items and in the component work activities for each lump-sum item. Do not include mobilization, general condition costs, overhead or profit as a separate item.

B. Do not break down unit price items. Use only the Contract Price for unit price items.

C. Total cost of all items shall equal the Contract Price. The Schedule of Values will form the basis for progress payments and the Construction Schedule.

2.2 CONSTRUCTION SCHEDULE REQUIREMENTS

A. Construction Baseline Schedule: Prepare Construction Baseline Schedule using a computerized, cost and resource-based**,** time-scaled Critical Path Method network analysis diagram for the Work.

1. Develop and finalize Construction Baseline Schedule so it can be accepted for use no later than 30 days after date established for the Notice of Award.

   a. Failure to include any work item required for performance of this Contract shall not excuse Construction Contractor from completing work within applicable completion dates, regardless of Governments acceptance of schedule.

2. Establish procedures for monitoring and updating Construction Baseline Schedule and for reporting progress. Coordinate procedures with progress meeting and payment request dates.

B. Construction Baseline Schedule Preparation: Prepare a list of all activities required to complete the Work. Using preliminary Critical Path Method network diagram, prepare a skeleton network to identify probable critical paths.

1. Activities: Indicate estimated duration, sequence requirements, and relationship of each activity in relation to other activities.
2. Critical Path Activities: Identify critical path activities, including those for interim completion dates. Scheduled start and completion dates shall be consistent with Contract milestone dates.
3. Processing: Process data to produce output data on a computer-drawn, time-scaled network. Revise data, reorganize activity sequences, and reproduce as often as necessary to produce the Critical Path Method schedule within the limitations of the Contract Time.
4. Show sequence and interdependence of activities required for completion of work. Ensure work sequences are logical and Construction Baseline Schedule shows a coordinated plan of the work.
5. Resource loading of each activity shall include personnel by labor category and equipment type and capacity proposed to complete the activity in duration shown.
6. Consider seasonal weather conditions in planning and scheduling work influenced by high and low ambient temperatures, wind, or precipitation to ensure completion of work within Contract Time.
7. Time Frame: Proposed duration assigned to each activity shall be Construction Contractor's best estimate of time required to complete activity considering the scope and resources planned for activity.

    a. An early finish date may be shown but the late finish date shall be same date as last day of contract period. An early completion schedule shall contain:

        1) Insert an activity titled "Project Float" as a successor to last activity in early project completion schedule network.
        2) Add a milestone titled "Contract End Date" as a successor to the activity "Project Float."
        3) Add duration to the activity "Project Float" as required so the milestone "Contract End Date" equals the last day of Contract Period.

    b. Contract completion date shall not be changed by submission of a schedule that shows an early completion date.
    c. Construction Contractor shall limit use of lead or lag duration's between schedule activities.

d. Project Calendars:

1) Develop and incorporate the following calendars:

a) Administrative Calendar: Include calendar based on a 7-day week to be used on activities based on calendar days. Apply this calendar to administrative tasks or other tasks not affected by non-working days (Federal Holidays, weather, etc.).

b) Project Calendar: Include calendar based on planned work week for the project. Include Federal Holidays, weekends, and non-workdays indicated in contract documents. Apply this calendar to activities not anticipated to be affected by weather. Be clear when identifying number of workdays in work week.

c) Weather Calendar: Utilize Project Calendar and show anticipated normal downtime related to weather as non-working time. Weather days shall be based on data for local area from a reliable source like the National Oceanic and Atmospheric Administration (NOAA), National Park Service records, or source acceptable to Contracting Officer. Apply this calendar to activities anticipated to be affected by weather.

e. Activity Duration: Define so no activity is longer than 14 days, except for non-construction activities including mobilization, Shop Drawings and submittals, fabrication and delivery of materials and equipment.

f. Procurement Activities: Include procurement process activities for long lead items and major items, requiring a cycle of more than 60 calendar days, as separate activities in the schedule. Procurement cycle activities can include submittals, approvals, purchasing, fabrication, and delivery.

1) Transformers.
2) Switchgear.
3) Generators for temporary power.
4) Canyon mechanical precast concrete building.

g. Submittal Review Time: Include review and re-submittal times indicated. Coordinate submittal review times in Construction Baseline Schedule.

h. Startup and Testing Time: Include not less than 14 days for startup, testing, and commissioning activities.

i. Substantial Completion: Allow time for Government administrative procedures necessary for certification of Substantial Completion. (For more information, refer to Section 01 77 00, Closeout Procedures.)

8. Constraints: Include constraints and work restrictions indicated in Contract Documents and as follows in schedule and show how the sequence of Work is affected.

   a. Phasing: Arrange list of activities on schedule by phase.
   b. Work under More Than One Contract: Include a separate activity for each contract.
   c. Work Restrictions:

      1) Show effect of the following on the schedule:

         a) Coordination with existing construction.
         b) Limitations of continued occupancies.
         c) Uninterruptible services.
         d) Partial occupancy before Substantial Completion.
         e) Use of premises restrictions.
         f) Provisions for future construction.
         g) Seasonal variations.
         h) Environmental control.
         i) Permit provisions.

   d. Other Constraints: Entrance Road must remain open to vehicular traffic at all times during the contract. Refer to Section 01 11 00, Summary of Work, for NPS.
   e. Work Stages: Indicate important stages of construction for each major portion of the Work.

      1) Subcontract awards.
      2) Submittals.
      3) Purchases.
      4) Mockups.
      5) Fabrication.
      6) Sample testing.
      7) Deliveries.
      8) Installation.
      9) Tests and inspections.
      10) Adjusting.
      11) Curing.
      12) Soil Preparation for Surface Restoration.
      13) Building flush-out.
      14) Building commissioning activities.

9. Milestones: Include milestones indicated in Contract Documents in schedule, including, but not limited to, Notice to Proceed, Substantial Completion.

C. Joint Review, Revision, and Acceptance:

1. Within 7 calendar days of receiving Construction Contractor's proposed Construction Baseline Schedule, Contracting Officer shall review initial Construction Baseline Schedule.
2. Within seven calendar days after review, Construction Contractor shall revise and resubmit Construction Baseline Schedule in accordance with comments presented from review.
3. In the event the Construction Contractor fails to define any element of work, activity, or logic and the Contracting Officer review does not detect this omission or error, such omission or error, when discovered by Construction Contractor or Contracting Officer, shall be corrected by Construction Contractor within 7 calendar days and shall not affect contract period.
4. Upon acceptance of the Construction Baseline Schedule, Contracting Officer saves schedule as a baseline and updates on a monthly basis. Construction schedule update will be used to evaluate Construction Contractor's monthly applications for payment based upon information developed at monthly Construction Schedule update meeting.

D. Cost Correlation: In the heading of the schedule, provide a cost correlation line, indicating planned and actual costs. On the line, show dollar volume of Work performed as of dates used to prepare payment requests.

1. Construction Contractor shall assign cost to construction activities on Construction Baseline Schedule. Costs shall not be assigned to submittal activities unless specified otherwise but may, with Contracting Officer's approval, be assigned to fabrication and delivery activities. Costs shall be included for testing and commissioning activities, operation and maintenance manuals, punch list activities, Project Record Documents, and demonstration and training (if applicable).
2. Each activity cost shall reflect an accurate value based on the Contract Price Schedule.
3. Total cost assigned to activities shall equal total Contract Price.

E. Recovery Schedule: When periodic schedule update indicates Work is 14 or more calendar days behind current accepted schedule, a separate recovery schedule indicating means by which Construction Contractor intends to regain compliance with the schedule shall also be submitted. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery shall be accomplished.

F. Computer Software: Prepare schedules using a program developed specifically to manage construction schedules.

1. Manufacturers:

a. Primavera.
b. Or equal.

2. Physical Characteristics: None.
3. Functional Characteristics:

a. Ability to prepare a Gantt Chart Layout with critical path report.
b. Ability to track project costs or Earned Value Management and prepare an Earned Value Report.
c. Ability to generate a 3-month look ahead.
d. Ability to prepare a functional group summary report to see planned activities for a certain group.

4. Performance Characteristics: None.

PART 3 EXECUTION

3.1 CONSTRUCTION SCHEDULE UPDATES

A. Progress Meeting Updates: Provide a 3-week look-ahead schedule, derived from the currently accepted schedule, before each weekly progress meeting. Utilize look-ahead schedule to facilitate and take notes on discussions held during progress meeting.

B. Monthly Schedule Updates:

1. General: Update Construction Schedule on monthly basis to reflect construction progress and activities throughout entire contract period and until project substantial completion. The status date of each schedule update shall be the 7th day preceding the progress payment request date.
2. Procedure: Construction Contractor shall meet with Contracting Officer each month at Construction Schedule update meeting to review progress made through the status date of the Construction Schedule update, including dates activities were started or completed and percentage of work completed on each activity started or completed.
3. Reports:

a. Concurrent schedule revisions, prepare tabulated reports showing:

1) Identification of activities that have changed.
2) Changes in early and late start dates.
3) Changes in early and late finish dates.
4) Changes in activity durations in workdays.

5) Changes in the critical path.
6) Changes in total float or slack time.
7) Changes in the Contract Time.

4. Narrative: Report shall include a brief description of actual progress made during update period; actual and potential delaying activities; impediments to progress; issues related to inclement weather; progress toward established milestones and project float. Report shall include a brief description of work anticipated to be performed in the next month. Minor revisions to the schedule should be identified for evaluation and acceptance or rejection.
5. As Work progresses, indicate Actual Completion percentage for each activity.
6. If schedule update shows a late finish date after contract completion date, include:

   a. Known delays.
   b. Actions to get back on schedule.
   c. Pending modifications.
   d. Impediments or constraints affecting progress.

7. Progress Payments: Monthly updating of the currently accepted Construction Schedule shall be an integral part of the process upon which progress payments will be made. If Construction Contractor fails to provide schedule updates or revisions, a portion of the monthly payment may be retained until corrections have been made.

C. Distribution: Distribute copies of accepted schedule to Contracting Officer, Contracting Officers Representative, Construction Management Representative, Subcontractors, testing and inspecting agencies, and other parties identified by Construction Contractor with a need-to-know schedule responsibility.

1. Post copies in Project meeting rooms and temporary field offices.
2. When revisions are made, distribute updated schedules to same parties and post in same locations. Delete parties from distribution when they have completed their assigned portion of the Work.

D. Construction Schedule Revisions:

1. Required Revisions: If, as a result of the monthly schedule update, it appears the currently accepted Construction Schedule no longer represents actual prosecution and progress of the work, Contracting Officer will request, and Construction Contractor shall submit, a revision to the Construction Schedule. Construction Contractor may also request reasonable revisions to currently accepted Construction Schedule in event the Construction Contractor's planning for the work is revised. If Construction Contractor desires to make changes, Construction Contractor shall notify Contracting Officer in writing, stating reason for proposed revision. Accepted revisions shall be incorporated

into currently accepted Construction Schedule for next monthly schedule update.

2. Procedure: If revision to currently accepted Construction Schedule is contemplated, Construction Contractor or Contracting Officer shall advise the other in writing at least seven calendar days prior to next monthly schedule update meeting, describing revision and reasons for the revision. Government-requested revisions will be presented in writing to the Construction Contractor, who shall respond in writing within seven calendar days.

3. Reports:

   a. Concurrent with making revisions to schedule, prepare tabulated reports showing:

      1) Identification of activities changed.
      2) Changes in early and late start dates.
      3) Changes in early and late finish dates.
      4) Changes in activity durations in workdays.
      5) Changes in critical path.
      6) Changes in total float or slack time.

3.2 TIME IMPACT ANALYSIS FOR CONTRACT MODIFICATIONS CHANGES DELAYS AND CONSTRUCTION CONTRACTOR REQUESTS

A. Requirements: When contract modifications or changes are initiated, delays experienced, or Construction Contractor desires to revise currently accepted Construction Schedule, Construction Contractor shall submit to Contracting Officer a written time impact analysis illustrating the influence of modification, change, delay, or Construction Contractor request on Contract Time.

B. Time Extensions: Activity delays, resulting in a late completion date projection, shall not automatically mean an extension of Contract Time is warranted or due to Construction Contractor. It is possible a modification, change, or delay will not affect existing critical path activities or cause non-critical activities to become critical. A modification, change, or delay may result in absorbing a part of available total float that may exist within an activity chain of the Schedule, not causing any effect on Contract Time. Time extensions will be granted in accordance with terms of contract.

C. Extension of Contract Time will be granted only to the extent the equitable time adjustments to activity or activities affected by modification, change, or delay exceeds total (positive or zero) float available on a particular activity.

D. Procedure: Each time impact analysis shall be submitted within time period stated in a request for proposal, or time period designated under the clauses entitled Changes or Default. In cases where Construction Contractor does not submit a written request for extension of time and a time impact analysis within the designated time, it is mutually agreed that the particular modification, change, delay, or Construction Contractor request does not require an extension of the Contract Time. Upon

acceptance, time impact analysis shall be incorporated into currently accepted Construction Schedule at next monthly schedule update.

E. Contract Modifications: Prepare time-impact analysis using fragnets to demonstrate effect of proposed change on overall Construction Schedule for each proposed contract modification concurrent with submission.

END OF SECTION

SECTION 01 32 33
PHOTO DOCUMENTATION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for:

1. Existing condition images.
2. Periodic construction images.

B. See Section 01 77 00, Closeout Procedures, for a complete listing of closeout documents.

C. See Section 01 79 00, Demonstration and Training, for submitting videotapes of demonstration of equipment and training of National Park Service (NPS) personnel.

1.2 SUBMITTALS

A. Construction Images:

1. Submit images electronically within 7 days of taking the image. Include the following for each:

   a. All images shall be date and time stamped.
   b. Date, time and number (sequentially number all images) in filename.
   c. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
   d. Submit digital images exactly as originally recorded in digital camera, without alteration, or modifications using image-editing software.

B. Closeout: Submit complete set of digital image electronic files as a Project Record Document. Submit photos either through digital format or online (i.e. cloud) storage at the direction of the Contracting Officer.

1. List each image as a file name with number, date, and time. Include description and or vantage point image was taken.
2. Submit images that have the same aspect ratio as the sensor, un-cropped.

PART 2 PRODUCTS

2.1 FORMAT REQUIREMENTS

A. Images: Provide sRGB (standard Red Green Blue) color images in JPEG (Joint Photographic Experts Group) format. Minimum sensor size of 12 megapixels, and at image resolution of not less than 4200 by 2800.

PART 3 EXECUTION

3.1 CONSTRUCTION IMAGES

A. General: Take digital images using the maximum range of depth of field, in-focus, to clearly show the Work. No blurry or out-of-focus areas accepted.

1. Maintain index with each set of Construction images and identify the number, date, time, and description for each.
2. Maintain one set of images accessible in field office at Project Site available for reference.

B. Existing Condition Images: Before commencement of excavation, commencement of demolition and starting construction, take color digital images of Project Site and surrounding properties, including existing items to remain during construction, from different vantage points.

1. Flag construction limits before recording construction images.
2. Take a sufficient number of separate images to show existing conditions of natural and man-made features adjacent to the work limits before starting the Work.
3. Take a sufficient number of separate images of existing features adjacent to the Work, to include but not limited to historic features (flagstone, gutters, walls, buildings, retaining walls, curbs, etc.), vegetation, drainage channels, trees indicated to be protected and remain, asphalt, etc. to accurately record the physical conditions at the start of construction. Take clear photographs of any pre-existing damage or deterioration to any adjacent features so as to document such conditions.

C. Periodic Construction Images: Take a minimum of 25 color, digital images daily, with timing each month adjusted to coincide with the cutoff date associated with each Application for Payment. Select vantage points to show status of construction and progress since last images were taken.

D. Storage: Provide photos either through digital format or online (i.e. cloud) storage at the direction of the Contracting Officer.

E. Additional Images: Contracting Officer may issue requests for additional images.

1. Three days advance, where feasible.
2. In emergency situations, take additional images within 24 hours of request.

3. Additional images include, but are not limited to:

   a. Immediate follow-up when on-site events result in construction damage or losses.
   b. Fabrication locations away from Project Site.
   c. Substantial Completion of a major phase or component of Work.
   d. Extra record images at time of final acceptance.

END OF SECTION

SECTION 01 33 23
SUBMITTAL PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for submitting Shop Drawings, Product Data, Samples, and other submittals.

1.2 DEFINITIONS

A. Action Submittals: Written, graphic information, and physical samples that require Government's responsive action.

B. File Transfer Protocol (FTP): Communications protocol that enables transfer of files to and from another computer over a network and that serves as the basis for standard Internet protocols. An FTP site is a portion of a network located outside of network firewalls within which internal and external users are able to access files.

C. Informational Submittals: Written information that does not require Government's responsive action. Submittals may be rejected for not complying with requirements.

D. Portable Document Format (PDF): An open standard file format licensed by Adobe Systems used for representing documents in a device-independent and display resolution-independent fixed-layout document format.

1.3 GENERAL SUBMITTAL PROCEDURES

A. General: Prepare and submit submittals required by individual specification sections and in some cases as requested on the Drawings. Types of submittals are indicated in individual specific sections and must be complete before submittal.

1. Contracting Officer (CO) reserves right to require submittals in addition to those called for in individual sections.

B. Coordination: Coordinate preparation and processing of submittals with performance of construction activities. Review for legibility, accuracy, completeness, and compliance with Contract Documents.

1. Coordinate submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

2. Coordinate transmittal of different types of submittals for related parts of Work so processing will not be delayed because of need for concurrent review coordination.

    a. Contracting Officer reserves right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

C. Submittal List: Submittal list is attached to the end of this section. The intent is to provide an overall summary of submittal requirements. The requirements of individual specification sections and terms and conditions of the Contract still apply regardless of what is shown on submittal list.

D. Processing Time: Allow enough time for submittal review and resubmittals. Contract time extensions will not be authorized if submittals are not transmitted with enough time to permit processing, including resubmittals.

1. Action Submittals:

    a. Initial Review: Allow 30 calendar days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required.
    b. Resubmittal Review: Allow 21 calendar days for review of each resubmittal or if a submittal is re-opened.

2. Informational Submittals:

    a. Review: Allow 14 calendar days for review of each submittal.

E. Approved Equal Submittal Requirements:

1. For each item proposed as an “approved equal,” submit supporting data, including:

    a. Drawings and samples as appropriate.
    b. Comparison of the salient characteristics of the proposed item with that specified.
    c. Changes required in other elements of the work because of the substitution.
    d. Name, address, and telephone number of vendor.
    e. Manufacturer’s literature regarding installation, operation, and maintenance, including schematics for electrical and hydraulic systems, lubrication requirements, and parts lists. Describe availability of maintenance service, and state source of replacement materials.

2. A request for approval constitutes a representation that Construction Contractor:

   a. Has investigated the proposed item and determined that it is equal or superior in all respects to that specified.
   b. Will provide the same warranties for the proposed item as for the item specified.
   c. Has determined that the proposed item is compatible with interfacing items.
   d. Will coordinate installation of an approved item and make changes required in other elements of the work because of the substitution.
   e. Waives claims for additional expenses that may be incurred as a result of the substitution.

F. Submittals: Identify and incorporate information in each submittal file as follows:

   1. Transmittal Form (CM-16): Utilize NPS Transmittal Form for all submittals. No action will be taken on a submittal item unless accompanied by this Transmittal Form.
   2. Physical Samples: Complete Transmittal Form and deliver physical sample to the Contracting Officer (or designee) on site for processing. All comments and actions will be documented on the Transmittal Form.

G. Identification: Submittal number or other unique identifier, including revision identifier.

   1. Submittal number shall use a sequential number (e.g., .001). Resubmittals shall include alphabetic suffix after another decimal point (e.g., .001.A).

H. Resubmittals: Make resubmittals using same process used with initial submittal.

   1. Note date and content of previous submittal.
   2. Note date and content of revision in the title block on the Transmittal Form (CM-16) and clearly indicate extent of revision.
   3. Resubmit submittals until they are marked “Approved” or “Approved with notations.”

I. Distribution: Furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, and others as necessary for performance of construction activities.

J. Use for Construction: Use only final submittals with mark indicating “Approved,” “Accepted,” or “Approved with notations.” Ensure notations have been incorporated and, at a minimum, keep one copy of final approved submittal on site for use during construction.

1.4 CONSTRUCTION CONTRACTOR'S USE OF CAD/BIM FILES

A. General:

1. At Construction Contractor's written request, copies of CAD/BIM (Computer Aided Design/Building Information Modeling) files will be provided to Construction Contractor for use in connection with Project, subject to:

a. Files provided as is; no format or other changes to files or changes to objects on the Drawings will be done by the Government.
b. The CAD files are provided for the convenience of the Contractor in planning for temporary working space, protection of existing utilities and features, and survey stakeout of new work. The printed construction documents prevail in the case of any discrepancies.

PART 2 PRODUCTS

2.1 ACTION SUBMITTALS

A. Product Data: Collect information into a single submittal for each element of construction and type of product or equipment.

1. If information must be specially prepared for submittal because standard printed data are not suitable for use, submit as Shop Drawings, not as Product Data.
2. Mark each submittal to show which products and options are applicable.
3. As applicable, include:

a. Manufacturer's product specifications.
b. Manufacturer's Installation Instructions: When Contract Documents require compliance with manufacturer's printed instructions, provide one complete set of instructions to Contracting Officer and keep another complete set of instructions at the Project Site until substantial completion.
c. Manufacturer's Catalog Cuts: Submit only pertinent pages; mark each page of standard printed data to identify specific products proposed for use.
d. Wiring diagrams showing factory-installed wiring.
e. Printed performance curves.
f. Operational range diagrams.
g. Compliance with specified referenced standards.
h. Testing by recognized testing agency.

4. Submit product data in PDF (portable document format) file format before or concurrent with samples.

B. Shop Drawings: Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data.

1. Preparation:

a. Fully illustrate requirements in Contract Documents. As applicable, include:

1) Dimensions.
2) Identification of products.
3) Fabrication and installation drawings.
4) Roughing-in and setting diagrams.
5) Wiring diagrams showing field-installed wiring, including power, signal, and control wiring.
6) Shopwork manufacturing instructions.
7) Templates and patterns.
8) Schedules.
9) Notation of coordination requirements.
10) Notation of dimensions established by field measurement.
11) Relationship to adjoining construction clearly indicated.
12) Seal and signature of professional engineer if specified.
13) Wiring Diagrams: Differentiate between manufacturer-installed and field-installed wiring.

2. Submit Shop Drawings as PDF electronic file.

C. Samples: Submit Samples for review of kind, color, pattern, and texture for a check of these characteristics with other elements and for a comparison of these characteristics between submittal and actual component as delivered and installed.

1. Transmit Samples that contain multiple, related components such as accessories together in one submittal package.
2. Complete and post the Transmittal Form (CM-16) on the NPS project management and communication software website for processing and documentation of action on submitted samples.
3. Identification:

a. Attach label on unexposed side of Samples that includes:

1) Generic description of Sample.
2) Product name and name of manufacturer.
3) Sample source.
4) Submittal Number and title of appropriate specification section.

4. Disposition: Maintain sets of approved Samples at Project Site, available for quality-control comparisons throughout course of construction activity. Sample

sets may be used to determine final acceptance of construction associated with each set.

5. Samples for Initial Selection: Submit manufacturer's color charts consisting of units or sections of units showing full range of colors, textures, and patterns available.

    a. Number of Samples: Submit two full set(s) of available choices where color, pattern, texture, or similar characteristics are required to be selected from manufacturer's product line. Contracting Officer will return with options selected.

6. Samples for Verification:

    a. Submit full-size units or Samples of size indicated, prepared from same material to be used for the Work, cured and finished in manner specified, and physically identical with material or product proposed for use, and that show full range of color and texture variations expected. Samples include: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.

        1) Number of Samples: Submit four sets of Samples. Contracting Officer will retain three Sample sets; remainder will be returned.

D. Construction Materials: Construction Contractor is encouraged to submit products made out of recycled or environmentally responsible material. Every effort will be made by NPS to approve these materials.

2.2 INFORMATIONAL SUBMITTALS

A. General: Prepare and submit Informational Submittals required by individual specification sections.

1. Post informational submittals as PDF electronic files directly to the NPS project management and communication software.
2. Certificates and Certifications: Provide a notarized statement with signature of entity responsible for preparing certification. Certificates and certifications shall be signed by officer or other individual authorized to sign documents on behalf of that entity.
3. Informational submittals that do not comply with requirements specified in Contract Documents will be rejected and one copy will be returned.

B. Coordination Drawings: Comply with requirements specified in Section 01 31 00, Project Management and Coordination.

C. Construction Contractors Construction Schedule: Comply with requirements specified in Section 01 32 16, Construction Schedule.

D. Accident Prevention Plan: Comply with requirements specified in Section 01 35 23, Safety Requirements.

E. Schedule of Values: Comply with requirements specified in Section 01 32 16, Construction Schedule.

F. Waste Recycling Plan: Comply with requirements specified in Section 01 74 19, Construction Waste Management and Disposal.

G. Quality Control Plan: Comply with requirements specified in Section 01 40 00, Quality Requirements.

H. Storm Water Pollution Prevention Plan: Comply with requirements specified in Section 01 57 23, Temporary Storm Water Pollution Prevention, and storm water permit requirements identified in Section 01 31 00, Project Management and Coordination.

I. Qualification Data: Prepare written information demonstrating capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

J. Welding Certificates: Prepare written certification that welding procedures and personnel comply with Contract Documents. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on American Welding Society (AWS) forms. Include names of firms and personnel certified.

K. Installer Certificates: Prepare written statements on manufacturer's letterhead certifying Installer complies with Contract Documents and, where required, is authorized by manufacturer for this specific Project.

L. Manufacturer Certificates: Prepare written statements on manufacturer's letterhead certifying manufacturer complies with Contract Documents. Include evidence of manufacturing experience where required.

M. Product Certificates: Prepare written statements on manufacturer's letterhead certifying product complies with Contract Documents.

N. Material Certificates: Prepare written statements on manufacturer's letterhead certifying material complies with Contract Documents.

O. Material Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements in Contract Documents.

P. Product Test Reports: Prepare written reports indicating current product produced by manufacturer complies with requirements in Contract Documents. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

Q. Research/Evaluation Reports: Prepare written evidence, from a model code organization acceptable to authorities having jurisdiction, that product complies with building code in effect for Project.

R. Preconstruction Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements in Contract Documents.

S. Compatibility Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

T. Field Test Reports: Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements in Contract Documents.

U. Maintenance Data: Prepare written and graphic instructions and procedures for operation and normal maintenance of products and equipment. Comply with requirements specified in Section 01 78 23, Operation and Maintenance Data.

V. Design Data:

1. Prepare written and graphic information, including: Performance and design criteria, list of applicable codes and regulations, and calculations. Include list of assumptions and other performance and design criteria and a summary of loads. Include load diagrams if applicable. Provide name and version of software, if any, used for calculations. Include page numbers.

W. Manufacturer's Instructions: Prepare written or published information documenting manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer.

X. Manufacturer's Field Reports:

1. Prepare written information documenting factory-authorized service representative's tests and inspections. As applicable, include:

a. Statement on condition of substrates and their acceptability for installation of product.
b. Summary of installation procedures being followed, compliance with requirements and, if not, what corrective action was taken.
c. Results of operational and other tests and a statement of whether observed performance complies with the requirements.

Y. Permit Compliance Products: Prepare required information for compliance with permit provisions. Products include written notification of project startup, suspension, and completion of work; photo documentation of site conditions; reports; and drawings.

PART 3 EXECUTION

3.1 CONSTRUCTION CONTRACTOR'S REVIEW

A. Review each submittal and check for coordination with other Work of Contract and for compliance with Contract Documents. Note corrections and field dimensions.

3.2 CONTRACTING OFFICER'S ACTION

A. General: Submittals will be disapproved without technical review if identification information is missing, not filled in, or if placed on back of submittal; an incorrect format of submittals is provided; transmittal form is incorrectly filled out; submittals are not coordinated; or submittals do not show evidence of Construction Contractor's approval.

1. Any work done or orders for materials or services placed before approval shall be at Construction Contractor's own risk.

B. Action Submittals:

1. Contracting Officer will review each submittal, generate comments on corrections or modifications required, and indicate appropriate action on the Transmittal Form (CM-16). Submittal will be marked as defined below:

a. APPROVED: Acceptable with no corrections.
b. APPROVED WITH NOTATIONS: Minor corrections or clarifications required. Comments are clear and no further review is required. Construction Contractor shall address review comments when proceeding with the work.

c. DISAPPROVED - RESUBMIT: Rejected as not in accordance with the contract or as requiring major corrections or clarifications. Contracting Officer will identify reasons for disapproval. Construction Contractor shall revise and resubmit with changes clearly identified.

C. Informational Submittals: Contracting Officer will review each submittal and will either accept or reject it.

D. Partial submittals are not acceptable, will be considered non-responsive, and will be returned without review.

3.3 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Submittal List.

END OF SECTION

Submittal List

National Park Service (NPS) - Denver Service Center (DSC) | 1-27-21

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E)
construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
01 31 00	**1.4**	**Project Management and Coordination**																		
		Coordination Drawing Organization						X		X										
		Division 01 Documents		X		X				X										
01 32 16	**1.3**	**Construction Schedule**				X														
01 32 33	**1.2**	**Photo Documentation**																		
		Construction Images				X														
01 35 23	**1.3**	**Safety Requirements**																		
		Accident Prevention Plan		X																
01 35 91	**1.3**	**Historic Preservation Treatment Procedures**																		
		Historic Preservation Treatment Plan								X										
		Alternate Methods and Materials		X		X														
		Photographs or Videotape				X														
01 40 00	**1.4**	**Quality Requirements**																		
		Quality Control Plan								X										
		Qualification Data								X										
		Contractor Quality Control Daily Reports		X																
		Test Reports	X	X																
		Accessibility Inspection Report		X																
		Offsite Inspection Report		X																
		Permits, Licensing and Certificates	X			X														
01 45 33	**1.04**	**Special Inspection, Observation and Testing**																		
		Special Inspector Qualifications	X																	
		AISC Certified Steel Fabricator Qualifications	X																	
		Contractor Statement of Responsibility				X														
01 57 23	**1.3**	**Temporary Storm Water Pollution Prevention**																		
		Storm Water Pollution Prevention Plan		X																
		Inspection Schedule		X																
		Erosion Control Products					X													

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
01 57 28	**1.05**	**Temporary Flow Control**																		
		Temporary Flow Control Plan		X																
		Emergency Cleanup Plan		X																
		Special Permits				X														
		Names and Qualifications for Personnel				X														
		Information on Equipment and Materials				X														
01 67 00	**1.3**	**Product Requirements**																		
		Material Safety Data Sheets			X															
		Affirmative Procurement Reporting Form								X										
		Manufacturer's Certificate of Proper Installation				X														
		Manufacturer's Certificate of Compliance				X														
01 73 29	**1.2**	**Cutting and Patching**																		
		Cutting and Patching Plan								X										
01 73 40	**1.2**	**Execution**																		
		Certificates				X														
		Landfill Receipts				X														
		Certified As-built Surveys								X										
01 74 19	**1.4**	**Construction Waste Management and Disposal**																		
		Waste Management Plan								X										
		Progress Documentation		X																
		Waste Reduction Calculations		X																
		Records of Donations				X														
		Records of Sales				X														
		Recycling and Processing Facility Records				X														
		Landfill and Incinerator Disposal Records				X														
		Qualification Data			X															
		Statement of Refrigerant Recovery				X														
		Progress Payment Requirement		X																
		Closeout Submittals		X																

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
01 77 00	**1.3**	**Closeout Procedures**																		
		Specific Warranties, Guarantees, Workmanship Bonds, Final Certificates, and similar.	X			X														
		Project Record Documents, Record Drawings, O&M Manuals, Final Completion Construction Digital Images, and similar		X		X		X												
		Environmental Record Documents		X	X															
		Posted Operating Instructions							X	X										
		Keys and Keying Schedule				X														
		Approved Pre-Functional Checklist and Performance Testing Reports		X		X														
		Test and Balance Report	X	X																
01 78 23	**1.2**	**Operation and Maintenance Data**																		
		Operation and Maintenance Manual								X										
		Equipment Data Sheet				X														
01 79 00	**1.3**	**Demonstration and Training**																		
		Instruction Program								X										
		Demonstration and Training Video				X														
01 81 13	**1.3**	**Sustainable Design Requirements for Non-LEED™**																		
		Recycled Content				X														
		Certified Wood			X															
		Low Emitting Materials - Adhesives and Sealants			X															
		Low Emitting Materials - Paints and Coatings			X															
		Low Emitting Materials - Flooring			X															
		Biopreferred Products				X														
01 88 15	**1.05**	**Anchorage and Bracing**																		
		Shop Drawings						X	X											
		Anchorage and Bracing Calculations		X																
		Manufacturer's Hardware Installation Requirements			X															
01 91 14	**1.6**	**Total System Commissioning**																		
		Two-Week Look Ahead Schedules				X														
		Certificate of Readiness	X																	
		Contractor's Commissioning Representative Qualifications				X														
		Commissioning Plan								X										

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Pre-functional Checklists		X																	
		Owner's Project Requirements		X																	
		Functional Performance Test Forms		X																	
		List of Test Instrumentation, Equipment and Monitoring Devices	X	X		X															
		Deficiency Report and Resolution Record		X																	
		Closeout Documentation	X	X		X		X													
02 41 00	**1.03**	**Demolition**																			
		Demolition Plan		X																	
		Notifications, Authorizations and Permits				X															
		Reports and Other Documentations		X		X															
02 61 00	**1.04**	**Removal and Disposal of Contaminated Soil**																			
		Permits, Certification and Acceptance Requirements	X			X															
		Qualifications				X															
		Soil and Debris Analytical and Physical Characterization Testing Plan		X																	
		Inspection Reports		X																	
		Excavation and Water Control Plan		X																	
		Site-specific Health and Safety Plan		X																	
		Emergency Response Plan		X																	
		Daily Job Progress Log		X																	
		Weekly Excavation Plans		X																	
		Copies of Manifests, Bills of Lading and Receipts		X																	
02 82 00	**1.04**	**Asbestos Remediation**																			
		Product Data Sheets			X				X												
		Test Reports		X						X											
		Certificates	X							X											
03 01 32	**1.03**	**Repair of Vertical and Overhead Concrete Surfaces**																			
		Product Data Sheets							X												
		Drawings						X		X											
		Repair Mortar Systems			X																
		Description of Equipment				X															
		Certificates	X																		

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Statement of Qualification	X			X															
		Field and Laboratory Test Reports	X	X																	
03 01 33	**1.03**	**Repair of Horizontal Concrete Surfaces**																			
		Product Data Sheets							X												
		Drawings						X		X											
		Repair Mortar Systems			X																
		Description of Equipment				X															
		Certificates	X																		
		Statement of Qualification	X			X															
		Field and Laboratory Test Results	X	X																	
03 10 00	**1.04**	**Concrete Forming and Accessories**																			
		Shop Drawings						X													
		Product Data							X												
		Statement of Qualification	X																		
03 15 00	**1.02**	**Concrete Joints and Accessories**																			
		Shop Drawings						X													
		Product Data							X												
		Samples					X														
		Certification	X			X															
		Manufacturer's Written Instruction			X																
03 21 00	**1.03**	**Steel Reinforcement**																			
		Shop Drawings						X	X												
		Welded, Metallic Sleeve Splice, and Mechanical Threaded Connection								X											
		Lab Test Reports	X																		
		Mechanical Threaded Connections				X															
		Test Results of Field Testing	X																		
		Product Data for Recycled Materials			X																
03 30 00	**1.03**	**Cast-in-Place Concrete**																			
		Mix Designs								X											
		Manufacturer's Certificate of Compliance	X																		
		Test Reports	X	X																	

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Aggregates							X	X											
		Product Data							X												
		Detailed Plan for Cold Weather Placement								X											
		Detailed Plan for Hot Weather Placement								X											
		Preinstallation Conference Minutes		X																	
		Manufacturer's Application Instructions			X																
		Statement of Qualification	X																		
		Field Test Reports		X																	
		Thermal Control Plan		X																	
		Recorded Temperature Data from Concrete Placement		X																	
		Liquid Tightness Test Results	X																		
		Concrete Delivery Tickets				X															
03 39 00	**1.02**	**Concrete Curing**																			
		Manufacturer's Data							X												
		Curing Methods								X											
		Manufacturer's Certificate of Compliance	X																		
		Product Data for Low Emitting Materials - Paint and Coatings			X																
		Manufacturer's Literature Documenting VOC content			X																
03 40 00	**1.02**	**Precast Concrete Structures**																			
		Experience Record on Production of Precast Structures								X											
		Drawings						X													
		Manufacturer's Catalog Data							X												
		Manufacturer's Design Structural Calculations and Certification	X	X																	
		Manufacturer's Catalog Data							X												
03 62 00	**1.02**	**Grouting**																			
		Product Data							X												
		Proposed Method for Keeping Concrete Wet Prior to Grouting							X												
		Forming Method for Fluid Grout Placements							X												
		Curing Method for Grout							X												
		Manufacturer's Written Instruction			X																
		Manufacturer's Proposed Training Schedule				X															

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Manufacturer's Certificate of Compliance	X																	
		Statements of Qualification	X																	
		Test Reports		X																
		List of Contractor's Equipment Installation Staff				X														
03 63 00	**1.03**	**Concrete Doweling**																		
		Product Data							X											
		Manufacturer's Instructions			X															
		Manufacturer's Written Letter of Certification	X																	
		ICC Evaluation Services Report		X																
03 64 23	**1.03**	**Epoxy Resin Injection Grouting**																		
		Physical and Chemical Properties							X											
		Technical Data for Metering, Mixing, and Injection Equipment							X											
		Marked-up Drawings						X												
		Health and Safety Plan		X																
		Sample Bottle					X													
		Pot Life Test								X										
		Plant Shear Test (Bond Strength)								X										
		Manufacturer's Recommended Surface Preparation Procedures			X															
		Certificate for NSF 61 Conformance	X																	
		Statements of Qualification for Epoxy Resin	X																	
		Sample of Epoxy Resin				X														
		Installation Instructions			X															
		Test Results of Epoxy Resin Bond Tests	X																	
		Epoxy Resin Two Component Ratio and Injection Pressure Test Records	X	X																
03 64 24	**1.03**	**Polyurethane Injection Grouting**																		
		Physical and Chemical Properties for Polyurethane Injection Resin							X											
		Technical Data for Metering, Mixing, and Injection Equipment							X											
		Marked-up Drawings						X												
		Sample Bottle					X													
		Manufacturer's Recommended Surface Preparation Procedures			X															
		Certificate for NSF 61 Conformance	X																	
		Statements of Qualification for Polyurethane Resin Injection	X																	
		Sample of Polyurethane Resin				X														

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Installation Instructions			X															
		Polyurethane Resins Injection Pressure Test Records	X																	
05 05 19	**1.03**	**Post-Installed Anchors**																		
		Shop Drawings						X	X											
		Manufacturer's Product Description and Installation Instructions			X															
		Current ICC-ES or IAPMO-UES Report		X																
		Adhesive Anchor Installer Certification	X																	
05 50 00	**1.03**	**Metal Fabrications**																		
		Shop Drawings						X	X											
		Samples					X													
		Passivation Method for Stainless Steel Members		X																
08 16 13	**1.02**	**Fiberglass Doors**																		
		Shop Drawings						X	X											
		Samples					X													
		Manufacturer's Installation Instructions			X															
		Manufacturer's Instructions							X											
		Executed Guarantee				X														
08 71 00	**1.02**	**Door Hardware**																		
		Shop Drawings						X												
		Product Data							X											
		Finish Hardware Schedule								X										
		Special Tools								X										
		Operation and Maintenance Data				X														
		Manufacturer's Field Service Report		X																
		Certification of Hardware Consultant	X																	
09 90 00	**1.03**	**Painting and Coating**																		
		Shop Drawing						X												
		Data Sheets							X											
		Detailed Chemical and Gradation Analysis								X										
		Samples					X													
		Factory Applied Coating	X																	
		Manufacturer's Written Verification that Submitted Material is Suitable			X															
		Coating for Faying Surfaces	X																	
		Manufacturer's Written Instructions			X															

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
10 14 00	**1.02**	**Signage**																			
		Shop Drawings						X	X												
		Manufacturer's Installation Instructions			X																
10 44 00	**1.03**	**Fire Protection Specialties and Safety Equipment**																			
		Shop Drawings						X	X												
		Manufacturer’s Installation Instructions			X																
		Operation and Maintenance Data				X															
13 34 20	**1.05**	**Precast Concrete Building**																			
		Shop Drawings						X	X												
		Building Engineering Calculations		X																	
		Manufacturer's Installation Instructions, and Certifications	X		X				X												
22 07 00	**1.02**	**Plumbing Piping Insulation**																			
		Product Description							X												
		Proof of Compliance for Test of Products for Fire Rating, Corrosiveness,	X																		
		Manufacturer’s Installation Instructions			X																
22 10 01	**1.03**	**Plumbing Piping and Accessories**																			
		Product Data Sheets																			
		2.03.A Hose Valves and Hydrants							X												
		2.05.D Gate Valves							X												
		2.05.E Ball Valves							X												
		2.05.F Thermoplastic Ball Valves 2 Inches and Smaller for Water Service							X												
		2.06.A Strainers for Water Service							X												
		2.06.B Sleeves							X												
		2.06.C Joint Solder							X												
		2.06.D Rubber Gaskets							X												
		2.07.A Pressure Gauge							X												
		2.08.A Fuel Piping Above Ground							X												
		2.08.B Fuel Piping Below Ground							X												
		2.08.C Flex Connector							X												
		2.08.D Anodeless Riser							X												
		2.08.E Above Grade Ball Valve							X												

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		2.08.F Lockwing Ball Valve							X											
		2.08.G Below Grade Polyethylene Ball Valve							X											
		2.08.H Natural Gas Pressure Reducing Valve							X											
		2.08.I Natural Gas Pressure Gauge							X											
		2.08.J Natural Gas Meter							X											
		Shop Drawings						X												
		Changes in Location of Equipment or Piping																		
		Building Mechanical		X				X												
		Natural Gas		X				X												
		Complete List of Products Proposed for Installation				X														
		Test Records																		
		2.08.H Manufacturer's test of pressure reducing valve							X											
		2.08.J Manufacturer's test of meters							X											
		3.02.E.5 Installed system tracer wire continuity testing								X										
		3.02.E.7 Installed system pressure testing								X										
		3.10.A.5 Test Records		X						X										
22 30 00	**1.02**	**Plumbing Equipment**																		
		Manufacturer's Product Data																		
		2.02 Backflow Preventer						X	X											
		2.04 Hydropneumatic Pressure Boosters						X	X											
		2.05 Water Fountains						X	X											
		Seismic Anchorage and Bracing Drawings and Cut Sheets						X	X											
		Seismic Anchorage and Bracing Calculations		X																
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
22 40 00	**1.02**	**Plumbing Fixtures**																		
		Catalog Information and Rough-in Dimensions							X											
		Product Data Sheets																		
		2.03.A.1 Cleanout (Exterior)							X											
		2.03.A.2 Floor Drain (Finished Areas)							X											

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
23 05 48	**1.03**	**Vibration Isolation for HVAC Piping and Equipment**																		
		Shop Drawings						X												
		Product Data							X											
		Schedule of Vibration Isolator Type								X										
		Vibration Isolation Base Details							X	X										
		Manufacturer's Installation Instruction			X															
		Manufacturer's Certificate of Compliance	X																	
		Manufacturer's Certificate of Proper Installation	X																	
23 81 00	**1.03**	**Unitary Air-Conditioning Equipment**																		
		Shop Drawings						X	X											
		Seismic Anchorage and Bracing Calculations		X																
		Manufacturer's Certificate of Compliance	X																	
		Detailed Information on Structural, Mechanical, Electrical, or other Modifications		X																
		Sample Copy of Guarantee				X														
		Test Reports		X																
		Operation and Maintenance Data				X														
23 82 00	**1.03**	**Terminal Heating and Cooling Units**																		
		Shop Drawings						X	X											
		Seismic Anchorage and Bracing Calculations		X																
		Manufacturer's Certificate of Compliance	X																	
		Detailed Information on Structural, Mechanical, Electrical, or other Modifications		X																
		Operation and Maintenance Data				X														
26 05 02	**1.05**	**Basic Electrical Requirement**																		
		Manufacturer's Product Data							X											
		Anchorage and Bracing Drawings and Cut Sheets						X	X											
		Anchorage and Bracing Calculations		X																
26 05 04	**1.02**	**Basic Electrical Materials and Methods**																		
		Manufacturer's Product Data							X											
		Seismic Anchorage and Bracing Drawings and Cut Sheets						X	X											
		Anchorage and Bracing Calculations		X																

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
26 05 05	**1.02**	**Conductors**																		
		Manufacturer's Product Data							X											
		Cable Pulling Calculations								X										
		Journeyman Lineman or Electrician Splicing Credentials	X																	
26 05 26	**1.02**	**Grounding and Bonding for Electrical Systems**																		
		Manufacturer's Product Data						X	X											
26 05 33	**1.02**	**Raceway Boxes for Electrical Systems**																		
		Manufacturer's Product Data							X											
		Precast Manholes, Handholes, and Frames/Covers						X	X	X										
		Seismic Anchorage and Bracing Drawings and Cut Sheets						X	X											
		Anchorage and Bracing Calculations		X																
26 05 70	**1.02**	**Electrical Systems Analysis**																		
		Short Circuit Studies								X										
		Protective Device Coordination Studies								X										
		Arc Flash Study								X										
		Arc Flash Warning Labels								X										
		Electronic Files of Final Studies								X										
26 08 00	**1.02**	**Commissioning of Electrical Systems**																		
		Testing Firm Qualifications	X																	
		Schedule for Performing Inspection and Tests				X														
		List of References to be used for each test				X														
		Sample Copy of Equipment and Materials Inspection Form(s)				X														
		Sample Copy of Individual Device Test Form				X														
		Sample copy of Individual System Test Form				X														
		Energization Plan		X																
		Test or Inspection Reports and Certificates	X	X																
		Operation and Maintenance Data				X														
		Programmable Settings				X														

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
26 12 02	**1.02**	**Oil-Filled Pad Mounted Transformers**																		
		Manufacturer's Product Data						X	X											
		Seismic Anchorage and Bracing Drawings and Cut Sheets						X	X											
		Seismic Anchorage and Bracing Calculations		X																
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
		Operation and Maintenance Data				X														
26 13 16.02	**1.02**	**Pad-Mounted Switchgear**																		
		Manufacturer's Product Data						X	X	X										
		Equipment Foundation Pedestals						X	X											
		Anchoring Details								X										
		Anchorage and Bracing Drawings and Cut Sheets						X	X											
		Seismic Anchorage and Bracing Calculations		X																
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
		Factory Test Report		X																
		Manufacturer's Installation Instructions			X															
		Operation and Maintenance Data				X														
26 20 00	**1.04**	**Low-Voltage AC Induction Motors**																		
		Manufacturer's Product Data							X	X										
		Maximum Brake Horsepower Required by the Equipment Driven by the Motor								X										
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
		Operation and Maintenance Data				X														
26 22 00	**1.02**	**Low-Voltage Transformers**																		
		Manufacturer's Product Data							X	X										
		Anchorage and Bracing Drawings and Cut Sheets						X	X											
		Anchorage and Bracing Calculations		X																
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
26 24 16	**1.02**	**Panelboards**																		
		Manufacturer's Data Sheets							X											
		Manufacturer's Shop Drawings						X												
		Tabulation of Features								X										
		Anchorage and Bracing Calculations		X																

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Manufacturer's recommended Installation Instructions			X															
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
26 27 26	**1.02**	**Wiring Devices**																		
		Manufacturer's Product Data							X											
26 32 13.16	**1.02**	**Natural Gas Engine Generator Set**																		
		Dimensioned Outline Drawing						X												
		Specification Compliance Statement								X										
		Engine and Generator Weight, and Anchoring Requirements							X											
		Complete List of Accessories Provided							X											
		Performance Curves							X											
		Circuit Breaker Data							X											
		Control Panel Instrument Identification Inscriptions								X										
		Sample Guarantee								X										
		Electrical Schematic and Wiring Diagrams							X											
		Engine Generator Set Motor Starting Capability and Percent Voltage Dip curve							X											
		Block Heater Size and Voltage							X											
		Jacket Water Heater Size and Voltage							X											
		Noise Data for Enclosed Engine Generator							X											
		Manufacturer's Certificate of Compliance	X																	
		Certification, Copies of Analyses, or Test Reports	X	X																
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
		Factory Test Report		X																
		Operation and Maintenance Data				X														
		Description of Parts and Service Availability			X															
		Manufacturer's Certificate of Proper Installation	X																	
		Special Guarantee				X														
26 43 00	**1.02**	**Surge Protective Devices**																		
		Manufacturer's Product Data							X											
		Product Data							X											
		Manufacturer's UL Certified Test Data and Nameplate Data							X	X										
26 50 00	**1.02**	**Lighting**																		

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Shop Drawings						X	X												
		Manufacturer's Printed Installation Instructions			X																
		Operation and Maintenance Data				X															
31 10 00	**1.02**	**Site Clearing**																			
		Overall Site Plan						X													
		Survey Information		X																	
31 23 16	**1.02**	**Excavation**																			
		Excavation Plan		X																	
		Excavation Permit				X															
31 23 19.01	**1.01**	**Dewatering**																			
		Water Control Plan		X																	
		Well Permits				X															
		Discharge Permits				X															
		Water Level Elevations Observed in Observation Wells		X																	
		Settlement Benchmark Elevations		X																	
		Inflow Measurements		X																	
31 23 23	**1.03**	**Fill and Backfill**																			
		Shop Drawings						X	X												
		Samples					X														
		Manufacturer's Data Sheets			X																
		Certified Test Results	X																		
31 23 23.15	**1.03**	**Trench Backfill**																			
		Shop Drawings						X	X												
		Catalog and Manufacturer's Data Sheets for Compaction Equipment			X																
		Certified Gradation Analysis	X																		
		Controlled Low Strength Material	X																		
		Shop Drawings																			
		2.01 Marking Tape			X			X	X												
		2.02 Trench Stabilization Material			X			X	X												
		2.03 Bedding Material and Pipe Zone Material			X			X	X												

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		2.04 Granular Drain Material			X			X	X											
		2.05 Earth Backfill			X			X	X											
		2.06 Processed Earth Backfill			X			X	X											
		2.07 Controlled Low Strength Material (CLSM)			X			X	X											
31 32 19.16	**1.03**	**Geotextile**																		
		Shop Drawings						X	X											
		Samples					X													
		Certifications of Geotextile Manufacturer	X																	
		Field Seam Efficiency Test Results	X																	
		Shop Drawings																		
		2.01 Nonwoven Geotextile						X	X											
		2.02 Sewing Thread						X	X											
		2.03 Securing Pins						X	X											
31 37 00	**1.03**	**Riprap**																		
		Shop Drawings						X	X											
		Certified Test Results	X																	
		Trip Tickets				X														
31 40 00	**1.03**	**Tunneled Crossings**																		
		Abandonment-Recovery Contingency Plan		X																
31 41 00	**1.02**	**Shoring**																		
		Excavation Support Plan (Open Cut)		X																
		Shaft/Pit Excavation Support Plan		X																
31 42 00	**1.03**	**Horizontal Auger Boring**																		
		Qualifications				X														
		Pre-Construction Surveys		X		X														
		Post-Construction Surveys		X		X														
		Quality Control Methods				X														
		Safety Plan		X																
		Schedule				X														
		Daily Records		X																
		Horizontal Auger Boring Work Plan								X										

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Calculations		X						X										
		Contingency Plans		X						X										
		Abandonment-Recovery Contingency Plan		X						X										
31 43 00	**1.03**	**Steel Casing Pipe**																		
		Steel Casing Pipe for the Trenchless Crossings						X												
		Calculations (1.04.B)		X																
31 44 00	**1.02**	**Settlement Monitoring**																		
		Qualifications	X																	
		Instrumentation Schedule				X														
		Description of Methods and Materials				X														
		Drawings with Locations of Proposed Monitoring Points				X														
		Monitoring Plan		X																
		Reports and Records (Location of Installed Instruments)		X																
		Reports and Records (Preconstruction Survey)				X														
		Shop Drawings (Monuments and Posts)						X	X											
31 45 00	**1.03**	**Installation of Carrier Pipe in Steel Casing**																		
		Carrier Pipe Installation Plan		X		X														
		Safety Plan		X																
		Emergency Response Plan		X																
		Shop Drawings						X	X											
		Written Confirmation that the Model, Type and Spacing of the Carrier Pipe Supports Meets the Minimum Requirements								X										
31 46 00	**1.04**	**Backfilling Grouting**																		
		Work Plan		X																
		Shop Drawings						X	X											
		Pre-Placement Test Reports and Certifications	X																	
		Daily Reports and Records of Backfill Grout Placement		X																
		Product Data							X											
		Equipment							X											
32 11 23	**1.03**	**Aggregate Base Course(s)**																		
		Certified Test Results on Source Materials	X																	
		Certified Results of In-Place Density Tests	X																	

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
32 12 16	**1.05**	**Asphalt Paving**																		
		Asphalt Concrete Job Mix Formula	X																	
		Test Report for Asphalt Cement		X																
		Manufacturer's Certificate of Compliance	X																	
		Statement of Qualification for Independent Testing Laboratory	X																	
		Test Results	X																	
		WMA Mix Design Information			X	X														
32 13 13	**1.02**	**Concrete Paving** (see 03 30 00 for general Concrete Submittals)																		
		Jointing Drawings						X												
		Colored Concrete Samples					X													
		Admixtures: Color Pigment Product Data							X											
32 16 00	**1.02**	**Curbs and Gutters**																		
		Form Materials								X										
		Complete Data on Concrete Mix							X											
		Curing Compound				X														
		Ready-Mix Delivery Ticket				X														
32 17 23	**1.02**	**Pavement Markings**																		
		Shop Drawings						X	X											
		Description of Proposed Methods for Removal of Drips, Overspray, Improper Markings, Paint and Thermoplastic Material Tracked by Traffic, and Existing Markings				X														
		Equipment List				X														
		Manufacturer's Instructions			X															
32 31 13	**1.03**	**Chain Link Fences and Gates**																		
		Shop Drawings						X												
		Product Data							X											
		Samples					X													
		Manufacturer's Recommended Installation Instructions			X															
		Evidence of Supplier and Installer Qualifications	X																	
		Shop Drawings																		
		2.01.B.1 Chain Link Fence Fabric						X	X											
		2.01.B.2 Posts						X	X											

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		2.01.B.3 Top and Brace Rails						X	X											
		2.01.B.4 Fence Fittings						X	X											
		2.01.B.5 Tension Wire						X	X											
		2.01.B.6 Barbed Wire						X	X											
		2.03 Concrete Mix						X	X											
32 91 13	**1.03**	**Soil Preparation**																		
		Certified Topsoil Analysis Reports		X																
33 05 01	**1.02**	**Conveyance Piping - General**																		
		Shop Drawings						X												
		Product Data							X											
		Manufacturer's Certificate of Compliance	X																	
		Shop Drawings																		
		2.04 Couplings						X	X											
		2.05 Service Saddles						X	X											
		2.06 Slab, Floor, Wall, and Roof Penetrations						X	X											
		2.07 Flanges, Flange Gaskets and Bolting Materials						X	X											
		2.11 Tracer Wire						X	X											
		2.12 Water Quality Sampling Station						X	X											
		2.13 PRV Enclosure						X	X											
		2.14 Water Bottle Filling Station						X	X											
33 05 01.02	**1.02**	**Ductile Iron Pipe and Fittings**																		
		Shop Drawings (Pipe and Fittings)						X	X											
		Manufacturer's Certificate of Compliance	X																	
		Field Hydrostatic Testing Plan		X																
		Certifications of Calibration	X																	
		Test Documentation Form and Results		X																
33 05 01.09	**1.02**	**Polyvinyl Chloride (PVC) Pressure Pipe and Fittings**																		
		Shop Drawings						X	X											
		Manufacturer's Certificate of Compliance	X																	
		Hydrostatic Testing Plan		X																
		Certification of Calibration	X																	

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Test Report Documentation		X																
33 05 01.12	**1.03**	**Gravity Sewer Pipe and Fittings**																		
		Shop Drawings						X	X											
		Certificates	X																	
		Manufacturer's Written Recommendations for Pipe Handling and Installation			X															
		Field Leakage Testing Plan		X																
		CCTV Inspection				X														
		Leakage Test Results	X																	
		Pipe Deflection Test Results	X																	
		Shop Drawings																		
		2.01 Piping						X	X											
		2.02 Joints						X	X											
		2.03 Gaskets						X	X											
		2.04 Gasket Lubricant						X	X											
		2.05 Plugs						X	X											
		2.06 Lateral Service Connection Pipe and Fittings						X	X											
		2.07 Pipe for Waterline Crossings						X	X											
		2.09 Flexible Compression Collar						X	X											
33 05 13	**1.02**	**Manholes**																		
		Shop Drawings						X												
		Product Data							X											
		Experience Record	X																	
		Calculations		X																
		Certificate of Compliance	X																	
		Test Reports	X	X																
		Certified Load Test Data		X																
		Manufacturer's Recommended Installation Instructions			X															
		Field Quality Control Report		X																
		Shop Drawings/Product Data																		
		2.01 General							X											
		2.02 Precast Manholes						X												

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		2.03 Manhole Frames and Covers						X												
		2.04 Manhole Frame Connection to Structure						X												
		2.05 Mortar						X	X											
		2.07 Flexible Joints for Sealing Pipes in Manholes						X												
		2.08 Cold-Applied Asphalt Emulsion Damproofing						X	X											
		2.09 Corrosion Resistant Coating (CRC) System						X	X											
33 05 23.13	**1.04**	**Utility Horizontal Directional Drilling**																		
		Description of Pilot Hole Drilling Procedure								X										
		Installation Plan								X										
		Descriptions of HDD Drill Rig and Equipment								X										
		Contingency Plan								X										
		Frac-Out, Surface Spill and Abandonment Contingency Plan								X										
		Record Drawing Plan and Profile		X																
33 12 13	**1.02**	**Water Service Connections**																		
		Shop Drawings						X												
		Manufacturer's Certificate of Compliance	X																	
		Statement of Qualifications	X																	
		Procedure for Field Testing Water Mains and Service Connections		X																
		Shop Drawings						X												
		2.02 Service Saddles						X												
		2.03 Repair Service Clamps						X												
		2.04 Corporation Stops						X												
		2.05 Miscellaneous Fittings						X												
		2.06 Curb Stops						X												
		2.07 Meter Boxes, Vaults and Covers						X												
		2.08 Meter Yokes						X												
		2.09 Angle Valves						X												
		2.10 Water Meters						X												
		2.11 High Density Polyethylene Plastic Pipe						X												
33 12 16	**1.02**	**Water Utility Distribution Valves**																		
		Shop Drawings (Gate Valves)						X	X											
		Manufacturer's Certificate of Compliance	X																	
		Method for Hydrostatic Testing				X														
		Tests and Inspection Results	X	X																
		Operation and Maintenance Data				X														

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Manufacturer's Certificate of Proper Installation	X																	
33 12 16.29	**1.02**	**Air and Vacuum Release Valve Assemblies**																		
		Product Data Sheets							X											
		Complete Catalog Information							X											
		Maximum Recommended Test Pressure							X	X										
		Recommended Seating Materials for Specified Operating Pressures								X										
		Manufacturer's Instructions			X															
		Operation and Maintenance Data				X														
		Affidavit of Compliance in Accordance with AWWA C512	X																	
		Affidavit of Compliance that Materials Comply with the Requirements of the EPA Safe Drinking Water Act	X																	
		Product Data																		
		2.02 Combination Air Release Vacuum Valves						X	X											
		2.03 Connection to Mainline							X											
		2.04 Isolation Valves							X											
		2.05 Piping Between Mainline and Air Valve and Piping for Air Vent							X											
		2.06 Valve Vault						X	X											
		2.07 Accessories							X											
33 12 19	**1.02**	**Water Utility Distribution Fire Hydrants**																		
		Certificate of Compliance	X																	
		Shop Drawings																		
		2.01 General						X	X											
		2.02 High Pressure Hydrant						X	X											
		2.03 Flush Type Hydrants						X	X											
		2.04 Yard Hydrant						X	X											
		2.05 Precast Concrete Pier Block						X	X											
		2.06 Gravel for Drainage						X	X											
		2.07 Concrete for Thrust Blocking						X	X											
33 13 00	**1.02**	**Disinfection of Water Utility Distribution Facilities**																		
		AWWA Standards Conformance Plan		X																
		Procedure and Plan for Cleaning System		X																
		Procedures and Plans for Disinfection and Testing		X																
		Proposed Locations within System where Samples will be Taken		X																
		Type of Disinfecting Solution and Method of Preparation		X																
		Employee Certification	X																	
		Method of Disposal for Highly Chlorinated Disinfecting Water		X																
		Independent Testing Agency	X																	
		Certified Bacteriological Test Results	X																	
40 05 15	**1.03**	**Piping Support Systems**																		

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Catalog Information and Drawings of Piping Support System			X	X														
		Calculations		X																
		Revisions to Support Systems Resulting from Changes in Related Piping System Layout or Addition of Flexible Joints				X														
		Anchorage and Bracing Drawings and Cut Sheets				X														
		Anchorage and Bracing Calculations		X																
		Maintenance Information on Piping Support System			X															
	1.05	Pedestrian Bridge Beam Clamp and Pipe Hanger System						X	X											
		Pedestrian Bridge Pipe Insulation and Jacket						X	X											
		Pedestrian Bridge Pipe Expansion Assembly						X	X											
40 27 00	**1.03**	**Process Piping - General**																		
		Shop Fabricated Piping						X	X	X										
		Pipe Wall Thickness							X											
		Hydraulic Thrust Restraint for Restrained Joints							X	X										
		Dissimilar Buried Pipe Joints								X										
		Pipe Corrosion Protection							X											
		Anchorage and Bracing Drawings and Cut Sheets							X	X										
		Manufacturer's Certification of Compliance	X																	
		Anchorage and Bracing Calculations		X																
		Flanged Pipe and Fittings			X															
		Qualifications	X																	
		Welding Procedures				X														
		Nondestructive Inspection and Testing Procedures	X	X																
		Test Logs	X	X																
		Pipe Coating Applicator Certification	X																	
		Laboratory Testing Equipment	X	X	X															
		CWI Inspection Records and NDE Test Records	X	X																
40 27 02	**1.02**	**Process Valves and Operators**																		
		Shop Drawings																		
		A. Gate Valves						X	X											
		B. Ball Valves						X	X											
		C. Butterfly Valves						X	X											
		D. Check and Flap Valves						X	X											
		E. Self Regulated Valves						X	X											
		Anchorage and Bracing Calculations		X																
		Manufacturer's Certificate of Compliance	X																	
		Component and Attachment Testing Seismic Certificate of Compliance	X																	
		Tests and Inspection Data	X	X																
		Operation and Maintenance Data				X														

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)										
			INFORMATIONAL				ACTION														
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Manufacturer's Certificate of Proper Installation	X																	
40 80 01	**1.01**	**Process Piping Leakage Testing**																		
		Testing Plan		X																
		Certifications of Calibration	X																	
		Certified Test Report		X																
40 91 00	**2.04A**	**Flow Element and Transmitter, Electromagnetic**																		
		Catalog Cuts							X											
		Component Data Sheets								X										
		Sizing and Selection Calculations								X										
		Installation Details							X											
		Factory and Field Test Documentation								X										
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Testing Related Submittals				X														
		Maintenance Service Agreement				X														
40 91 00	**2.04B**	**Flow Switch, Paddle:**																		
		Catalog Cuts							X											
		Component Data Sheets								X										
		Installation Details							X											
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Maintenance Service Agreement				X														
40 91 00	**2.04C**	**Level Element and Transmitter: Submersible.**																		
		Catalog Cuts							X											
		Component Data Sheets								X										
		Sizing and Selection Calculations								X										
		Installation Details							X											
		Factory and Field Test Documentation								X										
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Testing Related Submittals				X														
		Maintenance Service Agreement				X														
40 91 00	**2.04D**	**Intrusion Switch:**																		
		Catalog Cuts							X											
		Component Data Sheets								X										
		Installation Details							X											
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Maintenance Service Agreement				X														

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
40 91 00	**2.04E**	**Pressure Gauge:**																		
		Catalog Cuts							X											
		Component Data Sheets								X										
		Sizing and Selection Calculations								X										
		Installation Details							X											
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Maintenance Service Agreement				X														
40 91 00	**2.04F**	**Pressure Transmitter:**																		
		Catalog Cuts							X											
		Component Data Sheets								X										
		Sizing and Selection Calculations								X										
		Installation Details							X											
		Factory and Field Test Documentation								X										
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Testing Related Submittals				X														
		Maintenance Service Agreement				X														
40 91 00	**2.04G**	**Temperature Element and Transmitter, Resistance:**																		
		Catalog Cuts							X											
		Component Data Sheets								X										
		Sizing and Selection Calculations								X										
		Installation Details							X											
		Factory and Field Test Documentation								X										
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Testing Related Submittals				X														
		Maintenance Service Agreement				X														
40 91 00	**2.05**	**PLC PANEL COMPONENTS**																		
		Bill of Materials								X										
		Catalog Cuts							X											
		Component Data Sheets								X										
		Sizing and Selection Calculations								X										
		Preliminary Panel Elevation Drawings						X												
		Panel Construction Drawings						X												
		Diagrams								X										
		Panel Power Requirements and Heat Dissipation								X										
		Spares, Expendables, and Test Equipment								X										
		PLC I/O List								X										

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Identify Proposed Items, Options, Installed Spares, and Other Provisions for Future Work								X										
		Color schedule for control panels								X										
		Applications Software Documentation								X										
		Factory and Field Test Documentation								X										
		Legends and Abbreviation Lists								X										
		Shop Drawings for Changes Impacting PLC Programming						X												
		Proposed Submittal Breakdown Consisting of Sequencing and Packaging of Information				X														
		Statements of Qualification	X																	
		Operation and Maintenance Data				X														
		Testing Related Submittals				X														
		Maintenance Service Agreement				X														
40 91 00	**2.06**	**REMOTE MONITORING SYSTEM**																		
		Bill of Materials								X										
		Catalog Cuts							X											
		Component Data Sheets								X										
		Sizing and Selection Calculations								X										
		Preliminary Panel Elevation Drawings						X												
		Panel Construction Drawings						X												
		Diagrams								X										
		Panel Power Requirements and Heat Dissipation								X										
		Installation Details							X											
		Spares, Expendables, and Test Equipment								X										
		I/O List								X										
		Identify Proposed Items, Options, Installed Spares, and Other Provisions for Future Work								X										
		Factory and Field Test Documentation								X										
		Operation and Maintenance Data				X														
		Manufacturer's Certificate of Proper Installation	X																	
		Testing Related Submittals				X														
		Maintenance Service Agreement				X														
40 95 80	**1.04**	**Fiber Optic Communication System**																		
		Site Layout Diagram								X										
		Cable Schedule								X										
		Component Data							X	X										
		Manufacturer's Statement that Installer is Certified to Perform Installation Work	X																	
		Subcontractor Qualifications	X																	

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number: **BAND-266697**

Project Title: **UNDERGROUND UTILITIES REHABILITATION**

ACTION SUBMITTAL REVIEW ESTIMATE
(Complete this portion for Architect / Engineer (A/E) construction service task order negotiation)

SUBMITTAL			REQUIREMENTS (Indicate with **X**)								ARCHITECT / ENGINEER REVIEW TIME (Indicate in whole or partial hours)									
			INFORMATIONAL				ACTION													
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND INSTRUCTIONS	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND INSTRUCTIONS	OTHER		ARCHITECT	CIVIL ENGINEER (SITE CIVIL, NATURAL GAS, ROADWAY)	STRUCTURAL ENGINEER	BUILDING MECHANICAL ENGINEER	PROCESS MECHANICAL ENGINEER	ELECTRICAL ENGINEER	I&C ENGINEER	CCA SUBMITTAL PROCESSING	PROJECT MANAGER INTERDISCIPLINARY COORDINATION / QUALITY REVIEW	LANDSCAPE ARCHITECT
		Manufacturer's Certificate of Compliance	X																	
		Manufacturer's Suggested Installation Practice				X														
		Operation and Maintenance Data				X														
											Total:	0	0	0	0	0	0	0	0	0	0

SECTION 01 35 13.22
ARCHEOLOGICAL PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Section consists of protecting archeological resources contained in soil deposits.

1.2 DEFINITIONS

A. Archeological Monitor: Representative of Government designated to oversee construction activities that could disturb archeological resources.

B. Archeological Resources: Archeological resources are physical evidences of past human activity, including evidences of effects of that activity on the environment. Archeological resources represent both prehistoric and historic time periods, found above and below ground and under water.

C. Archeological Resources Protection Act (ARPA) of 1979 (Public Law (P.L.) 96-95; 93 United States Statues at Large (Stat.) 712): defines archeological resources as any material remains of past human life or activities that are of archeological interest and at least 100 years old; Section 4 of the statute describes the requirements that must be met before Federal authorities can issue a permit to excavate or remove any archeological resource on Federal or Indian lands; the curatorial requirements of artifacts, and other materials excavated or removed.

D. Archeologically Sensitive Area: All of Bandelier National Monument qualifies.

1.3 SCHEDULE COORDINATION

A. Include coordination with Archeological Monitor as part of weekly progress meetings in accordance with Section 01 31 00, Project Management and Coordination.

1.4 QUALITY ASSURANCE

A. In accordance with Section 01 31 00, Project Management and Coordination.

PART 2 PRODUCTS

2.1 SCHEDULE COORDINATION

A. Schedule Coordination is required. Include all work and key the schedule to the Drawings to include:

1. Starting and ending dates of ground-disturbing construction.
2. Locations of temporary facilities, such as barriers, field offices, staging areas, sanitary facilities, borrow pits, and haul and access roads.
3. Types of construction, such as clearing, topsoil stripping, structure or trench excavation, landscaping, and post construction clean-up.
4. Methods and equipment used for each type of construction.
5. Plan for relocating work in the event of temporary work stoppages due to an archeological finding.

PART 3 EXECUTION

3.1 BARRICADES

A. Comply with requirements specified in Section 01 50 00, Temporary Facilities and Controls.

3.2 ARCHEOLOGICAL INVESTIGATION BY NON-NPS PERSONNEL

A. NPS personnel will monitor site excavations.

B. A permit is required for archeological investigations (e.g., excavation, shovel testing, coring, pedestrian survey, underwater archeology, rock art documentation, or other types of reconnaissance including archaeological monitoring of construction) carried out on park lands by non-National Park Service (NPS) personnel, unless carried out under a contract or a cooperative agreement specifically written for archeological investigations. Permits are issued under the Archaeological Resources Protection Act of 1979 (ARPA). The NPS does not issue a permit for archeological investigations carried out by NPS archeologists, or to archeologists working on NPS archeological projects under a contract or cooperative agreement.

C. Applicants must submit a Permit Application (DI Form 1926 (Revision September 2004) Office of Management and Budget (OMB) Number (No.) 1024-0037, approved through 1/31/2008. Permit Application form is available, in PDF (portable document file) format, to the manager of the park in which they propose to work; or to the regional director, with a copy to the park manager.

3.3 OBSERVATION

A. Archeological Monitor will observe ground-disturbing site work, including construction of temporary facilities, from a safe location mutually agreed on by

Contractor and Monitor. As new ground is broken, Monitor will examine excavated materials, using construction layout centerline and perimeter staking as a reference point to record locations of findings.

3.4 DISCOVERY OF RESOURCES ON NPS PROPERTY

A. If Archeological Monitor discovers resources, immediate relocation of work to another project area may be required for Monitor to identify and document resources and, if necessary, develop appropriate mitigation plan. While Archeological Monitor is documenting resources, Contractor shall relocate work to less-sensitive areas where discovery of resources is estimated to be less likely.

B. If resources or human remains are discovered while Archeological Monitor is absent, stop work immediately and report the discovery to the Contracting Officer and the NPS Bandelier National Monument Integrated Resources Manager.

C. Collecting of artifacts is prohibited. All Contractor workers will be informed of the penalties of illegally collecting artifacts or intentionally damaging any archeological or historic property.

3.5 DISCOVERY OF RESOURCES ON LANL PROPERTY

A. The Los Alamos National Laboratory (LANL) policy prioritizes avoidance of all cultural resources, and the Cultural Resources Program uniformly prohibits all project activity within 30 feet of an archaeological resource. Two sites on LANL property are within 100 feet of the utility easement. These sites will need to be flagged for visibility and avoidance and a cultural resources monitor is required to be present for all earth-disturbing work near the two sites. Disturbance of these areas during project activity will result in an immediate pause of work. Notify personnel from the Cultural Resources Program via email 10 business days prior to the start of work to ensure the sites are flagged for visibility and avoidance and a Cultural Resources monitor is scheduled.

1. Cultural Resources Program Contacts:

   a. Kari Garcia: manzk@lanl.gov, (505) 699-2730.
   b. Ali Livesay: aklives@lanl.gov, (505) 695-3897.

B. During all ground-disturbing project activities, the Contractor is to pause work immediately if bones (possible burials), clusters or alignments of rock situated above bedrock (possible masonry walls), charcoal stains (possible hearths or burned wooden structures), or clusters of artifacts such as pottery, pieces of chipped stone, and historic debris such as cans or glass are encountered. Immediately contact the Cultural Resources Program at cultural@lanl.gov to notify of the issue and provide a phone number and point of contact. Cultural Resources subject matter experts will call the point of contact as soon as possible and arrange an emergency field inspection to be conducted prior to the resumption of project ground-disturbing activities.

3.6 WORK STOPPAGE

A. Contractor shall plan, schedule, and execute work to prevent stoppages at one area from stopping all work at construction site.

END OF SECTION

SECTION 01 35 23
SAFETY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes establishing an effective accident prevention program and providing a safe working environment for personnel and visitors.

1.2 CONDITIONS PRESENT FOR PROJECT

A. The following safety conditions shall be addressed by the Contractor at a minimum:

1. Confined spaces, water, electrocution, trenching, scaffolding, crane and lifting equipment procedures, wildlife, weather, hazardous materials, flooding, extended work hours, fatigue, heat, cold, cave-ins, wildfires, lack of cellphone coverage, fall protection, proximity to overhead and underground utilities, excavation, accessing the Canyon cliff by foot only to remove exposed pipes, potential contaminated soil at the Canyon, road work adjacent to the Canyon, among many other requirements.

1.3 SUBMITTALS

A. Accident Prevention Plan (APP): Submit APP after contract award and before Pre-Construction conference. Contracting Officer (CO) will review proposed APP. If APP requires any revisions or corrections, Contractor shall resubmit Plan within 10 days. No progress payments will be made until the APP is accepted.

1.4 QUALITY ASSURANCE

A. Comply with contract clauses “Accident Prevention” and “Permits and Responsibilities.” In case of conflicts between federal, state, and local safety and health requirements, the most stringent shall apply. Onsite equipment shall meet 29 CFR 1926 (Code of Federal Regulations) (Occupational Safety and Health Administration (OSHA)) requirements. Failure to comply with requirements of this section and related sections may result in suspension of work.

B. Site Safety Supervisor:

1. Designate authorized onsite representative for preparation and maintenance of the APP.
2. Shall be responsible for:

   a. Implementation and enforcement of the APP.
   b. Daily safety inspections.
   c. Conducting and documenting weekly and monthly safety meetings.

d. Review of safety requirements at progress meetings.
e. Compilation and maintenance of Safety Data Sheets (SDS) and safety reference materials.
f. Tracking and resolution of safety violations.
g. Site personnel and visitor compliance with site safety and health requirements and APP.
h. Investigation and reporting of accidents and injuries.

C. Qualifications of Employees:

1. Physically and able to perform their assigned duties in a safe manner.
2. Do not allow employees whose ability or alertness is impaired because of prescription or illegal drug use, fatigue, illness, intoxication, or other conditions that may expose themselves or others to injury to perform work.
3. Provide operating instructions for equipment. Operators of vehicles, hoisting equipment, and hazardous plant equipment shall be able to understand signs, signals, operating instructions, and be fully capable of operating such equipment. Retain copies of operator licenses and certifications onsite.

1.5 ACCIDENT REPORTING

A. Reportable Accidents:

1. Defined as: Death, occupational disease, and/or traumatic injury to employees or the public; fires; and/or property damage by accident in excess of $100.

a. Notify Contracting Officer immediately in the event of a reportable accident.
b. Fill out and forward an Accident/Property Damage Report Form (CM-22) to Contracting Officer within 7 days of a reportable accident. Obtain form from Contracting Officer.

1.6 RESOURCES

A. COVID-19 (Coronavirus Disease 2019) information provided below is not intended to provide a complete analysis of requirements for Contractor and is provided as a courtesy.

1. Coronoavirus.gov.
2. Occupational Safety and Health Administration (United States Department of Labor) -COVID-19.
3. Center for Disease Control (CDC):

a. Get the Facts About Coronavirus
b. What Construction Workers Need to Know about COVID-19

4. Federal Emergency Management Agency (FEMA) - Coronavirus (COVID-19) Response.
5. National Park Service (NPS) - NPS Public Health Update.

PART 2 PRODUCTS

2.1 ACCIDENT PREVENTION PLAN (APP)

A. APP shall be written to comply with OSHA and project requirements (generic plan is not acceptable) including but not limited to:

1. Name and qualifications of supervisor responsible to carry out program.
2. Weekly and monthly safety meetings shall be documented with topics and attendees.
3. First aid and rescue procedures.
4. Job Hazard Analysis (JHA) for each major phase. List of hazards associated and methods proposed to provide for property protection and safety of the public, National Park Service personnel, and Contractor's employees. Include initial and continuing training.

    a. List of hazards must include exposure to chemicals or materials potentially harmful to human health. Mitigation must prioritize elimination of risks over mitigation of risks.

5. Planning for possible emergency situations, as detailed in Article Conditions Present for Project. Such planning shall take nature of construction, site conditions, and degree of exposure of persons and property into consideration.

    a. Plan must account for low quality or absence of cell phone service in Frijoles Canyon. Cross reference this issue with Section 01 50 00, Temporary Facilities and Controls.

6. Infectious Disease Preparedness:

    a. Contractors are responsible for their employees' safety and the safety of Job Site visitors during the performance of this contract. We encourage Contractors to follow guidance from the Department of Labor (DOL), Occupational Safety and Health Administration (OSHA), the Centers for Disease Control and Prevention (CDC), and all other applicable local, city, and state mandates. We encourage Contractors to develop policies for infection prevention and an Infectious Disease Preparedness and Response Plan.
    b. To the extent appropriate, Contractors should include the protective health and safety measures they intend to implement in any accident prevention or safety submittals required under this contract. These plans should contain preventive measures the Contractor intends to follow while performing work on government property as well as responsive and

corrective actions to be taken if an employee exhibits symptoms or tests positive for contagion.

c. Upon contract award, Contractors should communicate with Contracting Officer regarding Contractor decisions and actions to protect the health and safety of workers for the duration of contract performance under which pandemic conditions exist.

7. Plan shall be available in languages other than English if non-English speaking workers are employed at the Project Site. Translation shall be available on Project Site at all times to ensure the training and communication between workers and supervisors is maintained.

2.2 FIRST AID FACILITIES

A. Provide adequate facilities for number of employees and appropriate to construction hazards.

2.3 PERSONNEL PROTECTIVE EQUIPMENT (PPE)

A. Selection shall conform to OSHA Subpart E.

PART 3 EXECUTION

3.1 DAILY SAFETY INSPECTIONS

A. Conduct daily safety inspections and maintain daily safety reports which include:

1. Area/operation inspected.
2. Date of inspection.
3. Identified hazards.
4. Corrective actions taken.

3.2 EMERGENCY INSTRUCTIONS

A. Post telephone numbers and reporting instructions for ambulance, physician, hospital, fire department, and police in conspicuous locations at Work Site.

3.3 FIRE AND LIFE SAFETY

A. Comply with requirements of 2024 International Fire Code Chapter 33.

B. Smoking is prohibited within any Park building or within 25 feet of entrances, operable windows, or outdoor air intakes. Smoking must also follow Park fire restrictions which can change throughout the year based on wildfire risk.

C. Protection During the Use of Heat-Generating Equipment: Before work with heat-generating equipment commences, furnish a fire watch (or watches) for the location(s) where work is to be performed.

D. Refer to additional requirements in Section 01 35 91, Historic Preservation Treatment Procedures, and Section 01 50 00, Temporary Facilities and Controls.

3.4 HAZARDOUS MATERIALS

A. Hazardous Materials: Explosive, flammable, poisonous, corrosive, oxidizing, irritating, or otherwise harmful substances that could cause death or injury.

B. Store hazardous materials in accordance with manufacturer's and OSHA Subpart D requirements. Maintain Safety Data Sheets (SDS) for each chemical readily available on site.

1. Immediately report spills of hazardous materials to the Park.
2. Maintain a spill emergency response kit.
3. Train employees how to respond to a spill and use emergency response kit.

3.5 PROTECTIVE EQUIPMENT

A. Inspect personal protective equipment daily and maintain in a serviceable condition. Clean, sanitize, and repair personal items as appropriate before issuing to another individual.

3.6 SAFETY MEETINGS

A. As a minimum, conduct one weekly 15-minute "toolbox" safety meeting conducted by a foreman or supervisor and attended by construction personnel at worksite. Topics shall coincide with work scheduled for following week. Document and submit meeting minutes to Contracting Officer within one day after meeting.

B. Conduct monthly safety meetings for personnel, contractors, and subcontractors performing work on the site. Notify Contracting Officer of meeting dates and times. Meetings shall be used to: Review effectiveness of Contractor's safety effort; resolve current health and safety problems; provide a forum for planning safe construction activities, and for updating Accident Prevention Plan. Contracting Officers Representative will attend meetings and enter results of meetings into the daily log.

3.7 HARD HATS AND PROTECTIVE EQUIPMENT AREAS

A. A hard hat use area shall be designated by Contractor. Hard hat area shall be posted by Contractor in a manner satisfactory to Contracting Officer.

B. It is Contractor's responsibility to require persons working on or visiting site to wear hard hats and PPE in good repair at all times. As a minimum, maintain six hard hats and other APP required equipment.

3.8 TRAINING

A. First Aid: Provide training to personnel to ensure prompt and efficient first aid.

B. Hazardous Material: Train and instruct each employee exposed to hazardous material in safe and approved methods of handling and storage.

END OF SECTION

SECTION 01 35 91
HISTORIC PRESERVATION TREATMENT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes special procedures for historic treatment on Project including, but not limited to:

1. Definitions.
2. Submittals.
3. Quality Assurance.
4. Storage and protection of existing historic materials.
5. Project Site conditions.
6. Historic Preservation Treatment Plan.
7. Protection, General.
8. Protection during application of chemicals.
9. Protection during use of heat-generating equipment.
10. Historic preservation treatment procedures.

1.2 DEFINITIONS

A. “Existing to Remain” or “Retain”: Existing items of construction not to be removed and not otherwise indicated to be removed and salvaged or removed and reinstalled.

B. Material in Kind: Material that closely matches existing materials through comparison of architectural qualities and salient characteristic such as species, cut, color, grain, dimension, profile, thickness, and finish.

C. Preservation: To apply measures necessary to sustain existing form, integrity, and materials of historic property. Work may include preliminary measures to protect and stabilize the property.

D. Protect and Maintain: To remove deteriorating corrosion, reapply protective coatings, and install protective measures such as temporary guards; to provide the least degree of intervention.

E. Protect in Place: To install temporary protective materials between historic features and nearby work zones in accordance with this section.

F. Reconstruction: To reproduce in exact form and detail, a building, structure, or artifact as it appeared at a specific period in time. Reconstructed elements do not possess historic integrity in their own right since they are-not original fabric.

G. Rehabilitation: To make possible a compatible use for property through repair, alterations, and additions while preserving those portions or features that convey its historical, cultural, or architectural values.

H. Remove: To demolish or detach items from existing construction and legally dispose of them off-site unless indicated to be removed and salvaged or removed and reinstalled.

I. Remove and Reinstall: To detach items from existing construction, repair and prepare for reuse, and reinstall where indicated.

J. Remove and Salvage: To detach items from existing construction and deliver them ready for reuse to Contracting Officer (CO) or designee.

K. Repair: To stabilize, consolidate, or conserve; to retain existing materials and features while employing as little new material as possible. Repair includes patching, piecing-in, splicing, consolidating, or otherwise reinforcing or upgrading materials. Within restoration, repair also includes limited replacement in kind, rehabilitation, and reconstruction, with compatible substitute materials for deteriorated or missing parts of features when there are surviving prototypes.

L. Replace:

1. To duplicate in its entirety, a historic element or feature by matching its historic pattern, detail, and appearance. Replacement is justified when original or historic elements are damaged beyond repair or are missing. Replacement conditions and methods include:

a. Replacement with New Materials: Includes replacement with new material of like kind (custom fabricated or manufactured). Duplication of appearance using like material.
b. Replacement with Original or Historic Fabric: Includes fabric salvaged from other locations or projects having identical architectural qualities. Duplication of appearance using identical material possessing historical significance.
c. Replacement with Substitute Materials: Includes replacement with a compatible substitute that is frequently contemporary and unlike the historic fabric. Duplication of appearance using modern (non-traditional) material. Use of substitute materials is not approved unless matching materials are not available.

M. Restoration: To accurately return form, features, and character of a property to its appearance at a particular period of time by means of removal of features from other

periods in its history and repair and reconstruction of missing and deteriorated features from the restoration period.

N. Stabilize: To apply measures designed to reestablish a weather-resistant enclosure or structural reinforcement of an item or portion of the building while maintaining its essential form as it exists at present. This level of intervention is aimed at retarding or arresting deterioration of buildings and structures.

1.3 SUBMITTALS

A. Historic Preservation Treatment Plan:

1. After contract award and before Pre-Construction conference, submit for approval a written Historic Preservation Treatment Plan (HPTP).
2. If the plan requires revisions or corrections, Contractor shall resubmit plan within 10 days.
3. No change in approved plan may be made without written concurrence by Contracting Officer.

B. Alternative Methods and Materials: If alternative methods and materials different from those indicated are proposed for any phase of work, provide a written description including evidence of successful use on other, comparable projects, and program of testing to demonstrate effectiveness for use on this Project.

C. Photographs or Videotape:

1. In accordance with Section 01 32 33, Photographic Documentation, photograph existing conditions of the landscape prior to utility installation, including adjoining construction and site improvements and finish surfaces that might be misconstrued as damage caused by utility installation or construction activities. Submit photographs before work begins of the following but not limited to:

   a. Existing landscape along utility trench installation, construction stockpile areas, and temporary generator locations.
   b. Entrance Road stone curbing and storm drainage.
   c. Stone House Road stone curbing.
   d. Casitas flagstone.
   e. Buildings with facades adjacent to areas of active construction.
   f. Retaining walls (top and exposed sides), and exposed façade.

D. Historic features are considered to be in good condition, unless noted. The Contractor is responsible for repairs of any damaged areas during or post construction operations.

1.4 QUALITY ASSURANCE

A. Historic Preservation Treatment Specialist Qualifications: Experienced firm with required NPS Professional Qualification Standards: 36 CFR Part 61, certifications and training able to demonstrate through past performance that they have experience in projects and have engaged in historic treatments similar in nature, materials, design with a record of successful in-service performance of not less than three recent projects that demonstrate the firm's qualifications to perform this work.

1. Field Supervisory Qualifications: Full-time supervisors experienced in historic treatment work similar in nature, material, design, and extent to that indicated for this Project. Supervisors shall be on Project Site during times that historic treatment work is in progress. Supervisor shall not be changed during the Project except for causes beyond control of the specialist firm.
2. Worker Qualification: Persons who are experienced in historic treatment work of types they will be performing.

1.5 STORAGE AND PROTECTION OF HISTORIC MATERIALS

A. Removed and Salvaged Historic Materials:

1. Clean only loose debris from salvaged historic items unless more extensive cleaning is approved.
2. Pack or crate items after cleaning, cushion against damage during handling. Identify and label contents of containers.
3. Store items in secure area until delivery to Contracting Officer.
4. Transport items to storage area on-site as designated by the Contracting Officer.
5. Protect items from damage during transport and storage.
6. Do not dispose of items removed from existing construction without prior written consent of Contracting Officer.

B. Removed and Reinstalled Historic Materials:

1. Clean and repair historic 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. Comply with installation requirements for historic materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use as indicated.

C. Existing Historic Materials to Remain: Protect materials indicated to remain against damage and soiling during construction. When permitted by Contracting Officer, items may be removed to suitable, protected storage location during construction, and cleaned and reinstalled in their original locations after construction operations are complete.

D. Storage and Protection: When removed from existing location, store historic materials within weather-tight enclosure protected from wetting by rain, snow, or ground water, and temperature variations. Secure stored materials to protect from theft.

1. Identify removed items with an inconspicuous and non-permanent mark indicating original location.
2. Develop key plan when many similar items are scheduled for removal and reinstallation.

1.6 PROJECT-SITE CONDITIONS

A. Exterior Cleaning and Repairing:

1. Proceed with work only when forecasted weather conditions are favorable.

a. Wet Weather: Do not attempt repairs during rainy or foggy weather. Do not apply primer, paint, putty, or epoxy when relative humidity is above 80 percent. Do not remove exterior elements of structures when rain is forecast or in progress.
b. Do not perform exterior wet work when air temperature is below 40 degrees F (5 degrees C).
c. Do not begin cleaning, patching, or repairing given likelihood of frost or freezing.
d. Do not begin cleaning when either air or surface temperature is below 45 degrees F (7 degrees C) unless approved means are provided for maintaining 45 degrees F (7 degrees C) temperature of air and materials during, and for 48 hours subsequent to, cleaning.

2. Perform cleaning and rinsing of the exterior only during daylight hours.

B. National Park Service will occupy portions of building immediately adjacent to construction area. Conduct construction activities so National Park Service operations will not be disrupted. Provide 72 hours' notice to Contracting Officer of activities that will affect National Park Service operations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 HISTORIC PRESERVATION TREATMENT PLAN

A. Prepare written plan for preservation work covering preservation components of project. Plan shall verify that construction strategy and intent is compatible with Department of the Interior's (DOI) standards for Treatment of Historic Properties, guidelines for Treatment of Cultural Landscapes, and National Park Service

management policies for cultural resources. Plan shall satisfy both project scope and resource protection requirements. Plan shall include:

1. Organized list of preservation components of project, systems, and tasks.
2. Staging and detailed sequence of work that includes protection of historic resources.
3. Disassembly and reassembly techniques and steps.
4. Stockpile areas for historic resources.
5. Equipment and tools required.
6. Supplies and materials with manufacturer or supplier identified including specific clean up/storage procedure with frequency and documentation of such.
7. Skilled trades and crafts required.
8. Anticipated testing and analysis of fabric.
9. Additional investigations for extent or magnitude of treatments needed.
10. Protective measures for individual items or elements.
11. Seasonal limitations on the work.
12. Alternative means if primary treatment method is unfeasible.
13. Work conducted off-site (Approval from Contracting Officer required prior to taking resources off-site).

3.2 PROTECTION, GENERAL

A. Comply with manufacturer's written instructions for precautions and effects of products and procedures on adjacent building materials, components, and vegetation.

B. Ensure supervisory personnel are present when work begins and during progress.

3.3 PROTECTION DURING APPLICATION OF CHEMICALS

A. Protect persons, motor vehicles, surrounding surfaces of building being restored, building site, plants, and surrounding buildings from harm or damage resulting from applications of chemical cleaners and paint removers.

B. Comply with requirements in Section 01 50 00, Temporary Facilities and Controls.

C. Cover adjacent surfaces with materials proven to resist chemical cleaners selected for Project unless chemicals being used will not damage adjacent surfaces. Use covering materials containing only waterproof, UV (ultraviolet)-resistant adhesives. Apply masking agents to comply with manufacturer's written instructions. Do not apply liquid masking agent to painted or porous surfaces. Promptly remove masking to prevent adhesive staining on completion.

D. Do not clean surfaces during winds of sufficient force to spread cleaning solutions to unprotected surfaces.

E. Neutralize and collect alkaline and acid wastes and dispose of outside park boundaries.

F. Dispose of runoff from chemical operations by legal means and in a manner preventing soil erosion, undermining of paving and foundations, damage to landscaping, and water penetration into building interiors.

G. Document daily clean-up, proper storage, and disposition of any flammable/combustible materials with daily reports.

3.4 PROTECTION DURING USE OF HEAT-GENERATING EQUIPMENT

A. Comply with following procedures while performing work with heat-generating equipment, including welding, cutting, soldering, brazing, paint removal with heat, and other operations where open flames or implements utilizing heat are used:

1. Obtain Contracting Officer's approval for operations involving use of open-flame or welding equipment.

   a. Notification shall be given for each occurrence and location of work with heat-generating equipment.
   b. Obtain appropriate permit from the park as required.

2. As far as practical, use heat-generating equipment in shop areas or outside building.
3. Before work with heat-generating equipment commences, furnish fire watch (or watches) for location(s) where work is to be performed.
4. Do not perform work with heat-generating equipment in or near rooms or in areas where flammable liquids or explosive vapors are present or thought to be present. Use combustible gas indicator test to ensure area is safe.
5. Remove and keep area free of combustibles, including, rubbish, paper, waste, etc., within area of operations.

   a. If combustible material cannot be removed, provide fireproof blankets to cover such materials.

6. Where possible, furnish and use baffles of metal or gypsum board to prevent spraying of sparks or hot slag into surrounding combustible material.
7. Prevent extension of sparks and particles of hot metal through open windows, doors, holes, and cracks in floors, walls, ceilings, roofs, and other openings.
8. Inspect each location of day's work not sooner than 30 minutes after completion of operations to detect hidden or smoldering fires; ensure proper housekeeping is maintained.

B. Where sprinkler protection exists and is functional, maintain without interruption while operations are performed. If operations are performed near automatic sprinkler heads, shield individual heads temporarily with guards.

3.5 HISTORIC PRESERVATION TREATMENT PROCEDURES

A. The principal aim of preservation work is to halt the process of deterioration and stabilize the item's condition to sustain the integrity of the historic element, feature or structure being preserved. Cyclic maintenance is often required as well as repair work. Repair is required where specifically indicated. The following procedures shall be followed:

1. Retain as much existing material as possible; repair and stabilize rather than replace.
2. Use additional material or structure to reinforce, strengthen, prop, tie, and support existing material or structure.
3. Use reversible processes wherever possible.
4. Use traditional replacement materials and techniques if possible. New work shall be distinguishable from old work and original materials and techniques.
5. Record repair work during construction with periodic construction photos and daily inspection reporting. Photo documentation is specified in Section 01 32 33, Photographic Documentation.

B. Prohibit smoking by personnel performing work on or near historic structures.

C. Notify Contracting Officer of visible changes in integrity of material or components due to environmental causes including biological attack, UV degradation, freezing, or thawing, or due to structural defects including cracks, movement, or distortion.

1. Do not proceed with work in question until directed by Contracting Officer.

D. Where Work requires existing features to be removed, cleaned, and reinstalled, perform operations without damage to material itself, to adjacent materials, or to substrate.

E. Identify new or replacement materials and features with inconspicuous, permanent marks to distinguish from original materials. Record legend of identification marks and locations of these marks on Record Drawings.

F. When cleaning, match samples of existing materials that have been cleaned and identified for acceptable cleaning levels. Avoid over-cleaning to prevent damage. Use gentlest methods available. Initiate cleaning using hand cleaning methods before introducing power cleaning methods and equipment.

G. Protect persons, motor vehicles, surrounding surfaces of building, building site, plants, and surrounding buildings from harm resulting from utility installation procedures.

1. Use only proven protection methods appropriate to each area and surface being protected.

2. Provide barricades, barriers, and temporary directional signage to exclude public from areas where utility installation work is being performed.
3. Erect temporary protective covers over historic elements in areas of construction activities.
4. Contain dust and debris generated by removal and dismantling work and prevent it from reaching the public or adjacent surfaces.
5. Provide shoring, bracing, and supports, as necessary. Do not overload structures.

H. Provide supplemental sound-control treatment to isolate removal and dismantling work from other areas of the building.

I. Comply with manufacturer's written instructions for precautions and effects of products and procedures on adjacent building materials, components, and vegetation.

J. Ensure that Contracting Officer reviews protection measures and makes modifications if desired to ensure the protection of historically sensitive elements that may be affected by installation of utility lines.

K. Temporary Protection of Historic Materials during Construction:

1. Protect existing materials during installation of temporary protections and construction. Do not deface or remove existing materials.
2. Attachments of temporary protection to existing construction shall be approved by the Contracting Officer prior to installation.

L. Historic structures and elements to be protected during utility installation operations as indicated on the drawings, plans, and details as approved by the Contracting Officer, including but not limited to:

1. Historic building walls to be protected by wood barriers constructed of solid 4 by 4 timbers and plywood sheathing.
2. Historic retaining walls and top of walls to be covered with Styrofoam insulation board and plywood sheathing to protect from mechanical equipment damage.
3. Historic stone curbs along entirety of the project to be protected by Styrofoam insulation board and plywood sheathing to protect from mechanical equipment damage.
4. Historic stone retaining wall along Entrance Road is to be protected by placement of protective vehicular barriers and Styrofoam backing in areas of active construction. Milling and paving machines must not go closer than 2 feet to the wall.
5. Historic stone gutter along entirety of the Project Area to be protected with solid steel plates, high density insulation and wood timbers in areas of active construction. If an additional length requires protection than the available number of steel plates, then use the steel plates in the most vulnerable locations according to equipment movements, and use plywood caps over the remaining

stone gutter. Protect the gutter during adjacent demolition, trenching, and repaving.

6. Historic stone culvert headwalls to be protected by shoring with plywood and 2 by 4 lumber to prevent damage from nearby trenching and repaving.

M. Protect landscape work adjacent to or within work areas as follows:

1. Provide barriers to protect tree trunks.
2. Bind spreading shrubs.
3. Coverings shall allow plants to breathe. Remove coverings at end of day. Do not cover plant material with waterproof membrane more than 8 hours at a time.
4. Set scaffolding and ladder legs away from plants.

N. Existing (non-historic) Flagstone sidewalks shall be considered as valued landscape elements and are to be protected from damage during construction operations. Include description of protection methods to be reviewed and accepted by the Contracting Officer.

O. Existing drains and culverts are part of the historic structures on site. Drains and culverts are not to be affected during the course of these operations.

P. Existing Drains: Prior to the start of work or any cleaning operations, test drains and other water removal systems to ensure proper operation and functionality. Notify the Contracting Officer immediately of stopped or blocked drains or systems. Do not begin work in this area until the drains are in working order.

1. Provide a method to prevent solids including stone or mortar residue from entering the drains or drain lines. Clean out drains and drain lines that become blocked or filled by sand or any other solids because of Work performed under this Contract.
2. Protect storm drains from pollutants. Block drains or filter out sediments, allowing only clean water to pass.
3. Provide a method to protect the historic stonework for review and approval by the Contracting Officer in advance of construction operations.

END OF SECTION

SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for quality assurance and quality control.

B. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with Contract Document requirements. Quality of work shall be responsibility of the Contractor.

1. Specified tests, inspections, and related actions do not limit Contractor's other quality assurance and control procedures that facilitate compliance with Contract Document requirements.

C. See Division 02 through Division 49 sections for specific test and inspection requirements.

1.2 DEFINITIONS

A. Field Quality Control Testing: Tests and inspections performed onsite for installation of work and for completed work.

B. Installer/Applicator/Erector: Contractor or another entity engaged by Contractor as an employee, Subcontractor, or Sub-subcontractor, to perform a particular construction operation, including installation, erection, application, and similar operations.

1. Using a term such as "carpentry" does not imply certain construction activities must be performed by accredited or unionized individuals of a corresponding generic name, such as "carpenter." It also does not imply that requirements specified apply exclusively to trades people of corresponding generic name.

C. Preconstruction Testing: Tests and inspections performed specifically for project before products and materials are incorporated into work to verify performance or compliance with specified criteria.

D. Product Testing: Tests and inspections performed by a Nationally Recognized Testing Laboratory (NRTL), a National Voluntary Laboratory Accreditation Program (NVLAP), or a testing agency qualified to conduct product testing, to establish product performance and compliance with industry standards.

E. Quality Assurance Services: Activities, actions, and procedures performed before and during execution of the Work to guard against defects and deficiencies and substantiate that proposed construction will comply with requirements.

F. Quality Control Services: Tests, inspections, procedures, and related actions during and after execution of the Work to evaluate actual products incorporated into the Work and completed construction comply with requirements.

G. Source Quality Control Testing: Tests and inspections performed at the source, i.e., plant, mill, factory, or shop.

H. Testing Agency or Laboratory: Entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.

1.3 CONFLICTING REQUIREMENTS

A. Reference Standards: If compliance with two or more standards is specified and standards establish different or conflicting requirements for minimum quality levels, comply with most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Contracting Officer before proceeding.

B. Minimum Quality Levels: Quality level shown or specified shall be minimum provided or performed. Actual installation may comply exactly with minimum quality specified, or it may exceed minimum within reasonable limits. To comply with requirements, indicated numeric values are minimum or maximum, as appropriate, for the context of requirements. Refer uncertainties to Contracting Officer before proceeding.

1.4 SUBMITTALS

A. Quality Control Plan:

1. After contract award and before Pre-Construction conference, submit a written Contractor Quality Control (CQC) plan.
2. If plan requires revisions or corrections, Contractor shall resubmit plan within 10 days.
3. Government reserves the right to require changes in plan during Contract period as necessary to obtain the quality specified.
4. No change in the approved plan may be made without written concurrence by Contracting Officer.

B. Qualification Data: For testing agencies specified in Article Quality Assurance, to demonstrate their capabilities and experience. Include proof of qualifications in form of a recent report on inspection of testing agency by a recognized authority.

C. Contractor Quality Control (CQC) Daily Reports: Submit showing inspections and tests on first workday following date covered by report. Quality Control Supervisor shall utilize DSC Forms available from the DSC Workflows website.

1. Review Construction Management Representative (CMR) Daily report if applicable and reconcile any differences prior to posting.

D. Test Reports:

1. Test reports shall be completed by person performing test.
2. Submit Daily Test Information Sheets with Quality Control Daily Reports.
3. Submit failing test results and proposed remedial actions within 4 hours of noted deficiency.
4. Submit three copies of complete test results no later than 1 calendar day after test was performed.

E. Accessibility Inspection Report:

1. Fill out applicable sections of the Accessibility Inspection Report and attach to Contractor Quality Control Daily Report.
2. Utilize attached Accessibility Inspection form to document compliance with Architectural Barriers Act Accessibility Standards (ABAAS).
3. Inspect at various stages of construction as needed to ensure finished product meets standards.
4. Submit report no later than 1 calendar day after inspection was performed.

F. Offsite Inspection Reports: Submit prior to shipment.

G. If Contractor Quality Control plan and Quality Control Daily Reports are not submitted as specified, Contracting Officer may retain payments until such time plan(s) is/are accepted and implemented, or may retain payments for work completed on days with no Quality Control Daily Reports.

H. Permits, Licenses, and Certificates: For National Park Service (NPS) records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, correspondence, records, and similar documents, established for compliance with standards and regulations bearing on performance of work.

1.5 QUALITY ASSURANCE

A. General: Qualifications paragraphs in this article establish minimum qualification levels required; individual specification sections specify additional requirements.

B. Contractors Quality Control Staff:

1. Contractor's Quality Control Supervisor may also perform other duties.
2. Contractor's designated Quality Control Supervisor shall be on the Project Site whenever contract work is in progress.
3. Contractor's job supervisory staff may be used to assist Quality Control Supervisor supplemented, as necessary, by additional certified testing technicians.

C. Installer Qualifications: Firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent indicated for Project, whose work has resulted in construction with a record of successful in-service performance.

D. Manufacturer Qualifications: Firm experienced in manufacturing products or systems similar to those indicated for Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Fabricator Qualifications: Firm experienced in producing products similar to those indicated for Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

F. Professional Engineer Qualifications: Professional engineer legally qualified to practice in jurisdiction where Project is located and is experienced in providing engineering services of kind indicated (including Structural Tests and Special Inspections (STSI)). Engineering services are defined as those performed for installations of system, assembly, or products similar to those indicated for Project in material, design, and extent.

G. Specialists: Certain sections of the Specifications require that specific construction activities shall be performed by entities who are recognized experts in those operations. Specialists shall satisfy qualification requirements indicated and shall be engaged for activities indicated.

1. Requirement for specialists shall not supersede building codes and regulations governing Work.

H. Testing Agency Qualifications: A Nationally Recognized Testing Laboratory (NRTL), a National Voluntary Laboratory Accreditation Program (NVLAP), or an independent agency with experience and capability to conduct testing and inspecting indicated, according to ASTM E329; and with additional qualifications specified in individual sections; and where required by Contract, is acceptable to Contracting Officer.

1. Nationally Recognized Testing Laboratory (NRTL): Nationally recognized testing laboratory according to 29 CFR 1910.7 (Code of Federal Regulations).

2. National Voluntary Laboratory Accreditation Program (NVLAP): Testing agency accredited according to National Institute of Standards and Technology's (NIST) National Voluntary Laboratory Accreditation Program.
3. Measuring devices, laboratory equipment, and instruments shall be calibrated at established intervals against certified standards in accordance with NIST requirements. Measuring and testing devices shall be made available for use by Government for verification tests.

I. Factory-Authorized Service Representative Qualifications: Authorized representative of manufacturer who is trained and approved by manufacturer to inspect installation of manufacturer's products similar in material, design, and extent to those indicated for Project.

1.6 QUALITY CONTROL

A. Contractor is responsible for testing and inspections, including Structural Tests and Special Inspections (STSI), as identified in Section 01 45 33, Special Inspection, Observation, and Testing, and the Statement of Special Inspections, as shown on the Drawings. Inspect and test work as needed to ensure quality of materials, workmanship, construction, finish, and functional performance are in compliance with applicable specifications, drawings, and those required by the Building Code.

1. Engage qualified testing agency to perform quality-control services.
2. Submit appropriate report for each quality-control service.
3. Testing and inspecting requested by Contractor and not required by Contract Documents are Contractor's responsibility.
4. Contracting Officer may designate test locations.

B. Manufacturer's Field Services: Where indicated, engage factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections. Report results in writing.

C. Re-testing/Re-inspecting: Regardless of whether original tests or inspections were Contractor's responsibility, provide quality-control services, including retesting and re-inspecting, for construction of replaced work that failed to comply with Contract Documents.

D. Testing Agency Responsibilities: Cooperate with NPS and Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.

1. Notify Contracting Officer and Contractor promptly of irregularities or deficiencies observed in work during performance of services.
2. Determine location from which test samples will be taken and in which in-situ tests are conducted.
3. Conduct and interpret tests and inspections. State in each report whether tested and inspected work complies with or deviates from requirements.

4. Submit three copies of certified written report of each test, inspection, and similar quality-control service through Contractor.
5. Do not release, revoke, alter, or increase Contract Document requirements or approve or accept any portion of Work.

E. Associated Services:

1. Cooperate with agencies performing required tests, inspections, and similar quality-control services, and provide reasonable auxiliary services as requested. Notify agency sufficiently in advance of operations to permit assignment of personnel. Provide:

a. Access to Work.
b. Incidental labor and facilities necessary to facilitate tests and inspections.
c. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
d. Facilities for storage and field curing of test samples.
e. Delivery of samples to testing agencies.
f. Preliminary design mix proposed for material mixes that require control by testing agency.
g. Security and protection for samples and testing and inspecting equipment at Project Site.

F. Coordination: Coordinate sequence of activities to accommodate required quality assurance and control services with minimum delay and to avoid removing and replacing construction to accommodate testing and inspecting.

1. Schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 PRODUCTS

2.1 QUALITY CONTROL PLAN

A. Quality Control Plan shall include:

1. List of personnel responsible for quality control and assigned duties. Include each person's qualifications. Include alternate(s) and qualifications.
2. Copy of letter of direction to Contractor's Quality Control Supervisor(s) outlining assigned duties and authorities designated by principal or owner.
3. Names, qualifications / accreditations, and descriptions of laboratories to perform sampling and testing, and samples of proposed report forms from laboratories.
4. Methods of performing, documenting, and enforcing quality control of work including Contractor report forms and acknowledgment of NPS forms.
5. Methods of monitoring and controlling environmental pollution and contamination as required by regulations and laws.

6. Specific discussion regarding mockups, offsite visits, receiving inspections, manufacturers representation, startup requirements, and other aspects of performance specific to Project.
7. Provisions for substantial completion(s) and final inspection(s) per Contract.

PART 3 EXECUTION

3.1 OFFSITE CONTROL

A. Items fabricated or assembled offsite shall be inspected for quality control at place of fabrication.

3.2 ONSITE CONTROL

A. Notification:

1. Notify Contracting Officer at least 48 hours in advance of preparatory phase meeting.
2. Notify Contracting Officer at least 24 hours in advance of initial and follow-up phases.

B. Preparatory Phase: Perform before beginning each feature of work.

1. Review control submittal requirements with personnel directly responsible for quality assurance and quantity control of the Work. As a minimum, Contractor's Quality Control Supervisor and foreman responsible for feature of work shall be in attendance.
2. Review applicable specifications sections and drawings related to feature of work.
3. Ensure copies of referenced standards related to sampling, testing, and execution for feature of work are available onsite.
4. Ensure provisions have been made for field control testing.
5. Examine work area to ensure preliminary work has been completed.
6. Verify field dimensions and advise Contracting Officer of discrepancies with Contract Documents.
7. Ensure necessary equipment and materials are at Project Site and they comply with approved Shop Drawings and submittals.
8. Document preparatory phase activities and discussions on Contractor's Quality Control Daily Report.

C. Initial Phase:

1. As soon as work begins, inspect and test representative portion of particular feature of work for quality of workmanship.
2. Review control testing procedures to ensure compliance with Contract requirements.

3. Document initial phase activities and discussions on Contractor's Quality Control Daily Report. Exact location of initial phase shall be indicated for future reference and comparison with follow-up phases.

D. Follow-Up Phase: Inspect and test as work progresses to ensure compliance with Contract requirements until completion of work.

1. Additional Preparatory and Initial Phases:

a. Additional preparatory and initial phases may be required on same feature of work for following reasons:

1) Quality of on-going work is unacceptable.
2) Changes in quality control staff, onsite production supervision, or work crew.
3) Work on particular feature of work is resumed after substantial period of inactivity.

3.3 DOCUMENTATION

A. Maintain Quality Control Daily Reports, Daily Test Report Information Sheets, and Accessibility Inspection Reports of quality control activities and tests. (Download from DSC Workflows website > Forms/Templates/Samples/Guidelines page > Construction Forms section.)

B. Quality Control Daily Reports shall not be substituted for other written reports required under clauses of Contract, such as Disputes, Differing Site Conditions, or Changes.

3.4 ENFORCEMENT

A. Contractor shall stop work on any item or feature pending satisfactory correction of deficiency noted by quality control staff or Contracting Officer.

3.5 REPAIR AND PROTECTION

A. General: On completion of testing, inspecting, sample taking, and similar services, repair damaged construction and restore substrates and finishes.

1. Comply with Contract Document requirements for Section 01 73 29, Cutting and Patching.

B. Protect construction exposed by or for quality-control service activities.

C. Repair and protection are Contractor's responsibility, regardless of the assignment of responsibility for quality-control services.

3.6 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Statement of Structural Tests and Special Inspections.

END OF SECTION

Statement of Structural Tests and Special Inspections

National Park Service (NPS) - Denver Service Center (DSC) | 6-29-21

Park: Bandelier National Monument

Project Management Information System (PMIS) Number: 266697

Project Name: Utility Rehabilitation Project

Structural Engineering Firm: Jacobs Engineering

This Statement of Structural Tests and Special Inspections is being submitted as required by Chapter 17 of the **2021 International Building Code** (IBC-21). It includes the following:

1. Seismic requirements
2. Wind requirements
3. Qualification Requirements for Inspectors and Testing Technicians
4. Listing of Required Structural Tests and Special Inspections

The Construction Contractor's Quality Control Supervisor will provide copies of all special inspection reports and associated documentation to the Contracting Officer (CO). The Construction Contractor will be required to correct all deficiencies discovered in the Special Inspection and Structural Testing program.

Prepared By: Thomas Paige, P.E.
(Type or print name)

Signature: Thomas Paige Date: 4.4.2024

THOMAS E. PAIGE
NEW MEXICO
17930
LICENSED PROFESSIONAL ENGINEER

Stamped by Professional Engineer (PE) or Structural Engineer (SE)

Seismic and Wind Requirements

Seismic Requirements, IBC-21 Section 1704.3

Description of seismic-force-resisting system and designated seismic systems subject to special inspections:

Upper Canyon Tank – Below grade cast-in-place concrete vault. Ordinary reinforced concrete shear wall / bearing wall system.

Canyon Mechanical Building – Prefabricated building set on a cast-in-place concrete slab on grade.

Wind Requirements, IBC-21 Section 1704.3

Description of wind-force-resisting system and designated wind systems subject to special inspections:

None required. Project wind speeds are below that required for special inspections specific to wind resistance in accordance with IBC-21 Section 1705.12 and are exempt.

Instructions:

1. Under Listing of Required Structural Tests and Special Inspections:
    a. **Required?** - Place an **X** for all Special Inspections and Tests required for this project.
    b. **Required Qualifications** - Provide qualifications for the special inspector, using the Qualification Requirements for Inspector and Testing Technicians list below, for all required Structural Tests and Special Inspections.
    c. **Continuous** - If marked with an **X**, continuous special inspection shall be as defined in Chapter 2, IBC-21.
    d. **Periodic** - If marked with an **X**, provide the minimum number of tests, i.e. 20% of all field welds, or the amount of work to be inspected (e.g. 10% of all wall surfaces).
2. Attach completed Statement of Structural Tests and Special Inspections to the end of NPS DSC Division 1 Specifications **Section 01 40 00 Quality Requirements**.

Qualification Requirements for Inspectors and Testing Technicians

PE/SE	Structural Engineer – licensed PE or SE specializing in the design of buildings and structures
PE/GE	Geotechnical Engineer – licensed PE specializing in soil mechanics and foundations
EIT	Engineer-In-Training – graduate engineer who has passed the Fundamentals of engineering examination

American Concrete Institute (ACI) Certification

ACI-CCSI	Concrete Construction Special Inspector
ACI-LTT	Concrete Laboratory Testing Technician Level 1 or 2
ACI-STT	Concrete Strength Testing Technician
ACI-FTT	Concrete Field Testing Technician – Grade I

American Society of Non-Destructive Testing (ASNT) Certification

Non-Destructive Testing Technician – Level II or III

American Welding Society (AWS) Certification

AWS-CWI	Certified Welding Inspector

Exterior Design Institute (EDI) Certification

EDI-EIFS	Certified EIFS inspector

International Code Council (ICC) Certification

ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector
ICC-SSI	Soils Special Inspector
ICC-SFSI	Spray-applied Fireproofing Special Inspector
ICC-SMSI	Structural Masonry Special Inspector
ICC-SSBSI	Structural Steel and Bolting Special Inspector
ICC-SWSI	Structural Welding Special Inspector

National Institute for Certification in Engineering Technologies (NICET) Certification

NICET-CT	Concrete Technician – Levels I, II, III and IV
NICET-GET	Geotechnical Engineering Technician - Levels I, II, III and IV
NICET-ST	Soils Technician - Levels I, II, III and IV

Other

Listing of Required Structural Tests and Special Inspections

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	Steel Construction (IBC-21 Section 1705.2; American Institute of Steel Construction: AISC 360-16 Chapter N, AISC 341-16 Chapter J)				
	Prior to Welding (AISC 360-16 Table N5.4-1)				
	1. Welder qualification records and continuity records		X		
	2. Welding procedure specifications (WPS) available		X		
	3. Manufacturer certifications for welding consumables available		X		
	4. Material identification (type/grade)			X	
	5. Welder identification system			X	
	6. Fit-up of groove welds (including joint geometry)				
	a. Joint preparation			X	
	b. Dimensions (alignment, root opening, root face, bevel)			X	
	c. Cleanliness (condition of steel surfaces)			X	
	d. Tacking (tack weld quality and location)			X	
	e. Backing type and fit (if applicable)			X	
	7. Fit-up of CJP (complete joist penetration) groove welds of HSS (hollow structural sections) T-, Y- and K-joints without backing (including joint geometry)				
	a. Joint preparation				
	b. Dimensions (alignment, root opening, root face, bevel)				
	c. Cleanliness (condition of steel surfaces)				
	d. Tacking (tack weld quality and location)				

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	8. Configuration and finish of access holes			X	
	9. Fit-up of fillet welds				
	a. Dimensions (alignment, gaps at root)			X	
	b. Cleanliness (condition of steel surfaces)			X	
	c. Tacking (tack weld quality and location)			X	
	10. Check welding equipment			X	
	During Welding (AISC 360-16 Table N5.4-2)				
	1. Control and handling of welding consumables				
	a. Packaging			X	
	b. Exposure control			X	
	2. No welding over cracked tack welds			X	
	3. Environmental conditions				
	a. Wind speed within limits			X	
	b. Precipitation and temperature			X	
	4. WPS followed				
	a. Settings on welding equipment			X	
	b. Travel speed			X	
	c. Selected welding materials			X	
	d. Shielding gas type/flow rate			X	
	e. Preheat applied			X	
	f. Interpass temperature maintained (minimum/maximum)			X	
	g. Proper position (F, V, H, OH)			X	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	h. Intermix of filler metals avoided unless approved (reference: AISC 341-10 Table J6.2)			X	
	5. Use of qualified welders		X		
	6. Welding techniques				
	a. Interpass and final cleaning			X	
	b. Each pass within profile limitations			X	
	c. Each pass meets quality requirements			X	
	7. Placement and installation of headed stud anchors		X		
	After Welding (AISC 360-16 Table N5.4-3)				
	1. Welds cleaned			X	
	2. Size, length and location of welds		X		
	3. Welds meet visual acceptance criteria				
	a. Crack prohibition		X		
	b. Weld/base-metal fusion		X		
	c. Crater cross section		X		
	d. Weld profiles		X		
	e. Weld size		X		
	f. Undercut		X		
	g. Porosity		X		
	4. Arc strikes		X		
	5. k-area		X		
	6. Weld access holes in rolled heavy shapes and built-up heavy shapes		X		
	7. Backing removed and weld tabs removed (if required)		X		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	8. Repair activities		X		
	9. Document acceptance or rejection of welded joint or member		X		
	10. No prohibited welds have been added without the approval of the EOR (Engineer of Record)		X		
	11. Placement of reinforcing or contouring fillet welds (if required) (reference: AISC 341-16)		X		
	Nondestructive Testing (AISC 360-16 Section N5 and AISC 341-16 Section J6)				
	1. Risk Category II Structures - Perform Ultrasonic Testing on 10% of CJP groove welds in butt, T- and corner joints subject to transversely applied tension loading, in materials 5/16 inch thick or greater.			X	
	2. Risk Category III or IV Structures - Perform Ultrasonic Testing on all CJP groove welds subject to transversely applied tension loading in butt, T- and corner joints, in materials 5/16 inch thick or greater.		X		
	3. Access Holes – Perform Magnetic Particle Testing or Liquid Penetrant Testing when the flange thickness exceeds 2 inches for rolled shapes, or when the web thickness exceeds 2 inches for built-up shapes.		X		
	4. Welded Joints Subject to Fatigue		X		
	Nondestructive Testing (AISC 341-16 Section J6)				
	Column Splice and Column to Base Plate PJP Groove Weld (AISC 341-16 Section J6 2b)				
	1. Perform Ultrasonic Testing on 100% of PJP (partial-joint-penetration) groove welds in column splices and column to base plate welds		X		
	2. CJP Groove weld		X		
	3. Lamellar tearing		X		
	4. Beam cope and access hole		X		
	5. Reduced beam section repair		X		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	6. Weld tab removal		X		
	Prior to Bolting (AISC 360-16 Table N5.6-1)				
	These inspections are not required for snug-tight joints.				
	1. Manufacturer's certifications available for fastener materials		X		
	2. Fasteners marked in accordance with ASTM requirements			X	
	3. Correct fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane)			X	
	4. Correct bolting procedure selected for joint detail			X	
	5. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements			X	
	6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used			X	
	7. Protected storage provided for bolts, nuts, washers and other fastener components			X	
	During Bolting (AISC 360-16 Table N5.6-2)				
	These inspections are not required for snug-tight joints.				
	These inspections are not required for pretensioned joints and slip-critical joints, when the installer is using the turn-of-nut method with matchmarking techniques, the direct-tension-indicator method, or the twist-off-type tension control bolt method.				
	1. Fastener assemblies, of suitable condition, placed in all holes and washers (if required) are positioned as required			X	
	2. Joint brought to the snug-tight condition prior to the pretensioning operation			X	
	3. Fastener component not turned by the wrench prevented from rotating			X	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	4. Fasteners are pretensioned in accordance with the RCSC (Resource Council on Structural Connections) Specification, progressing systematically from the most rigid point toward the free edges			X	
	After Bolting (AISC 360-16 Table N5.6-2)				
	Document acceptance or rejection of bolted connections.		X		
	Other Inspection Tasks (AISC 360-16 Section N5.7)				
	1. Verify compliance of fabricated steel with the details shown on the approved shop drawings.			X	
	2. Verify compliance of the erected steel frame with the details shown on the approved erection drawings, including braces, stiffeners, member locations and joint details.			X	
	3. Anchor rods and other embedments support structural steel				
	a. Verify the diameter, grade, type and length of the anchor rod or embedded item.			X	
	b. Verify the extent or depth of embedment into the concrete.			X	
	4. RBS (reduce beam section) requirements, if applicable (AISC 341-16)				
	a. Contour and finish			X	
	b. Dimensional tolerances			X	
	5. Protected zone - no holes and unapproved attachments made by fabricator or erector, as applicable. (AISC 341-16)			X	
	6. H-piles - Protected zone - no holes and unapproved attachments made by the responsible contractor, as applicable. (AISC 341-16)			X	
	Cold-formed Steel Deck (IBC-21 1705.2.2)				
	1. Special inspections in accordance with QA/QC-2017 Standard for Quality control (QC) and				

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	Quality assurance (QA) for Installation of Steel Deck				
	Open-Web steel Joists and Joist Girders (IBC-21 Table 1705.2.3)				
	1. Installation of open-web steel joists and joist girders.				
	a. End connections - welding or bolted			X	
	b. Bridging - horizontal or diagonal				
	1. Standard bridging			X	
	2. Bridging that differs from the SJI (Steel Joist Institute) specifications listed in Section 2207.1.			X	
	Inspection of Composite Structures Prior to Concrete Placement (AISC 341-16 Table J9.1)				
	1. Material identification of reinforcing steel (Type/Grade)			X	
	2. Determination of carbon equivalent for reinforcing steel other than ASTM A706			X	
	3. Proper reinforcing steel size, spacing and orientation			X	
	4. Reinforcing steel has not been rebent in the field			X	
	5. Reinforcing steel has been tied and supported as required			X	
	6. Required reinforcing steel clearances have been provided			X	
	7. Composite member has required size			X	
	Inspection of Composite Structures During Concrete Placement (AISC 341-16 Table J9.2)				
	1. Concrete: Material identification (mix design, compressive strength, maximum large aggregate size, maximum slump)			X	
	2. Limits on water added at the truck or pump			X	
	3. Proper placement techniques to limit segregation			X	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	Inspection of Composite Structures During Concrete Placement (AISC 341-16 Table J9.2)				
	1. Achievement of minimum specified concrete compressive			X	
	Cold-formed Steel Trusses Spanning 60-feet or Greater (IBC-21 Section 1705.2.4)				
	1. Verify temporary installation restraint/bracing installed in accordance with the approved shop drawings.			X	
	2. Verify permanent individual truss member restraint/bracing installed in accordance with the approved shop drawings.			X	
	Concrete Construction (IBC-21 Section 1705.3)				
X	1. Inspect reinforcing steel, including prestressing tendons, and placement.	**ACI-CCSI**		X	**Prior to every concrete pour**
	2. Inspection of reinforcing steel welding				
	a. Verify weldability of reinforcing bars other than ASTM A706.		X		
	b. Inspect single pass fillet welds, maximum 5/16 inch.			X	
	c. Inspect all other welds.			X	
X	3. Inspection of anchors cast in concrete.	**ACI-CCSI**		X	**Prior to concrete pour**
X	4. Inspection of anchors post-installed in hardened concrete members.	**ACI-CCSI**			**50%. Overhead installations shall require continuous inspection**
X	a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension load	**ACI-CCSI**	X		
X	b. Mechanical anchors and adhesive anchors not defined in 4 a	**ACI-CCSI**		X	**50%**
X	5. Verify use of approved design mix.	**ACI-CCSI**		X	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
X	6. Prior to placement fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	**ACI-FTT**	X		
X	7. Inspect concrete and shotcrete placement for proper application techniques.	**ACI-CCSI**	X		
X	8. Inspect for maintenance of specified curing temperature and techniques.	**ACI-CCSI**		X	**50%**
	9. Inspection of prestressed concrete:				
	a. Application of prestressing forces		X		
	b. Grouting of bonded prestressing tendons in the seismic-force-resisting system.		X		
	10. Erection of precast structural members			X	
	11. For precast concrete diaphragm connections or reinforcement at joints classified as moderate or high deformability elements (MDE or HDE) in structures assigned to Seismic Design Category C, D, E, or F, inspect such connections and reinforcement in the field for:				
	a. Installation of the embedded parts		X		
	b. Completion of the continuity of reinforcement across joints		X		
	c. Completion of connections in the field		X		
	12. Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5 (American Concrete Institute).			X	
X	13. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	**ACI-CCSI**		X	
X	14. Inspection formwork for shape, location and dimensions of the concrete member being formed.	**ACI-CCSI**		X	**Prior to every concrete pour**
	Masonry Construction (IBC-21 Section 1705.4)				

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	1. Inspect masonry construction in accordance with IBC-21 Section 1705.4 and TMS 602-13 (The Masonry Society)/ACI 530.1-13 Article 1.6.				
	Level A Quality Assurance				
	Tests: None.				
	Inspection: Verify compliance with the approved submittal and project specifications.			X	
	Level B Quality Assurance				
	Tests:				
	1. Verify slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with TMS 602-13/ACI 530.1-13 Specification Article 1.5B.1.b.3 for self-consolidating grout.				
	2. Verify f'm and f'aac in accordance with TMS 602-13/ACI 530.1-13 Specification Article 1.4B prior to construction, except where specifically exempted.				
	Inspection:				
	1. Verify compliance with the approved submittals and project specifications.			X	
	2. At the start of masonry construction, verify:				
	a. Proportions of site-prepared mortar.			X	
	b. Construction of mortar joints.			X	
	c. Grade and size of prestressing tendons and anchorages.				
	d. Location of reinforcement, connectors, prestressing tendons and anchorages.			X	
	e. Prestressing technique.			X	
	f. Properties of thin-bed mortar for AAC (autoclaved aerated concrete) masonry. (Continuous inspection is required for the first 5000 square feet of AAC masonry.		X	X	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	Periodic inspection is required after the first 5000 square feet of AAC masonry.)				
	3. Prior to grouting, verify:				
	a. Grout space is clean.			X	
	b. Grade, type and size of reinforcement and anchor bolts, and prestressing tendons and anchorages.			X	
	c. Placement of reinforcing and connectors, and prestressing tendons and anchorages.			X	
	d. Proportions of site-prepared grout and prestressing grout for bonded tendons.			X	
	e. Construction of mortar joints.			X	
	4. During masonry construction, verify:				
	a. Size and location of structural members.			X	
	b. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction.			X	
	c. Welding of reinforcement.		X		
	d. Preparation, construction and protection of masonry during cold weather (temperature below 40 degrees Fahrenheit) or hot weather (temperature above 90 degrees Fahrenheit).			X	
	e. Application and measurement of prestressing force.		X		
	f. Placement of grout and prestressing grout for bonded tendons is in compliance.		X		
	g. Placement of AAC masonry units and construction of thin-bed mortar joints. (Continuous inspection is required for the first 5000 square feet of AAC masonry. Periodic inspection is required after the first 5000 square feet of AAC masonry.)		X	X	
	5. Observe preparation of grout specimens, mortar specimens and/or prisms.			X	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	Level C Quality Assurance				
	Tests:				
	1. Verify f'm and f'aac in accordance with TMS 602-13/ACI 530.1-13/ASCE 6-13 Specification Article 1.4B prior to construction, and for every 5000 square feet during construction.				
	2. Verify proportions of materials in premixed or pre-blended mortar, prestressing grout, and grout other than self-consolidating grout as delivered to the project site.				
	3. Verify slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with TMS 602-13/ACI 530.1-13/ASCE 6-13 Specification Article 1.5B.1.b.3 for self-consolidating grout.				
	Inspection:				
	1. Verify compliance with the approved submittals and project specifications.			X	
	2. Verify:				
	a. Proportions of site-prepared mortar, grout and prestressing grout for bonded tendons.			X	
	b. Grade, type and size of reinforcement and anchor bolts, and prestressing tendons and anchorages.			X	
	c. Placement of masonry units and construction of mortar joints.			X	
	d. Placement of reinforcement, connectors and prestressing tendons and anchorages.		X		
	e. Grout space prior to grouting.		X		
	f. Placement of grout and prestressing grout for bonded tendons.		X		
	g. Size and location of structural elements.			X	
	h. Type, size and location of anchors, including other details of anchorage of masonry to structural members, frames or other construction.		X		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	i. Welding of reinforcement.		X		
	j. Preparation, construction and protection of masonry during cold weather (temperature below 40 degrees Fahrenheit) or hot weather (temperature above 90 degrees Fahrenheit).			X	
	k. Application and measurement of prestressing force.		X		
	l. Placement of AAC masonry units and construction of thin-bed mortar joints.		X		
	m. Properties of thin-bed mortar for AAC masonry.		X		
	3. Observe preparation of grout specimens, mortar specimens and/or prisms.		X		
	Wood Construction (IBC-21 Section 1705.5)				
	1. Inspect prefabricated wood structural elements in accordance with Section 1704.2.5.			X	
	2. High load diaphragms:				
	a. Verify sheathing grade and thickness.			X	
	b. Verify nominal size of framing members at adjoining panel edges.			X	
	c. Verify nail or staple diameter and length.			X	
	d. Verify number of fastener lines.			X	
	e. Verify spacing between fasteners in each line and at panel edges.			X	
	3. Shearwalls:				
	a. Verify sheathing grade and thickness.			X	
	b. Verify nominal size of framing members at adjoining panel edges.			X	
	c. Verify nail or staple diameter and length.			X	
	d. Verify number of fastener lines.			X	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	e. Verify spacing between fasteners in each line and at panel edges.			X	
	f. Location and size of holdowns.			X	
	4. Verify nailing, bolting, anchoring and fastening of:				
	a. Drag struts and collectors.			X	
	b. Braces.			X	
	c. Hold-downs.			X	
	5. Metal-plate-connected wood trusses spanning 60 feet or greater:				
	a. Verify temporary installation restraint/bracing installed in accordance with the approved shop drawings.			X	
	b. Verify permanent individual truss member restraint/bracing installed in accordance with the approved shop drawings.			X	
	Soils (IBC-21 Section 1705.6)				
X	1. Verify materials below shallow foundations are adequate to achieve the required bearing capacity.	**ICC-SSI**		X	
X	2. Verify excavations are extended to proper depth and have reached proper material.	**ICC-SSI**		X	
X	3. Perform classification and testing of compacted fill materials.	**ICC-SSI**		X	
X	4. During fill placement, verify use of proper materials and procedure in accordance with the provisions of the approved geotechnical report. Verify densities and lift thicknesses during placement and compaction of compacted fill.	**ICC-SSI**	X		
X	5. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly.	**ICC-SSI**		X	
	Driven Deep Foundation Elements (IBC-21 Section 1705.7)				

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	1. Verify element materials, sizes and lengths.		X		
	2. Determine capacities of test elements and conduct additional load tests when required. Refer to project specifications.		X		
	3. Inspect driving operations and maintain complete and accurate records for each element.		X		
	4. Verify element locations and plumbness.		X		
	a. Verify type and size of hammer.		X		
	b. Record number of blows per foot of penetration.		X		
	c. Determine required penetration to achieve specified capacity.		X		
	d. Record pile tip and butt elevations.		X		
	e. Document any damage to any foundation element.		X		
	5. For steel piling, perform additional inspection in accordance with Section 1705.2 and AISC 341-16, Table J10.1.				
	6. For concrete elements and concrete-filled elements, perform additional inspections in accordance with Section 1705.3.				
	7. For specialty elements, perform additional inspections as required in the project specifications.				
	Cast-in-Place Deep Foundation (IBC-21 Section 1705.8)				
	1. Inspect drilling operations and maintain complete and accurate records for each element.		X		
	2. Verify element locations and plumbness.		X		
	a. Verify element diameter.		X		
	b. Verify bell diameter (if applicable).		X		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	c. Verify element lengths.		X		
	d. Verify embedment depth into bedrock (if applicable).		X		
	e. Verify adequate end-bearing strata capacity.		X		
	f. Record concrete or grout volumes.		X		
	3. For concrete elements, perform additional inspections in accordance with Section 1705.3.				
	Helical Piles (IBC-21 Section 1705.10)				
	1. Verify pile locations.		X		
	a. Verify installation equipment used.		X		
	b. Verify pile dimensions.		X		
	c. Verify tip elevations.		X		
	d. Verify final depth.		X		
	e. Verify final installation torque.		X		
	f. Other data as required by the project specifications.		X		
	Fabricated Items (IBC-21 Section 1705.11)				
	1. Inspect fabricated items in accordance with Section 1704.2.5.		X		
	Wind Resistance (IBC-21 Section 1705.12)				
	1. Provide inspections when required by Section 1705.12.				
	Seismic Resistance (IBC-21 Section 1705.13)				
	1. Provide inspections when required by Section 1705.13.				

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	Testing and Qualification for Seismic Resistance (IBC-21 Section 1705.14)				
	1. Test and qualify seismic resistance in accordance with IBC-21 Section 1705.14 and the project specifications.				
	Sprayed Fire-Resistant Materials (IBC-21 Section 1705.15)				
	1. Inspect sprayed fire-resistant materials in accordance with IBC-21 Section 1705.15 and the project specifications.				
	Mastic and Intumescent Fire-Resistant Coatings (IBC-21 Section 1705.16)				
	1. Perform inspections in accordance with AWCI 12-B (Association of the Wall and Ceiling Industry) and IBC-21 Section 1705.16.			X	
	Exterior Insulation and Finish Systems (EIFS) (IBC-21 Section 1705.17)				
	1. Perform inspections in accordance with project specifications and IBC-21 Section 1705.17.			X	
	Fire-Resistant Penetrations and Joints (IBC-21 Section 1705.18)				
	1. Perform inspections in accordance with project specifications and IBC-21 Section 1705.18.			X	
	Smoke Control (IBC-21 Section 1705.19)				
	1. Perform testing in accordance with project specifications and IBC-21 Section 1705.19.				
	Sealing of Mass Timber (IBC-21 Section 1705.20)				
	1. Perform testing in accordance with project specifications and IBC-21 Section 1705.20.				

SECTION 01 42 00
REFERENCE STANDARDS

PART 1 GENERAL

1.1 ENVIRONMENTAL DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114 and as specified herein.

B. Biobased Materials: As defined in the Farm Security and Rural Investment Act, for purposes of Federal procurement of biobased products, "biobased" means a "commercial or industrial product (other than food or feed) that is composed, in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials." Biobased materials also include fuels, chemicals, building materials, or electric power or heat produced from biomass as defined by The Biomass Research and Development Act of 2000.

1. Biobased Content: Amount of biobased carbon in the material or product as a percentage of weight (mass) of total organic carbon in the material or product.

C. Chain-of-Custody: Process whereby a product or material is maintained under physical possession or control during its entire life cycle.

D. Deconstruction: Disassembly of buildings for purpose of recovering materials.

E. DFE (Design for the Environment): A technique that includes elements of resource conservation and pollution prevention as applied in various product sectors. A technique that incorporates approaches which are part of product (or assembly) concept, need and design. Considerations involve material selection, material and energy efficiency, reuse, maintainability and design for disassembly and recyclability. Refer to International Organization for Standardization (ISO) Guide 64 for additional clarification.

F. Environmentally Preferable Products: Products and services that have a lesser or reduced effect on the environment in comparison to conventional products and services. Refer to EPA's Final Guidance on Environmentally Preferable Purchasing Program.

G. Non-Renewable Resource: A resource that exists in a fixed amount that cannot be replenished on a human time scale. Non-renewable resources have potential for renewal only by geological, physical, and chemical processes taking place over of millions of years. Examples include iron ore, coal, and oil.

H. Perpetual Resource: A resource that is virtually inexhaustible on a human time scale. Examples include solar energy, tidal energy, and wind energy.

I. Recycled Content Materials: Products that contain pre-consumer or post-consumer materials as all or part of their feedstock. Recycled content claim shall be consistent Federal Trade Commission (FTC) Guide for Use of Environmental Marketing Claims.

J. Renewable Resource: A resource that is grown, naturally replenished, or cleansed, at a rate which exceeds depletion of the usable supply of that resource. A renewable resource can be exhausted if improperly managed. However, a renewable resource can last indefinitely with proper stewardship. Examples include trees in forests, grasses in grasslands, and fertile soil.

1.2 QUALITY ASSURANCE

A. Applicability of Standards: Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into Contract Documents to the extent referenced. Such standards are made a part of Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of Contract Documents, unless otherwise indicated.

C. Conflicting Requirements: Where compliance with two or more standards is specified, and standards may establish different or conflicting requirements for minimum quantities or quality levels, comply with most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to Contracting Officer (CO) for decision before proceeding.

1.3 INDUSTRY STANDARDS

A. Applicability of Standards: Unless Contract Documents include more stringent requirements, applicable construction industry standards have same force and effect as if bound or copied directly into Contract Documents to the extent referenced. Such standards are made a part of Contract Documents by reference.

B. Publication Dates: Comply with standards in effect as of date of Contract Documents unless otherwise indicated.

C. Copies of Standards: Each entity engaged in construction on Project should be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with Contract Documents.

1. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations:

1. Where abbreviations and acronyms are used in the Specifications or other Contract Documents, they shall mean the recognized name of the entities found in the following industry reference:

a. Section 01 42 00 Sources for Reference Publications, Unified Facilities Guide Specifications (UFGS) (accessible via Masters website > Downloads section > click on UFGS Master (WBDG Website). Names, telephone numbers, and websites are subject to change and are believed to be accurate and up-to-date as of date of Contract Documents.

B. Code Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in following list. Names, telephone numbers, and websites are subject to change and are believed to be accurate and up-to-date as of date of Contract Documents.

IAPMO	International Association of Plumbing and Mechanical Officials www.iapmo.org	(909) 472-4100
ICC	International Code Council www.iccsafe.org	(888) 422-7233
ICC-ES	ICC Evaluation Service, Inc. icc-es.org	(800) 423-6587 (562) 699-0543

C. Federal Government Agencies: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities in following list. Names, and websites are subject to change and are believed to be accurate and up-to-date as of date of Contract Documents.

ABA & ABAAS United States Access Board	Architectural Barriers Act (ABA) Architectural Barriers Act Accessibility Standards (ABAAS) www.access-board.gov
CoE	Army Corps of Engineers www.usace.army.mil
CPSC	Consumer Product Safety Commission www.cpsc.gov

DOC	Department of Commerce www.commerce.gov
DOD	Department of Defense www.defense.gov
DOJ	Department of Justice www.justice.gov
DOE	Department of Energy www.energy.gov
EPA	Environmental Protection Agency www.epa.gov
FAA	Federal Aviation Administration www.faa.gov
FCC	Federal Communications Commission www.fcc.gov
FDA	Food and Drug Administration www.fda.gov
GSA	General Services Administration www.gsa.gov
HUD	Department of Housing and Urban Development www.hud.gov
LBL	Lawrence Berkeley National Laboratory www.lbl.gov
NCHRP	National Cooperative Highway Research Program (See TRB (Transportation Resource Board))
NIST	National Institute of Standards and Technology www.nist.gov
OSHA	Occupational Safety & Health Administration www.osha.gov
PHS	U.S. Department of Health and Human Services www.hhs.gov

RUS	Rural Utilities Service (See USDA (Department of Agriculture))
SD	State Department www.state.gov
TRB	Transportation Research Board www.nationalacademies.org/trb/transportation-research-board
USDA	Department of Agriculture www.usda.gov
USP	U.S. Pharmacopeia www.usp.org
USPS	Postal Service www.usps.com

D. Standards and Regulations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in following list. Names, telephone numbers, and websites are subject to change and are believed to be accurate and up-to-date as of date of Contract Documents.

ABAAS	Architectural Barriers Act Accessibility Standards www.access-board.gov
CFR	Code of Federal Regulations Available from Government Printing Office www.govinfo.gov/app/collection/cfr
DOD	Department of Defense Military Specifications and Standards Available from Department of Defense Single Stock Point www.dsp.dla.mil/Specs-Standards/
DSCC	Defense Supply Center Columbus (See FS (Federal Specification))
FED-STD	Federal Standard (See FS (Federal Specification))

FS	Federal Specification Available from Department of Defense Single Stock Point www.dsp.dla.mil/Specs-Standards/ Available from General Services Administration www.gsa.gov Available from National Institute of Building Sciences www.nibs.org
FTMS	Federal Test Method Standard (See FS (Federal Specification))
MIL	(See MILSPEC (Military Specification and Standards))
MIL-STD	(See MILSPEC (Military Specification and Standards))
MILSPEC	Military Specification and Standards Available from Department of Defense Single Stock Point www.dsp.dla.mil/Specs-Standards/
UFAS	Uniform Federal Accessibility Standards Available from Access Board www.access-board.gov/guidelines-and-standards/buildings-and-sites/about-the-aba-standards/ufas *(UFAS is **only** for housing projects per Fair Housing Act. See also the Fair Housing Act Design Manual, www.huduser.gov/portal/publications/destech/fairhousing)*

1.5 ENVIRONMENTAL REFERENCE STANDARDS

A. American Forest and Paper Association: Sustainable Forestry Initiative

B. American Society of Heating Refrigerating and Air Conditioning Engineers (ASHRAE):

- **ASHRAE 52.2,** *Method of Testing General Ventilation Air Cleaning Devices for Removal Efficiency by Particle Size*
- **ASHRAE 55,** *Thermal Environmental Conditions for Human Occupancy*
- **ASHRAE 62.1,** *Ventilation for Acceptable Indoor Air Quality*
- **ASHRAE 62.2,** *Ventilation and Acceptable Indoor Air Quality in Low-Rise Residential Buildings*
- **ASHRAE/IESNA 90.1,** *Energy Standard for Buildings, Except Low-Rise Residential Buildings*
- **ASHRAE 90.2,** *Energy Efficient Design of Low-Rise Residential Buildings*

C. American Association of State Highway and Transportation Officials (AASHTO):

- **M288 Geotextile Specification for Highway Applications**
- **MP009-06 Standard Specification for Compost for Erosion/Sediment Control (Filter Berms and Filter Socks)**
- **MP010-03 Standard Specification for Compost for Erosion/Sediment Control (Compost Blankets)**

D. American Society for Testing and Materials International (ASTM):

- **A478 Standard Specification for Chromium-Nickel Stainless Steel Weaving and Knitting Wire**
- **A580/A580M Standard Specification for Stainless Steel Wire**
- **A653/A653M Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process**
- **B813 Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube**
- **C33 Standard Specification for Concrete Aggregates**
- **C67 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile**
- **C128 Standard Test Method for Density, Relative Density (Specific Gravity), and Absorption of Fine Aggregate**
- **C131 Standard Test Method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine**
- **C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates**
- **C289 Standard Test Method for Potential Alkali-Silica Reactivity of Aggregates (Chemical Method)**
- **C311 Test Methods for Sampling and Testing Fly Ash or Natural Pozzolans for Use as a Mineral Admixture in Portland-Cement Concrete**
- **C593 Standard Specification for Fly Ash and Other Pozzolans for Use With Lime**
- **C595 Standard Specification for Blended Hydraulic Cements**
- **C618 Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete**
- **C739 Standard Specification for Cellulosic Fiber (Wood-Base) Loose-Fill Thermal Insulation**
- **C936 Standard Specification for Interlocking Concrete Paver Units**
- **C989 Standard Specification for Ground Granulated Blast-Furnace Slag for Use in Concrete and Mortars**
- **C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures**
- **C1319 Standard Specification for Concrete Grid Paving Units**
- **C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings**

- **C1371 Standard Test Method for Determination of Emittance of Materials Near Room Temperature Using Portable Emissometers**
- **C1386 Standard Specification for Precast Autoclaved AERATED Concrete (PAAC) Wall Construction Units**
- **C1483 Standard Specification for Exterior Solar Radiation Control Coatings on Buildings**
- **C1549 Standard Test Method for Determination of Solar Reflectance Near Ambient Temperature Using a Portable Solar Reflectometer**
- **C1601 Standard Test Method for Field Determination of Water Penetration of Masonry Wall Surfaces**
- **D198 Standard Test Methods of Static Tests of Lumber in Structural Sizes**
- **D217 Standard Test Methods for Cone Penetration of Lubricating Grease**
- **D692 Standard Specification for Coarse Aggregate for Bituminous Paving Mixtures**
- **D696 Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics Between -30°C and 30°C With a Vitreous Silica Dilatometer**
- **D698 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3))**
- **D1435 Standard Practice for Outdoor Weathering of Plastics**
- **D1557 Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 foot pound force per cubic foot (ft-lbf/ft3) (2,700 kilonewton meter per cubic meter (kN-m/m3))**
- **D1972 Standard Practice for Generic Marking of Plastic Products**
- **D2103 Standard Specification for Polyethylene Film and Sheeting**
- **D2369 Standard Test Method for Volatile Content of Coatings**
- **D3273 Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber**
- **D3786 Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method**
- **D3792 Standard Test Method for Water Content of Coatings by Direct Injection Into a Gas Chromatograph**
- **D3864 Standard Guide for Continual On-Line Monitoring Systems for Water Analysis**
- **D3960 Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings**
- **D4017 Standard Test Method for Water in Paints and Paint Materials by Karl Fischer Method**
- **D4263 Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method**
- **D4444 Standard Test Methods for Use and Calibration of Hand-Held Moisture Meters**

- **D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity**
- **D4552 Standard Practice for Classifying Hot-Mix Recycling Agents**
- **D4632 Standard Test Method for Grab Breaking Load and Elongation of Geotextiles**
- **D4716 Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head**
- **D4833 Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Product**
- **D4840 Standard Guide for Sampling Chain-of-Custody Procedures**
- **D4887 Standard Test Method for Preparation of Viscosity Blends for Hot Recycled Bituminous Materials**
- **D5106 Standard Specification for Steel Slag Aggregates for Bituminous Paving Mixtures**
- **D5116 Standard Guide for Small-Scale Environmental Chamber Determinations of Organic Emissions from Indoor Materials/Products**
- **D5199 Standard Test Method for Measuring the Nominal Thickness of Geosynthetics**
- **D5261 Standard Test Method for Measuring Mass per Unit Area of Geotextiles**
- **D5268 Standard Specification for Topsoil Used for Landscaping Purposes**
- **D5359 Standard Specification for Glass Cullet Recovered from Waste for Use in Manufacture of Glass Fiber**
- **D5505 Standard Practice for Classifying Emulsified Recycling Agents**
- **D5509 Standard Practice for Exposing Plastics to a Simulated Compost Environment**
- **D5512 Standard Practice for Exposing Plastics to a Simulated Compost Environment Using an Externally Heated Reactor**
- **D5539 Standard Specification for Seed Starter Mix**
- **D5957 Standard Guide for Flood Testing Horizontal Waterproofing Installations**
- **D5603 Standard Classification for Rubber Compounding Materials—Recycled Vulcanizate Particulate Rubber**
- **D5663 Standard Guide for Validating Recycled Content in Packaging Paper and Paperboard**
- **D5759 Standard Guide for Characterization of Coal Fly Ash and Clean Coal Combustion Fly Ash for Potential Uses**
- **D5792 Standard Practice for Generation of Environmental Data Related to Waste Management Activities: Development of Data Quality Objectives**
- **D5834 Standard Guide for Source Reduction Reuse, Recycling, and Disposal of Solid and Corrugated Fiberboard (Cardboard)**

- **D5851 Standard Guide for Planning and Implementing a Water Monitoring Program**
- **D5852 Standard Test Method for Erodibility Determination of Soil in the Field or in the Laboratory by the Jet Index Method**
- **D6002 Standard Guide for Assessing the Compostability of Environmentally Degradable Plastics**
- **D6006 Standard Guide for Assessing Biodegradability of Hydraulic Fluid**
- **D6007 Standard Test Method for Determining Formaldehyde Concentration in Air from Wood Products Using a Small Scale Chamber**
- **D6046 Standard Classification of Hydraulic Fluids for Environmental Impact**
- **D6081 Standard Practice for Aquatic Toxicity Testing of Lubricants: Sample Preparation and Results Interpretation**
- **D6108 Standard Test Method for Compressive Properties of Plastic Lumber and Shapes**
- **D6109 Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastic Lumber**
- **D6112 Standard Test Methods for Compressive and Flexural creep and Creep-Rupture of Plastic Lumber and Shapes**
- **D6117 Standard Test Methods for Mechanical Fasteners In Plastic Lumber and Shapes**
- **D6155 Standard Specification for Nontraditional Coarse Aggregates for Bituminous Paving Mixtures**
- **D6245 Standard Guide for Using Indoor Carbon Dioxide Concentrations to Evaluate Indoor Air Quality and Ventilation**
- **D6261 Standard Specification for Extruded and Compression Molded Basic Shapes Made from Thermoplastic Polyester (TPES)**
- **D6262 Standard Specification for Extruded, Compression Molded, and Injection Molded Basic Shapes of Poly(aryl ether ketone) (PAEK)**
- **D6270 Standard Practice for Use of Scrap Tires in Civil Engineering Applications**
- **D6329 Standard Guide for Developing Methodology for Evaluating the Ability of Indoor Materials to Support Microbial Growth Using Static Environmental Chambers**
- **D6330 Standard Practice for Determination of Volatile Organic Compounds (Excluding Formaldehyde) Emissions from Wood-Based Panels Using Small Environmental Chambers Under Defined Test Conditions**
- **D6345 Standard Guide for Selection of Methods for Active, Integrative Sampling of Volatile Organic Compounds in Air**
- **D6400 Standard Specification for Compostable Plastics**
- **D6435 Standard Test Method for Shear Properties of Plastic Lumber and Plastic Lumber Shapes**

- **D6629 Standard Guide for Selection of Methods for Estimating Soil Loss by Erosion**
- **D6662 Standard Specification for Polyolefin-Based Plastic Lumber Decking Boards**
- **D6712 Standard Specification for Ultra-High-Molecular-Weight Polyethylene (UHMW-PE) Solid Plastic Shapes**
- **D6886 Standard Test Method for Speciation of the Volatile Organic Compounds (VOCs) in Low VOC Content Waterborne Air-Dry Coatings by Gas Chromatography**
- **D7186 Standard Practice for Quality Assurance Observation of Roof Construction and Repair**
- **E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements**
- **E241 Standard Guide for Limiting Water-Induced Damage to Buildings**
- **E408 Standard Test Methods for Total Normal Emittance of Surfaces Using Inspection-Meter Techniques**
- **E413 Standard Classification for Rating Sound Insulation**
- **E477 Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers**
- **E648 Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source**
- **E683 Standard Practice for Installation and Service of Solar Space Heating Systems for One- and Two-Family Dwellings**
- **E779 Standard Test Method for Determining Air Leakage Rate by Fan Pressurization**
- **E781 Standard Practice for Evaluating Absorptive Solar Receiver Materials When Exposed to Conditions Simulating Stagnation in Solar Collectors With Cover Plates**
- **E782 Standard Practice for Exposure of Cover Materials for Solar Collectors to Natural Weathering Under Conditions Simulating Operational Mode**
- **E823 Standard Practice for Nonoperational Exposure and Inspection of a Solar Collector**
- **E881 Standard Practice for Exposure of Solar Collector Cover Materials to Natural Weathering Under Conditions Simulating Stagnation Mode**
- **E903 Standard Test Method for Solar Absorptance, Reflectance, and Transmittance of Materials Using Integrating Spheres**
- **E948 Standard Test Method for Electrical Performance of Photovoltaic Cells Using Reference Cells Under Simulated Sunlight**
- **E1021 Standard Test Methods for Measuring Spectral Response of Photovoltaic Cells**
- **E1038 Standard Test Method for Determining Resistance of Photovoltaic Modules to Hail by Impact with Propelled Ice Balls**

- **E1039 Standard Test Method for Calibration of Silicon Non-Concentrator Photovoltaic Primary Reference Cells Under Global Irradiation**
- **E1040 Standard Specification for Physical Characteristics of Nonconcentrator Terrestrial Photovoltaic Reference Cells**
- **E1105 Standard Test Method for Field Determination of Water Penetration of Installed Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform or Cyclic Static Air Pressure Difference**
- **E1171 Standard Test Method for Photovoltaic Modules in Cyclic Temperature and Humidity Environments**
- **E1333 Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Under Defined Test Conditions Using a Large Chamber**
- **E1362 Standard Test Method for Calibration of Non-Concentrator Photovoltaic Secondary Reference Cells**
- **E1433 Standard Guide for Selection of Standards on Environmental Acoustics**
- **E1462 Standard Test Methods for Insulation Integrity and Ground Path Continuity of Photovoltaic Modules**
- **E1596 Standard Test Methods for Solar Radiation Weathering of Photovoltaic Modules**
- **E1597 Standard Test Method for Saltwater Pressure Immersion and Temperature Testing of Photovoltaic Modules for Marine Environments**
- **E1609 Standard Guide for Development and Implementation of a Pollution Prevention Program**
- **E1686 Standard Guide for Selection of Environmental Noise Measurements and Criteria**
- **E1690 Standard Test Method for Determination of Ethanol Extractives in Biomass**
- **E1721 Standard Test Method for Determination of Acid-Insoluble Residue in Biomass**
- **E1755 Standard Test Method for Ash in Biomass**
- **E1758 Standard Test Method for Determination of Carbohydrates in Biomass by High Performance Liquid Chromatography**
- **E1780 Standard Guide for Measuring Outdoor Sound Received from a Nearby Fixed Source**
- **E1799 Standard Practice for Visual Inspections of Photovoltaic Modules**
- **E1802 Standard Test Methods for Wet Insulation Integrity Testing of Photovoltaic Modules**
- **E1821 Standard Test Method for Determination of Carbohydrates in Biomass by Gas Chromatography**
- **E1827 Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door**

- **E1830 Standard Test Methods for Determining Mechanical Integrity of Photovoltaic Modules**
- **E1861 Standard Guide for Use of Coal Combustion By-Products in Structural Fills**
- **E1918 Standard Test Method for Measuring Solar Reflectance of Horizontal and Low-Sloped Surfaces in the Field**
- **E1971 Standard Guide for Stewardship for the Cleaning of Commercial and Institutional Buildings**
- **E1980 Standard Practice for Calculating Solar Reflectance Index of Horizontal and Low-Sloped Opaque Surfaces**
- **E1991 Standard Guide for Environmental Life Cycle Assessment of Building Materials/Products**
- **E2047 Standard Test Method for Wet Insulation Integrity Testing of Photovoltaic Arrays**
- **E2114 Standard Terminology for Sustainability Relative to the Performance of Buildings**
- **E2128 Standard Guide for Evaluating Water Leakage of Building Walls**
- **E2129 Standard Practice for Data Collection for Sustainability Assessment of Building Products**
- **E2397 Standard Practice for Determination of Dead Loads and Live Loads associated with Green Roof Systems**
- **E2398 Standard Test Method for Water Capture and Media Retention of Geocomposite Drain Layers for Green Roof Systems**
- **E2399 Standard Test Method for Maximum Media Density for Dead Load Analysis of Green Roof Systems**
- **E2400 Standard Guide for Selection, Installation, and Maintenance of Plants for Green Roof Systems**
- **E2432 Standard Guide for General Principles of Sustainability Relative to Buildings**
- **F1869 Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride**
- **F2034 Standard Specification for Sheet Linoleum Floor Covering**
- **F2170 Standard Test Method for Determining Relative Humidity in Concrete Floor Slabs Using in situ Probes**

E. Bat Conservation International:
- Bat Approved Bat Houses

F. Carpet and Rug Institute:
- Green Label & Green Label Plus Testing Programs, carpet-rug.org/testing/green-label-plus

G. Center for Resource Solutions:
- Green-e program

H. Environmental Protection Agency (EPA):

- **Comprehensive Procurement Guidelines**
- **ENERGY STAR**
- **Environmentally Preferable Purchasing Program Final Guidance**
- **GreenScapes program**
- **Heat Island Initiative**
- **Indoor Air Quality Building Education and Assessment Model (I-BEAM)**
- **National Environmental Performance Track**
- **Pollution Prevention (P2)**
- **Product Stewardship Program**
- **Significant New Alternatives Policy (SNAP) Program**

I. Federal Trade Commission:

- **Guide for the Use of Environmental Marketing Claims**

J. Forest Stewardship Council:

- **Chain-Of-Custody**
- **Forest Management**

K. Green Building Initiative (GBI):

- **Green Globes - US**

L. Green Seal:

- **GC-03 Anti-Corrosive Paints**
- **GC-12 Occupancy Sensors**
- **GC-13 Split-Ductless Air-Source Heat Pumps**
- **GS-05 Compact Fluorescent Lamps**
- **GS-11 Paints**
- **GS-13 Windows**
- **GS-14 Window Films**
- **GS-31 Electric Chillers**
- **GS-32 Photovoltaic Modules**
- **GS-36 Commercial Adhesives**
- **GS-37 Industrial & Institutional Cleaners**

M. International Iron and Steel Institute:

- **CO2 Breakthrough Program**

N. International Organization of Standardization:

- **Guide 64; Guide for Inclusion of Environmental Aspects in Product Standards**
- **9660 Information processing -- Volume and file structure of CD-ROM for information interchange**
- **14001 Environmental management systems – Specification with guidance for use**

- **14004 Environmental Management Systems – General Guidelines on Principles, Systems and Supporting Techniques**
- **14020 Environmental labels and declarations – General principles**
- **14024 Environmental labels and declarations – Type I environmental labelling - Principles and procedures**
- **14040 Environmental management – Life cycle assessment – Principles and framework**

O. National Association of Home Builders:
- **Advanced Framing Techniques: Optimum Value Engineering**

P. National Institute of Building Sciences:
- **MOIST program for transfer of heat and moisture**
- **Whole Building Design Guide**

Q. National Institute of Standards and Technology:
- **BEES (Building for Environmental and Economic Sustainability) Lifecycle Decision Support Tool**

R. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
- **IAQ Guidelines for Occupied Buildings Under Construction**

S. Southcoast Air Quality Management District:
- **1168 Adhesive And Sealant Applications**

T. US Composting Council:
- **SEAL OF TESTING ASSURANCE PROGRAM**

U. US Department of Agriculture:
- **Biobased Products – Definitions and Descriptions**

V. US Green Building Council:

- **LEED™ 2009 Green Building Rating System**
- **LEED™ v4 (version 4) Green Building Rating System**

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 01 45 33
SPECIAL INSPECTION, OBSERVATION, AND TESTING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for Special Inspection, Observation, and Testing required in accordance with Chapter 17 of the 2021 International and is in addition to and supplements requirements included in Statement of Special Inspections shown on the Drawings.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. International Code Council (ICC):
   a. Evaluation Service (ICC-ES) Reports and Legacy Reports.
   b. International Building Code (IBC).

1.03 DEFINITIONS

A. Agencies and Personnel:

1. Agency Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be National Park Service when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.
2. Approved Agency: An established and recognized agency regularly engaged in conducting tests or furnishing inspection services, when such agency has been approved.
3. Registered Design Professional in Responsible Charge: An individual who is registered or licensed to practice their respective design profession as defined by statutory requirements of professional registration laws of state or jurisdiction in which Project is to be constructed.
4. Special Inspector: Qualified person retained by the Contractor who will demonstrate competence to the satisfaction of AHJ and Contracting Officer for inspection of a particular type of construction or operation requiring Special Inspection. Must be an independent third party hired directly by the Contractor.

B. Nonstructural Components:

1. Architectural Component Supports: Structural members or assemblies of members which transmit loads and forces from architectural systems or components to structure, including braces, frames, struts, and attachments.
2. Electrical Component Supports: Structural members or assemblies which transmit loads and forces from electrical equipment to structure, including braces, frames, legs, pedestals, and tethers, as well as elements forged or cast as part of component for anchorage.
3. Mechanical and Plumbing Component Supports: Structural members or assemblies which transmit loads and forces from mechanical or plumbing equipment to structure, including braces, frames, skirts, legs, saddles, pedestals, snubbers, and tethers, as well as elements forged or cast as part of component for anchorage.

C. Professional Observation:

1. Does not include or waive responsibility for required Special Inspection or inspections by building official.
2. Requirements are indicated on Statement of Special Inspections provided on the Drawings.
3. Geotechnical Observation: Visual observation of selected subgrade bearing surfaces and installation of deep foundation elements by a registered design professional for general conformance to Contract Documents.
4. Structural Observation: Visual observation of structural system(s) by a registered design professional for general conformance to Contract Documents.

D. Statement of Special Inspections: Detailed written procedure contained on the Drawings establishing systems and components subject to Special Inspection, Observation, and Testing during construction, type and frequency of testing, extent and duration of Special Inspection, and reports to be completed and distributed by Special Inspector.

E. Special Inspection:

1. Special Inspection: Inspection required of materials, installation, fabrication, erection, or placement of components and connections requiring special expertise to ensure compliance with approved Contract Documents and referenced standards.
2. Special Inspection, Continuous: Full-time observation of work requiring Special Inspection by an approved Special Inspector who is present in area where the Work is being performed.

3. Special Inspection, Periodic: Part-time or intermittent observation of the Work requiring Special Inspection by an approved Special Inspector who is present in area where the Work has been or is being performed, and at completion of the Work.

F. Structural Systems and Components:

1. Diaphragm: Component of structural lateral load resisting system consisting of roof, floor, or other membrane or bracing system acting to transfer lateral forces to vertical resisting elements of structure.
2. Drag Strut or Collector: Component of structural lateral load resisting system consisting of diaphragm or shear wall element that collects and transfers diaphragm shear forces to vertical force-resisting elements or distributes forces within diaphragm or shear wall.
3. Seismic-Force-Resisting System: That part of structural lateral load resisting system that has been considered in the design to provide required resistance to seismic forces identified on the Drawings.
4. Shear Wall: Component of structural lateral load resisting system consisting of a wall designed to resist lateral forces parallel to plane of the wall. Unless noted otherwise on the Drawings, load-bearing walls with direct in-plane connections to roof and floors shall be considered to be shear walls.
5. Wind Force Resisting System: That part of the structural system that has been considered in the design to provide required resistance to wind forces identified on the Drawings.

1.04 SUBMITTALS

A. Qualifications for each special inspector showing required credentials for items to be inspected in accordance with the International Building Code.

B. AISC Certified Steel Fabricator Qualifications.

C. Informational Submittals:

1. Contractor’s Statement of Responsibility: Form shall be completed by entity responsible for construction of main seismic-force-resisting system, listed in Statement of Special Inspections as shown on the Drawings. Refer to Article Supplement, located at end of section.

1.05 STATEMENT OF SPECIAL INSPECTIONS REQUIREMENTS

A. Designated Systems for Inspection:

1. Seismic-force-resisting systems designated under IBC Section 1705 and subject to Special Inspection under Section 1705: See the Drawings for

basic lateral load resisting systems for each structure and other designated seismic systems.

2. Wind-force-resisting systems designated under IBC Section 1705: None required.
3. Architectural, Plumbing, Mechanical, and Electrical Components subject to Special Inspection under IBC Sections 1705.12.5 and 1705.12.6 for Seismic Resistance: None required.

B. Statement of Special Inspections:

1. As included on the Drawings, Project-specific requirements were prepared by Registered Design Professional in Responsible Charge. The following identifies elements of inspection, observation, and testing program to be followed in construction of the Work:
   a. Designated seismic systems and main seismic force-resisting systems and components that are subject to Special Inspection and Structural Observation for lateral load resistance.
   b. Special Inspection and testing required by IBC Section 1705 and other applicable sections and referenced standards therein.
   c. Type and frequency of Special Inspection required.
   d. Type and frequency of testing required.
   e. Required frequency and distribution of testing and Special Inspection reports to be distributed by Special Inspector to Contracting Officer.
   f. Geotechnical Observation to be Performed: Required frequency and distribution of Geotechnical Observation reports by registered design professional to Contracting Officer.
   g. Structural Observations to be Performed: Required frequency and distribution of Structural Observation reports by registered design professional to Contracting Officer.

C. Special Inspection and associated testing of shop fabrication and field construction will be performed by an approved accredited independent agency or by Authority Having Jurisdiction’s (AHJ) approved, qualified inspection staff. Contractor will secure and pay for services of agency to perform Special Inspection and associated testing.

D. Code required Special Inspection with associated testing and Professional Observation, as provided in Statement of Special Inspections as shown on the Drawings and further provided in this section, is for benefit of National Park Service and does not:

1. Relieve Contractor of responsibility for providing adequate quality control measures.
2. Relieve Contractor of responsibility for damage to or loss of material before acceptance.

3. Constitute or imply acceptance.
4. Affect continuing rights of National Park Service after acceptance of completed Work.

E. The presence or absence of code required Special Inspector and Professional Observer does not relieve Contractor from Contract requirements.

F. Contractor is responsible for additional costs associated with Special Inspection and Testing and Observation when Work is not ready at time identified by Contractor and Special Inspectors and Professional Observer are onsite, but not able to provide contracted services.

G. Contractor is responsible for associated costs for additional Special Inspection and Testing and Professional Observation by Special Inspectors and Professional Observers required because of rejection of materials of in place Work that cannot be made compliant to Contract Document without additional inspections and observation and testing.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. All other testing and inspections, unless noted otherwise, are provided by Contractor.

B. Provide access to shop or Site for Special Inspection and Testing and Professional Observation requirements.

C. Notify Contracting Officer in advance of required Special Inspection and Professional Observation no later than 48 hours prior to date of Special Inspection and Professional Observation.

D. Provide access for Special Inspector to construction documents.

E. Retain special inspection records onsite to be readily available for review.

F. Cooperate with Special Inspector, Contracting Officer, and Contracting Officer’s Representatives and provide safe access to the Work to be inspected.

G. Submit Fabricator’s Certificates of Compliance for approved fabricators.

H. Provide reasonable auxiliary services as requested by the Special Inspector. Auxiliary services required include, but not limited to:

1. Providing access to the Work and furnishing incidental labor and facilities necessary to facilitate inspections and tests to assist the Special Inspector in performing test/inspections.
2. Providing storage space for the Special Inspector's exclusive use, such as for storing and curing concrete test samples and delivery of samples to testing laboratories.
3. Providing the Special Inspector with access to all approved submittals.
4. Providing security and protection of samples and test equipment at the Project Site.
5. Provide samples of materials to be tested in required quantities.

I. Materials and systems shall be inspected during placement where Continuous Special Inspection is required.

J. Where Periodic Special Inspection is indicated in the Statement of Special Inspections:

1. Schedule inspections for either during or at completion of their placement or a combination or both.
2. Schedule periodically inspected Work (either inspected during or after its placement) so that corrections can be completed and re-inspected before Work is inaccessible.
3. Sampling a portion of the Work is not allowed. Schedules shall provide for inspection of all Work requiring periodic inspection.

3.02 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Contractor's Statement of Responsibility.

END OF SECTION

CONTRACTOR'S STATEMENT OF RESPONSIBILITY

_____
(Project)

_____
(Name of Contracting Company)

_____
(Business Address)

(_____) _____ (_____) _____
(Telephone) (Fax)

I, (We) hereby certify that I am (we are) aware of the Special Inspection and Testing and Professional Observation requirements contained in Contract Documents for this Project for seismic force-resisting systems as listed in Statement of Special Inspections, and that:

1. I, (We) aware of the systems and the requirements of the special inspection and acknowledge our responsibility in the implementation of the Statement of Special Inspections for the construction of the applicable project components.

2. Control of this Work will be exercised to obtain conformance with Contract Documents approved by Contracting Officer.

3. Procedures within the Contractor's organization to be used for exercising control of the Work, method and frequency of reporting, and distribution of reports required under Statement of Special Inspections for Project are attached to this statement.

4. I, (We) will provide 48-hour notification to Contracting Officer and approved inspection agency as required for structural tests and Special Inspection for Project.

5. The following person is hereby identified as exercising control over requirements of this section for the Work designated above:

Name: _____

Qualifications: _____

_____

_____

(Print name and official title of person signing this form)

Signed by: _____

Date: _____

Project Name: _____

SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, temporary traffic control, and security and protection facilities.

1.2 DEFINITIONS

A. Permanent Enclosure: As determined by Contracting Officer (CO), permanent or temporary roofing is complete, insulated, and weathertight; exterior walls are insulated and weathertight; and openings are closed with permanent construction or substantial temporary closures.

1.3 USE CHARGES

A. General: Cost or use charges for temporary facilities shall be included in Contract Sum as required.

B. Water Service: Potable Water from existing water system is available for use with metering and with payment of use charges. Provide connections and extensions of services as required for construction operations with any additional permit costs.

C. Electric Power Service: Electric power from existing system is available for use with metering and with payment of use charges. Provide connections and extensions of services as required for construction operations with any additional permit costs.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with National Electrical Contractors Association (NECA), National Electrical Manufacturers Association (NEMA), and UL standards and regulations for temporary electric service. Install service to comply with National Fire Protection Association (NFPA) 70.

B. Environmental Protection:

1. Provide environmental protection as required by agency(ies) with jurisdiction and as indicated in Contract Documents. Coordinate with requirements of the following:

   a. Regulatory Requirements.
   b. Indoor Air Quality (IAQ) Management.
   c. Noise and Acoustics Management.

d. Environmental Management.
e. Construction Waste Management.

C. Accessible Temporary Egress: Comply with applicable provisions in the United States (U.S.) Architectural & Transportation Barriers Compliance Board's Architectural Barriers Act Accessibility Standard (ABAAS) Accessibility Guidelines.

1.5 PROJECT CONDITIONS

A. Temporary Use of Permanent Facilities: Installer of each permanent service shall assume responsibility for operation, maintenance, and protection of each permanent service during its use as a construction facility before NPS acceptance, regardless of previously assigned responsibilities.

PART 2 PRODUCTS

2.1 MATERIALS

A. Temporary materials may be new or used, but must be adequate in capacity for required usage, must not create unsafe conditions, and must not violate requirements of applicable codes and standards.

B. Pavement: Comply with Division 32, Exterior Improvements.

C. Chain-Link Fencing: Minimum 2 inch (50 mm), 0.148 inch (3.76 mm) thick, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 mm) high with galvanized steel pipe posts; minimum 2-3/8 inch (60 mm) OD (outside diameter) line posts and 2-7/8 inch (73 mm) OD corner and pull posts, with 1-5/8 inch (42 mm) OD top rails.

D. Portable Chain-Link Fencing: Minimum 2 inch (50 mm), 9-gage, galvanized steel, chain-link fabric fencing; minimum 6 feet (1.8 millimeters) high with galvanized steel pipe posts; minimum 2-3/8 inch (60 mm) OD line posts and 2-7/8 inch (73 mm) OD corner and pull posts, with 1-5/8 inch (42 mm) OD top and bottom rails. Provide concrete bases for supporting posts.

E. Safety Barrier Fence: Orange plastic fence, minimum height, 4 feet.

F. Barrier Tape: Yellow tape Imprinted with "CAUTION: CONSTRUCTION AREA".

G. Wood Enclosure Fence: Plywood, 6 feet (1.8 mm) high, framed with four 2-inch by 4-inch (50-mm by 100-mm) rails, with preservative-treated wood posts spaced not more than 8 feet (2.4 mm) apart.

H. Gypsum Board: Minimum 1/2-inch (12.7-mm) thick by 48-inch (1,219-mn) wide by maximum available lengths; regular-type panels with tapered edges. Comply with ASTM C36/C 36M.

I. Insulation: Unfaced mineral-fiber blanket, manufactured from glass, slag wool, or rock wool; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively.

J. Polyethylene Sheet: Reinforced, fire-resistive sheet, 10-mil (0.25-mm) minimum thickness, with flame-spread rating of 15 or less per ASTM E84 and passing NFPA 701 Test Method 2.

K. Dust-Control Adhesive-Surface Walk-off Mats: Provide mats minimum 36 inches by 60 inches (914 by 1,624 mm).

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.

B. Contracting Officers Field Office: Field office shall be a separate structure from Contractor's office.

1. Prefabricated, job built, or a mobile unit; excellent condition, structurally sound, non-flammable exterior construction, weather tight, minimum 300 square feet.
2. Operable windows and security screens, adjustable ventilation.
3. Restroom (minimum of lavatory and toilet, with exhaust fan if room is windowless).
4. Air conditioner and heater.
5. Interior partition with lockable door to divide office.
6. Paneling or freshly painted walls, acoustical tile or painted ceilings, and resilient flooring.
7. Two exterior doors with dead bolts keyed from outside.
8. Minimum 20-square-foot landing and steps at each exterior door.

C. Storage and Fabrication Sheds: Temporary weather tight sheds or other covered facilities for storage of materials subject to weather damage. Number and size of structures shall be subject to Contracting Officer's approval.

D. Toilets: Sufficiently lighted and ventilated toilet facilities in weatherproof, sight proof, handicap accessible, sturdy enclosures with privacy locks.

1. Provide separate toilet facilities for men and women.

2.3 EQUIPMENT

A. Fire Extinguishers: Portable, UL rated; with class and extinguishing agent as required by locations and classes of fire exposures.

B. Heating, Ventilation, and Air Conditioning (HVAC) Equipment: Unless Contracting Officer authorizes use of permanent HVAC system, provide vented, self-contained, liquid-propane-gas or fuel-oil heaters with individual space thermostatic control.

1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
2. Heating Units: Listed and labeled for type of fuel being consumed, by a testing agency acceptable to agency(ies) with jurisdiction, and marked for intended use.

C. Direct Digital Control (DDC) Internet Connection: Furnish, install and maintain a high-speed connection (Digital Subscriber Line (DSL) or similar) between the project's DDC system and the internet through a Contractor furnished internet service provider. Contractor is responsible for maintenance of this connection and costs associated with internet service provider through warranty period of this contract. Upon completion of warranty period, service shall be transferable to the Government at which time future costs for connection will no longer be the responsibility of Contractor.

D. Contracting Officers Field Office:

1. Outlets: Minimum of two, quad outlets with surge protection.
2. Refrigerator: Under counter, 3.2 cubic-foot volume with 0.8 cubic-foot freezer with dedicated power receptacle.
3. Fire Extinguisher: UL listed and FM (Fire Pump Motors) approved, minimum rating of 2-A:10-B:C, dry chemical.
4. First-Aid Kit: General office/light industrial kit which includes antiseptic wipes, bandages, disposable gloves, tape, instant cold pack, dressing pads, eye pads, scissors, and acetaminophen tablets.
5. Two desks with five drawers each and two chairs with casters; two drafting tables (minimum 40 inches wide by 5 feet long) and two stools; drawing rack; two two-drawer and one four-drawer legal size locking filing cabinets with keys; 8 feet of 12 inch deep shelving; coat rack; two additional guest chairs; two desk lamps; two drafting table lamps; and a maximum/minimum thermometer.
6. Manufactured computer work station, capable of containing CPU (central processing unit), monitor, keyboard, printer; work station chair.
7. Additional tables necessary for FAX machine and copier.
8. Two 5-gallon trash cans and one 30-gallon trash can with lid.
9. Ceiling mounted general lighting fixtures.

PART 3 EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate facilities where they will serve Project adequately and result in minimum interference with performance of the Work. Relocate and modify facilities as required by progress of the Work.

1. Locate facilities to limit site disturbance and as directed by the Contracting Officer.

B. Provide each facility ready for use when needed to avoid delay. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

3.2 TEMPORARY UTILITY INSTALLATION

A. General: Install temporary service or connect to existing service.

1. Arrange with utility company, NPS, and existing users for time when service can be interrupted, if necessary, to make connections for temporary services. Acquire necessary permits.

B. Storm Sewers and Drainage: Provide temporary utilities to remove effluent lawfully.

1. Connect temporary sewers to private system indicated as directed by the agencies with jurisdiction.

C. Non-potable water for construction is available within the park boundaries.

D. Potable water is available on site. Furnish cool, potable water for construction personnel in locations convenient to work stations. Coordinate with Contracting Officer for filling location, water meter and billing rate.

E. Sanitary Facilities: Provide temporary toilets, and wash facilities for use by construction personnel.

1. Place in approved locations secluded from public observation and convenient to work stations. Relocate as work progress requires.
2. Maintain and clean toilet facilities at least weekly.
3. Completely remove sanitary facilities on completion of work.

F. Heating and Cooling: Provide temporary heating and cooling required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of low temperatures or high humidity. Select

equipment that will not have a harmful effect on completed installations or elements being installed.

1. Use of permanent heating and cooling system will not be allowed without written authorization from Contracting Officer. When the permanent heating and cooling system is approved for use as temporary heating and cooling, pay costs until final acceptance. Permanent heating and cooling system shall be sufficiently complete, including controls, to permit safe operation.
2. Provide and maintain adequate approved facilities, as required for safety and construction requirements, during the work. Provide ample clearance around stoves, heaters, chimney and vent connections to prevent ignition of combustible material.
3. Install and maintain temporary filters when air handing equipment is used for temporary heating and cooling. Install new filters before final acceptance in addition to any extra sets of filters required. Clean coils as determined by Contracting Officer.
4. Warranties for equipment used for temporary heating and cooling shall start on date of Final Acceptance.

G. Ventilation and Humidity Control: Provide temporary ventilation required by construction activities for curing or drying of completed installations or for protecting installed construction from adverse effects of high humidity. Select equipment that will not have a harmful effect on completed installations or elements being installed. Coordinate ventilation requirements to produce ambient condition required and minimize energy consumption.

H. Electric Power Service:

1. Use of existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to NPS.
2. When temporary connections are removed, restore existing utility services to original condition.
3. Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

    a. Install electric power service underground, unless otherwise indicated.

I. Lighting: Provide temporary lighting with local switching that provides adequate illumination for construction operations, observations, inspections, and traffic conditions.

1. Install and operate temporary lighting that fulfills security and protection requirements without operating entire system.
2. Comply with environmental protection requirements for temporary lighting in accordance with Section 01 11 00, Summary of Work, Article Work Restrictions, Paragraph Extended Hours with Coordination.

3.3 TEMPORARY CONTROLS

A. Water Pollution Control:

1. Divert sanitary sewage and non-storm waste flow interfering with construction and requiring diversion to sanitary sewers. Do not cause or permit action to occur which would cause an overflow to existing waterway.
2. Prior to commencing excavation and construction, obtain Contracting Officer's agreement with detailed plans showing procedures intended to handle and dispose of sewage, groundwater, and dewatering pump discharges.
3. Comply with Section 01 57 13, Temporary Storm Water Pollution Prevention, for stormwater flow and surface runoff.
4. Do not dispose of volatile wastes such as mineral spirits, oil, chemicals, or paint thinner in storm or sanitary drains. Disposal of wastes into streams or waterways is prohibited. Provide acceptable containers for collection and disposal of waste materials, debris, and rubbish.

B. Erosion, Sediment, and Flood Control: Provide, maintain, and operate temporary facilities as specified in Section 01 57 23, Temporary Storm Water Pollution Prevention, to control erosion and sediment releases, and to protect the Work and existing facilities from flooding during construction period.

3.4 TEMPORARY POWER GENERATION

A. General: Provide continuous power to all facilities during construction. Contractor is responsible for obtaining all permits and approvals necessary to provide power.

1. Submit Temporary Power Plan to Contracting Officer for approval. Temporary Power Plan shall include, at a minimum, the following information:

   a. Location of the generator, fuel storage locations and dimensions to adjacent property lines and buildings identified on the site plan.
   b. Generator sizes (kilowatts and voltage).
   c. Fuel type, storage, and quantity.
   d. Fuel tank details.
   e. Venting details including pipe location, diameter, and height for normal and emergency vents.
   f. Noise dB (A) rating.
   g. A single line diagram showing loads to the temporary generator, including emergency load requirements for power from an approved emergency power source.
   h. Load calculations demonstrating that generator size is sufficient for the load to be served.
   i. Transfer switch method (manual/auto) and details (voltage, amps, number of poles), the transfer switch shall be listed by UL or other approved testing agency.
   j. Overcurrent protection and conductor size.

k. Grounding method.
l. A valid permit.
m. Applicable hazardous material signs shall be provided at the generator location.
n. A fire extinguisher shall be provided at all generator locations.
o. After obtaining a temporary generator permit, inspection approval is required.

3.5 SUPPORT FACILITIES INSTALLATION

A. General: Comply with the following:

1. Provide incombustible construction for offices, shops, and sheds located within construction area or within 50 feet of building lines. Comply with NFPA 241.
2. Maintain support facilities until near Substantial Completion. Remove structures, equipment, and furnishings, and terminate services after punch list is 100 percent completed or when directed by Contracting Officer. Personnel remaining after Substantial Completion will be permitted to use permanent facilities, under conditions acceptable to Contracting Officer.

B. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Locate temporary roads and paved areas in same location as permanent roads and paved areas. Extend temporary roads and paved areas, within construction limits indicated, as necessary for construction operations.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.
2. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Section 31 23 13, Subgrade Preparation, and Section 32 11 23, Aggregate Base Course(s).
3. Recondition base after temporary use, including removing contaminated material, regrading, proof-rolling, compacting, and testing.

C. Temporary Traffic Controls: Erect and maintain barricades, lights, danger signals, and warning signs in accordance with Manual on Uniform Traffic Control Devices (MUTCD), Part 6, latest edition.

1. Protect historic structures and elements as per Section 01 35 91, Historic Preservation Treatment Procedures.
2. Protect existing site improvements to remain including curbs, pavement, and utilities.
3. Maintain access for fire-fighting equipment and access to fire hydrants.
4. Illuminate barricades and obstructions at night; keep safety lights burning from sunset to sunrise.
5. Adequately barricade and post open cuts in or adjacent to thoroughfares.
6. Protect pedestrian traffic by guardrails or fences.

7. When pedestrian traffic is detoured onto a roadway, provide temporary walkways with protection as required at ends and overhead. For walkways, use lumber running parallel to direction of traffic movement and provide Architectural Barriers Act compliant ramps at changes of elevation. Contractor is responsible for maintaining signage and barriers to direct pedestrian traffic.
8. Cover pipes, hoses, and power lines crossing sidewalks and walkways with troughs using beveled edge boards.
9. Install Barrier Tape where directed by Contracting Officer. Keep a minimum of two rolls on site.

D. Parking: Use designated parking areas for construction personnel shown on the Drawings.

E. Pedestrian Detours: Coordinate pedestrian detours with Monument staff and Contracting Officer.

F. Dewatering Facilities and Drains: Comply with requirements of the agency(ies) with jurisdiction. Maintain Project Site, excavations, and construction free of water.

1. Dispose of rainwater in lawful manner that will not result in flooding Project or adjoining properties nor endanger permanent Work or temporary facilities.
2. Remove snow and ice as required to minimize accumulations.

G. Project Identification and Temporary Signs:

1. Provide temporary, directional signs for construction personnel and visitors.
2. Maintain and touchup signs so they are legible at all times.
3. Erect and maintain sufficient detour signs at road closures and along detour routes.

H. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of agencies with jurisdiction.

I. Lifts and Hoists: Provide facilities necessary for hoisting materials and personnel.

1. Truck cranes and similar devices used for hoisting materials are considered “tools and equipment” and not temporary facilities.

3.6 SECURITY AND PROTECTION FACILITIES INSTALLATION

A. Environmental Protection: Provide protection, operate temporary facilities, and conduct construction in ways and by methods that comply with environmental regulations and minimize possible air, waterway, and subsoil contamination or pollution or other undesirable effects.

B. Cleaning of Equipment: Contractor shall ensure prior to moving on to Project Area, equipment, is free of soil, seeds, vegetative matter, or other debris that could contain or hold seeds. All construction equipment that will leave paved or dirt roads shall be pressure-washed prior to entering the park and shall be clean of any soil, plant matter, or other materials. Equipment shall be considered free of soil, seeds, and other debris when visual inspection does not disclose such material. NPS personnel shall inspect the vehicles prior to entry into the Park. Disassembly of equipment components or specialized inspection tools are not required.

C. Temporary Erosion and Sedimentation Control: Refer to Section 01 57 23, Temporary Storm Water Pollution Prevention.

D. Tree and Plant Protection: Refer to Section 01 11 00, Summary of Work.

E. Pest Control: Follow NPS requirements to minimize attraction and harboring of rodents, roaches, and other pests and perform extermination and control procedures at regular intervals so Project will be free of pests and residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

F. Work Zone Enclosure Fence: Before daily construction operations begin, furnish and install chain link fencing to prevent people and animals from easily entering work zone except by entrance gates.

1. Extent of Fence: To enclose staging areas, storage areas, and portion of the Project Site that need to be protected from people and animals, as determined sufficient by the Contracting Officer, to accommodate construction operations.
2. Locate vehicular gates to avoid interference with traffic on public thoroughfares.
3. Locate pedestrian entrance gates as required to provide controlled personnel entry.
4. Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Contracting Officer with one set of keys.

G. Security Enclosure and Lockup: Install substantial temporary enclosure around partially completed areas of construction. Provide lockable entrances to prevent unauthorized entrance, vandalism, theft, and similar violations of security.

H. Barricades, Warning Signs, and Lights: Comply with requirements of Manual on Uniform Traffic Control Devices (MUTCD), Part 6, latest edition for erecting structurally adequate barricades, including warning signs and lighting.

I. Temporary Enclosures: Provide temporary enclosures for protection of construction, in progress and completed, from exposure, foul weather, other construction

operations, and similar activities. Provide temporary weathertight enclosure for building exterior.

1. Where heating or cooling is needed and permanent enclosure is not complete, insulate temporary enclosures.

J. Temporary Partitions: Provide floor-to-ceiling dustproof partitions to limit dust and dirt migration and to separate areas occupied by NPS from fumes and noise.

1. Construct dustproof partitions with gypsum wallboard with joints taped on occupied side, and fire-retardant plywood on construction operations side.
2. Construct dustproof partitions with two layers of 3-mil (0.07-mm) polyethylene sheet on each side. Cover floor with two layers of 3-mil (0.07-mm) polyethylene sheet, extending sheets 18 inches (460 mm) up the sidewalls. Overlap and tape full length of joints. Cover floor with fire-retardant plywood.

    a. Construct vestibule and airlock at each entrance through temporary partition with not less than 48 inches (1,219 mm) between doors. Maintain water-dampened foot mats in vestibule.

3. Insulate partitions to provide noise protection to occupied areas.
4. Seal joints and perimeter. Equip partitions with dustproof doors and security locks.
5. Protect air-handling equipment.
6. Weather strip openings.
7. Provide walk-off mats at each entrance through temporary partition.

K. Temporary Fire Protection: Install and maintain temporary fire-protection facilities of types needed to protect against reasonably predictable and controllable fire losses. Comply with NFPA 241.

1. Fire Danger: During periods of fire danger, the Contracting Officer may require a person to be detailed as a fire watch for 1 hour after the use of heat-generating equipment, or for 2 hours during periods of extreme fire danger. Prohibitions on the use of explosives, chain-saws or other internal combustion engines (possibly during certain hours), welding and other heat-generating equipment may be implemented.
2. Additional restrictions on Contractor activities or additional quantities and pre-positioning of onsite firefighting supplies may be required during periods of elevated local area fire hazard.
3. Responsible Person: Capable and qualified person shall be placed in charge of fire protection. Responsibilities shall include locating and maintaining fire protective equipment and establishing and maintaining safe torch cutting and welding procedures.
4. Tobacco Use, Smoking, and Vaping: Smoking within buildings or temporary storage sheds is prohibited.

5. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of NPS. Coordinate “hot work” in accordance with Section 01 32 16, Construction Schedule.
6. Develop and supervise overall fire-prevention and -protection program for personnel at Project Site. Review needs with local fire department and establish procedures to be followed. Instruct personnel in methods and procedures. Post warnings and information.
7. Hazard Control: Take necessary precautions to prevent fire during construction. Do not store flammable or combustible liquids in historic structures or existing buildings. Provide adequate ventilation during use of volatile or noxious substances. Ensure cleanup procedures and storage requirements are followed at close of every work session.
8. Spark Arresters: Equip gasoline or diesel powered equipment used during periods of potential fire hazards or in potential forest and grass fire locations with spark arresters approved by United States Department of Agriculture (USDA) Forest Service.

    a. Written determinations of periods and areas of potential fire hazard will be issued by Contracting Officer.

9. Buildings: Furnish a minimum of one extinguisher for each 1,500 square feet of area or major fraction thereof.

    a. Travel distance from any work station to nearest extinguisher shall not exceed 75 feet.

10. Vehicles and Equipment: Provide one extinguisher on each vehicle or piece of equipment.
11. Service and Refueling Areas: Locate areas a minimum of 50 feet from buildings. Shut down equipment before refueling.
12. Work Performed in Los Alamos National Lab Property: Review Fire Danger Matrix for proposed activities/operations prior to commencing work, each morning and each afternoon.

3.7 OPERATION, TERMINATION, AND REMOVAL

A. Supervision: Enforce strict discipline in use of temporary facilities. Minimize waste and abuse, limit availability of temporary facilities to essential and intended uses.

B. Maintenance: Maintain facilities in good operating condition until removal.

    1. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on 24-hour basis where required to achieve indicated results and avoid possibility of damage.

C. Temporary Facility Changeover: Do not change over from using temporary security and protection facilities to permanent facilities until Substantial Completion.

D. Termination and Removal: Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

1. Materials and facilities that constitute temporary facilities are property of Contractor. NPS reserves right to take possession of Project identification signs.
2. At Substantial Completion, clean and renovate permanent facilities used during construction period.

END OF SECTION

SECTION 01 57 19.12
NOISE AND ACOUSTICS MANAGEMENT

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes: Special requirements for noise and acoustics management during deconstruction, renovation, and construction operations.

1.2 DEFINITIONS

A. Ambient Noise Level: The total noise associated with a given environment, being usually a composite of normal or existing sounds from all sources near and far, excluding the noise source at issue.

B. Daytime: The hours from 8:00 a.m. to dusk on weekdays and with the approval of the Contracting Officer on weekends and holidays.

C. Nighttime: All non-daytime hours.

D. Property Line: The real or imaginary line along the ground surface and its vertical extension, which separates real property owned or controlled by one person from contiguous real property owned or controlled by another person or from any public right-of-way or from any public space.

E. Receiving Noise Area: Any real property where people live or work and where noise is heard, excluding the project or source area. For this Project, the receiving area is staff housing and public campgrounds.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 NOISE MANGEMENT

A. Noise Control: Perform deconstruction, renovation, and construction operations to minimize noise. Perform noise-producing work in less sensitive hours of the day or week as directed by the Contracting Officer (CO).

B. Construction activities along Frijoles Canyon developed Area, Stone House Road, Mesa Top Residential Area, and Juniper Campground shall be performed during the hours of the day when the buildings and residences are least occupied. Coordinate times with the Contracting Officer.

C. Repetitive and/or Intermittent, High-Level Noise: Permitted only during Daytime.

1. Do not exceed the following dB(A) limitations at 50 feet:

Sound Level in dB(A)	Time Duration of Impact Noise
70	More than 12 minutes in any hour
80	More than 3 minutes in any hour

2. Maximum permissible construction equipment noise levels at 50 feet:

EARTHMOVING	dB(A)	MATERIALS HANDLING	dB(A)
Front Loaders	75	Concrete Mixers	75
Backhoes	75	Concrete Pumps	75
Dozers	75	Cranes	75
Tractors	75	Derricks Impact	75
Scrapers	80	Pile Drivers	95
Graders	75	Jack Hammers	75
Trucks	75	Rock Drills	80
Pavers, Stationary	80	Pneumatic Tools	80
Pumps	75	Saws	75
Generators	75	Vibrators	75
Compressors	75		

D. Ambient Noise:

1. Maximum noise levels (dB (decibel)) for receiving noise area at property line shall be as follows:

   a. Residential Receiving Area:

      1) Daytime: 65 dB.
      2) Nighttime: 45 dB.

   b. Commercial/Industrial receiving area:

      1) Daytime: 67 dB.
      2) Nighttime: 65 dB.

2. In the event the existing local ambient noise level exceeds the maximum allowable receiving noise level (dB), the receiving noise level maximum for construction operations shall be adjusted as follows:

   a. Residential Receiving Area: Maximum 3 additional dB above the local ambient as measured at property line.
   b. Commercial/Industrial Receiving Area: Maximum 5 additional dB above the local ambient as measured at the property line.

3. Noise from generators used for temporary power generation shall be approved by the Contracting Officer in accordance with Section 01 50 00, Temporary Facilities and Controls.

3.2 FIELD QUALITY CONTROL

A. Assess potential effects of construction noise on facility occupants in accordance with ASTM E1686 and as follows:

1. Ambient Noise Measurement: Measure at property line at a height of at least 4 feet above the immediate surrounding surface. Average the ambient noise level over a period of at least 15 minutes.

B. Monitor noise produced from construction operations in accordance with ASTM E1780.

END OF SECTION

SECTION 01 57 23
TEMPORARY STORM WATER POLLUTION PREVENTION

PART 1 - GENERAL

1.1 SUMMARY

A. Federal Regulations for controlling discharges of pollutants (including chemicals, erodible material, and trash) from municipal separate storm sewer systems, construction sites, and industrial activities, were brought under the National Pollution Discharge Elimination System (NPDES) permit process by amendments to the Clean Water Act (CWA), and promulgation of federal stormwater regulations issued by the United States Environmental Protection Agency (USEPA). The USEPA uses amount of ground disturbance as a measure of a project potential to generate pollution from erosion. NPDES Phase I regulates discharges from construction sites that disturb 5 acres or more. NPDES Phase II regulations expand existing General Permit requirements under Phase I to include/regulated discharges from construction sites that disturb land equal to or greater than 1 acre and less than 5 acres, known as Small Construction Activity. Construction disturbances 1 acre and above typically require a formal NPDES permit and a formal Stormwater Pollution Prevention Plan (SWPPP) must be submitted to Agency(ies) with Jurisdiction for review and approval.

B. The work of this section consists of implementing measures to prevent discharges of pollutants, including temporary storm water pollution during construction activities, through compliance with NPDES permit program.

1.2 DEFINITIONS

A. Definitions pertaining to sustainable development: As defined in ASTM E2114.

B. Environmental Pollution and Damage: The presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances; or degrade utility of the environment for aesthetic, cultural, or historical purposes.

C. National Pollution Discharge Elimination System (NPDES) Phase I: Regulates discharges from construction sites that disturb 5 acres or more.

D. NPDES Phase II: Regulations expand existing General Permit requirements under Phase I to include and regulate discharges from construction sites that disturb land equal to or greater than 1 acre and less than 5 acres, known as Small Construction Activity.

E. Storm Water Pollution Prevention Plan (SWPPP): Developed and implemented stormwater management measures to protect surface water from pollutants during

construction activities disturbing an acre or more in compliance with federal, state, and local requirements for permit approval under NPDES program.

1.3 SUBMITTALS

A. After Contract award and before pre-construction conference, prepare and submit:

1. A SWPPP showing SWPPP satisfies Federal and State NPDES permit requirements.

B. Inspection Schedule: Submit schedule for inspection and monitoring of pollution prevention measures.

C. Erosion Control Products: Submit manufacturer's product information and installation recommendations for silt fence, filter fabric, erosion control blanket, straw bales, and other materials proposed for use on this Project.

1.4 QUALITY ASSURANCE

A. Contractor shall prepare and submit a plan to Contracting Officer (CO) for review and concurrence.

B. Orientation Meeting: Contractor shall arrange and conduct an Erosion and Sediment Control meeting/briefing to inform parties, scheduled to be on-site during project, of measures to be implemented for proper erosion and sediment control (may be included as part of Pre-Construction Meeting).

1. Installation of silt fences, storm drain protection, and other forms of erosion and sediment control shall not begin until after this meeting has occurred.

C. Pollution Prevention and Erosion Control Manager: Contractor shall designate Pollution Prevention and Erosion Control Manager responsible for implementation, inspection, maintenance, and amendments to approved plan.

1. Pollution Prevention and Erosion Control Manager shall be familiar with temporary storm water pollution prevention procedures and Best Management Practices and ensure emergency procedures and plan are updated as needed and available for inspection.
2. When changes in approved plan are required, Pollution Prevention and Erosion Control Manager shall prepare and certify an amendment and submit to Contracting Officer for review and concurrence.

PART 2 PRODUCTS

2.1 TEMPORARY STORM WATER POLLUTION PREVENTION PLAN

A. Provide SWPPP which satisfies Federal and State NPDES permit requirements and includes:

1. Site description.
2. Identification and contract information for Pollution Prevention and Erosion Control Manager.
3. Expected sequencing of operations and construction schedule.
4. Weather monitoring procedure.
5. Descriptions and details Best Management Practices for of pollution prevention and erosion controls, including dust control.
6. Pollution prevention and erosion control plans.
7. Controls for other potential onsite storm water pollutants.
8. Applicable specifications.
9. Maintenance and inspection procedures and forms.
10. Description of potential non-storm water discharges at site.
11. Notice of Intent (NOI) form.
12. Notice of Termination (NOT) form.
13. Contractor and Sub-contractor Certification forms.
14. Other record keeping forms and procedures.
15. Housekeeping Best Management Practices, including vehicle wash-down areas, protection of equipment storage and maintenance areas, and sweeping of roadways related to hauling activities.

PART 3 EXECUTION

3.1 ENVIRONMENTAL PROTECTION

A. Protection of Natural Resources: Comply with applicable regulations and these Specifications. Preserve natural resources within the project boundaries and outside limits of work performed under this Contract in their existing condition. Restore natural resources within project boundaries in accordance with project specifications.

B. Construction Zone: Arrange construction activities to minimize pollution (i.e., erosion, trash, etc.) to maximum practical extent.

1. Clearing, excavation, and grading shall be limited to those areas of project site necessary for construction. Minimize area exposed and unprotected.
2. Clearly mark and delineate limits of work activities.
3. Equipment shall not be allowed to operate outside limits of work or to disturb existing vegetation.

4. Excavation and grading shall be completed during dry season to maximum extent possible.
5. Material shall be stored away from locations where water is present to greatest extent practicable.

3.2 REGULATORY REQUIREMENTS

A. Permits: Contractor shall obtain required NPDES permits resulting in no impacts to scheduled work. Contractor shall account for possibility of significant lead time in scheduling and executing work.

1. Implement requirements of NPDES permit for erosion control due to storm water runoff during construction.
2. Implement good housekeeping practices, inspections and record keeping.
3. Prior to construction, Contractor and Subcontractors shall sign certifications (included in the plan) that they understand requirements of NPDES permit.
4. Subcontractors shall comply with requirements of NPDES under supervision of Contractor.
5. Accepted plan shall comply with terms and conditions of EPA permit.

B. Notice of Intent (NOI): Contractor shall file a Notice of Intent and formal SWPPP as required to the Agencies with Jurisdiction.

C. Notice of Termination (NOT): After Substantial Completion of Work, file a Notice of Termination (NOT) with the Agencies with Jurisdiction.

D. Contracting Officer Notification:

1. Contractor shall notify Contracting Officer in writing and by telephone of these events:

a. Erosion and sediment control meeting/briefing.
b. Following installation of required sediment control structures.
c. Prior to removal of or modification to sediment control structures.
d. Prior to removal of sediment control structures.

3.3 TEMPORARY STORM WATER POLLUTION PREVENTION PLAN

A. Review and Acceptance: Contractor and Contracting Officer will jointly review draft Plan and agree to needed revisions. Contractor shall incorporate revisions, sign, and submit final Plan to Contracting Officer. Final Plan will be the document enforced on the Project.

1. Accepted Plan will describe and ensure implementation of practices to be used to reduce pollutants in storm water discharges.
2. Contractor shall maintain current copy of Plan and associated records and forms at jobsite throughout duration of project.

3. Plan shall be available for public inspection and inspection and use of Contracting Officer.
4. Approval of Contractor's Plan will not relieve Contractor of responsibility for compliance with applicable environmental regulations.

B. Implementation: Implement Plan as required throughout construction period and maintain erosion control elements in proper working order.

1. Do not perform clearing and grubbing or earthwork until Plan has been implemented.

C. SWPPP (including inspection forms) and data used to complete the NOI shall be provided to Contracting Officer after Substantial Completion of project.

3.4 SITE INSPECTIONS AND PLAN REVISIONS

A. Inspections: Contractor and Contracting Officer will perform a weekly inspection onsite.

1. Inspection shall include disturbed areas not completely stabilized, areas used for storage of materials, locations where vehicles enter or exit site, and other erosion and sediment controls included in the Plan.
2. Inspections shall be documented.
3. Inspection forms shall be retained onsite in Plan notebook throughout construction period.

B. Plan Revisions: It may be necessary to revise Plan during construction to make necessary improvements, revisions, or to respond to unforeseen conditions noted during construction or site inspections.

1. Plan shall specify mechanism whereby revisions may be proposed by Contractor or Contracting Officer.
2. Contractor and Contracting Officer will jointly review each revision to Plan before changes incorporated and implemented. Contractor will then provide revised copy of Plan to Contracting Officer.
3. Accepted modifications will be implemented within 7 calendar days following date of inspection when deficiencies or necessary corrections are first noted.

C. Negligence: Provide additional temporary erosion and pollution controls made necessary by Contractor's errors or negligence at no additional cost to Government.

3.5 HOUSEKEEPING AND SITE MANAGEMENT

A. Store materials onsite in conformance to Federal, state, local, and manufacturer's regulations and specifications. Use Best Management Practices to minimize risk of materials coming into contact with environmental conditions (i.e., water and wind) that could disperse them.

B. Manage solid waste in conformance to Federal, state, and local regulations. Best Management Practices should be used to minimize risk of materials coming into contact with environmental conditions (i.e., water and wind) that could disperse them.

C. Include a spill prevention and control plan with provisions placed in SWPPP.

D. Manage hazardous waste (including contaminated soil) in conformance to Federal, state, local, and NPS regulations and guidelines.

3.6 EROSION CONTROL MEASURES

A. Erosion control measures shall consist of Best Management Practices for storm water discharges, including silt fencing, barrier protectors, straw bales, temporary soil retention blankets, excelsior drainage filters, sediment traps and berms.

B. Berms and excelsior drainage filters shall be used to form sediment traps and control run-on and run-off into other areas, including creeks, streams, marshes, access roads, well areas, and staging areas.

C. Erosion control measures shall be used to contain only direct precipitation in construction zone. Contained water shall be allowed to percolate into ground or drain slowly through drainage filter sediment traps.

D. Earthen sediment traps or holding ponds shall not be used unless accepted by Contracting Officer.

E. Reduce runoff velocity and direct surface runoff around and away from fuel containment, storage, and borrow areas.

F. Divert surface runoff around and away from cut and fill slopes.

G. Place drainage filters around catch basins to create sediment traps to control run-off from construction area.

H. Excess water used for dust control shall be contained within demolition areas by erosion control measures.

I. Contractor shall prevent deposition of materials onto paved areas. Contractor shall inspect paved areas for deposited materials weekly and remove materials immediately.

J. Furnish, install, maintain, and operate necessary control measures and other equipment necessary to prevent erosion as described in approved SWPPP.

K. Before work begins, sufficient equipment shall be available on site to assure operation and adequacy of erosion control system can be maintained.

3.7 MAINTENANCE OF TEMPORARY FACILITIES

A. Ensure erosion and sediment control structures remain effective throughout excavation and grading operations. Relocate structures, as necessary.

B. Inspect control structures after each significant rainfall. Promptly repair breaches which occur.

C. Contractor shall remove entrapped sediment from behind excelsior drainage filter after each storm.

3.8 REPORTING

A. If a discharge occurs or if project receives written notice or order from regulatory agency, Contractor shall immediately notify Contracting Officer and shall file written report to Agency(ies) with Jurisdiction within 7 days of discharge event, notice, or order. Corrective measures shall be implemented immediately following discharge, notice, or order. The report to the Agency(ies) with Jurisdiction shall contain:

1. Date, time, location, nature of operation, and type of discharge, including cause or nature of notice or order.
2. Best Management Practices deployed before discharge event, or prior to receiving notice or order.
3. Date of deployment and type of Best Management Practices deployed after discharge event, or after receiving notice or order, including additional Best Management Practices installed or planned to reduce or prevent re-occurrence.
4. An implementation and maintenance schedule for affected Best Management Practices.

3.9 SEDIMENT DISPOSAL

A. Sediment excavated from temporary sediment control structures shall be disposed on site with general fill, or with topsoil. Sediment shall be allowed to dry out as required before reuse.

B. Contractor shall place sediment removed from traps and other structures where it will not enter a storm drain or watercourse and where it will not immediately reenter the basin.

3.10 REMOVAL OF TEMPORARY POLLUTION CONTROL MEASURES

A. Temporary control measures shall be removed with permission of Contracting Officer and District Resource Management Specialist within 30 working days after final acceptance of project, and/or after final site stabilization or after the temporary measures are no longer needed.

END OF SECTION

SECTION 01 57 28
TEMPORARY FLOW CONTROL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Inspection, Cleaning, and Restoration Certification (IICRC): S500, Standard and Reference Guide for Professional Water Damage Restoration.

1.02 DEFINITIONS

A. Bypass Pumping: Temporary flow control accomplished by diverting flow away from the Work area using one or more pumps.

B. Temporary Flow Control: Reducing, limiting, or excluding flow in or to a sanitary sewer, storm sewer, pump station, force main, or other facility as required for performing the Work under the Contract. Draining, handling, and disposal of sanitary sewage and stormwater from pipelines and other facilities as required for performing the Work under the Contract is also part of temporary flow control.

C. Temporary Flow Control Plan: Plan prepared by Contractor containing complete information on how Contractor proposes to perform temporary flow control in accordance with specified requirements.

1.03 SYSTEM DESCRIPTION

A. Provide facilities and controls required to intercept, convey, and discharge flow to be controlled; include standby and emergency equipment.

B. Conform to regulatory requirements.

C. Protect water resources, wetlands, and other natural resources.

D. Temporary flow control shall be done in a manner that will not damage private or public property, or create a nuisance or public menace. Flow shall be conveyed in enclosed pipes that are adequately protected from traffic or other hazards.

E. Discharge:

1. To sanitary sewer system.
2. Dumping or free flow on private or public property, gutters, streets, or sidewalks is prohibited.
3. Discharge of sanitary sewage to storm sewers, to surface waters or wetlands, or into the ground, is prohibited.

1.04 SITE CONDITIONS

A. Obtain approval and secure permits for placement of temporary flow control facilities within public right-of-ways.

B. Existing facilities in vicinity of sewer manholes and lines to be bypassed are shown on the Drawings.

1.05 SUBMITTALS

A. Informational Submittals:

1. Temporary Flow Control Plan.
2. Emergency Cleanup Plan.
3. Special permits required for temporary flow control.
4. Names and qualifications of industrial hygienist and standby cleanup Subcontractor, including but not limited to, certification by IICRC.
5. Information describing equipment and materials to be used and showing conformance with specified requirements.

1.06 SEQUENCING AND SCHEDULING

A. Notify and provide schedule to Contracting Officer 7 days prior to temporary flow control and obtain approval prior to commencing.

B. Schedule temporary flow control as to minimize service outage.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Install temporary flow control facilities only within public right-of-way, NPS property, temporary construction easement, permanent easement, or easement obtained by Contractor.

B. Operate and maintain temporary flow control 24 hours per day, 7 days per week, including without limitation, holidays, as required to control flows.

C. Promptly remove temporary flow control facilities as soon as they are no longer needed.

3.02 REQUIRED TEMPORARY FLOW CONTROL

A. Except at pipe sags, depth of flow during television inspection and joint testing shall not exceed that shown below for respective pipe sizes:

Maximum Depth of Flow in Inches	
Pipe Size (Inches)	**Television Inspection and Joint Testing**
6	1.20
8	1.60
10	2.00
12	3.00

B. Eliminate flow from sewer manhole to manhole segments during spot repair, service connection rehabilitation, manhole construction, and sewer pipe replacement within that segment.

3.03 EQUIPMENT AND MATERIALS

A. General:

1. Provide materials and equipment that will ensure continuous and successful operation of temporary flow control systems.
2. Repair or modify systems as necessary.
3. Unless otherwise shown or specified, materials and equipment may be new or used at Contractor’s option.

B. Plugs:

1. Provide with taps for connection of pressure gauges and air hoses, and flow-through capability.
2. Pipe Diameters 24 Inches and Smaller: Use mechanical plugs with rubber gaskets or pneumatic plugs with rubber boots.

C. Pumps:

1. Fully automatic, self-priming units that do not require use of foot valves or vacuum pumps in priming system.
2. Solids handling design with ability to pump minimum 3-inch diameter sphere.
3. Able to run dry for long periods of time to accommodate cyclical nature of flows.
4. Engine: Equipped to minimize noise. Noise levels shall not exceed 86 dBA at a distance of 50 feet from source.

D. Electric Power Generators:

1. Be able to simultaneously start and run electric powered pumps required for flow to be controlled.
2. Equipped to minimize noise. Noise levels shall not exceed 86 dBA at a distance of 50 feet from source.
3. Include automatic transfer switch if flow control system is to operate unattended.

E. Standby Equipment:

1. Standby Pump: One of each size to be available onsite.
2. Electric Power Generators: Minimum of one if temporary flow control system contains electric powered pump. Able to simultaneously start and run electric powered pumps required for flow to be controlled.

3.04 TEMPORARY FLOW CONTROL PLAN

A. Prepare and submit Temporary Flow Control Plan at least 7 days before starting the Work requiring temporary flow control; include following information:

1. Drawings indicating location of temporary sewer plugs and bypass discharge lines.
2. Traffic Control Plan specifically applicable to temporary flow control adhering to requirements of applicable agencies and as may be specified in Contract Documents.
3. Locations where flow will be intercepted and discharged.
4. If trucks are to be employed include the following:
   a. Numbers and sizes of trucks.
   b. Configuration of facilities to be used to load trucks at each interception location.
   c. Locations where trucks will unload.
   d. Time for loading, unloading, and travel.
5. Complete descriptions and performance characteristics of pumps, electric power generators, and standby equipment.

6. Acoustical information for equipment to be used showing compliance with noise control requirements of Section 01 50 00, Temporary Facilities and Control.
7. Details of temporary force mains, including horizontal and vertical alignments, pipe materials, protection of existing buried and aboveground facilities and improvements, maintenance of traffic and access to properties.
8. Design calculations proving adequacy of temporary system and selected equipment to convey all flows.
9. Drawings showing layouts and configurations of temporary flow control facilities and also showing locations relative to right-of-way easement, and property boundaries.
10. Drawings and design calculations of temporary bulkheads and plugs.
11. Drawings and design calculations for thrust restraint of temporary piping.
12. Details of system controls and control logic; include diagrams and narrative.
13. Anticipated schedule for the Work.
14. Other information to completely describe temporary flow control facilities and conformance to specified requirements.
15. Anticipate coordination needs with Contracting Officer and Park utility operators.

3.05 EMERGENCY CLEANUP PLAN

A. Prepare and submit not less than 60 days before scheduled date of temporary flow control activities. As a minimum plan shall include the following:

1. Procedures for removal of water.
2. Procedures for determining nature and extent of damage and required restoration where restoration is possible.
3. Provide for industrial hygienist and standby Subcontractor for cleanup of exterior and building interior spaces that might be affected by a spill, backup, or overflow. Industrial hygienist and cleanup Subcontractor shall be certified by IICRC and follow IICRC S500 for cleanup of Category 3 water.

B. Implement for Full Scale Test and during temporary flow control.

3.06 BLOCKING FLOW

A. Flow control may consist of blocking flow with mechanical or pneumatic plugs if only small amount of flow needs to be controlled and adequate storage is available.

B. Use primary and secondary plugs for each flow control location.

C. When blocking flow is no longer needed for performance and acceptance of the Work, remove plugs in a manner that permits sewage flow to slowly return to normal without surcharging or causing other major disturbances downstream.

D. Remove temporary plugs at end of each working day and restore normal flow. If downstream work is not or cannot be completed during workday provide, operate, and maintain bypass pumping system or other method of flow control to accommodate flows.

3.07 PIPING

A. Minimize disturbance of existing utilities.

B. Where temporary flow control pipelines cross streets and private driveways, install pipeline in trench and cover with temporary pavement.

C. Installation of bypass pipelines is prohibited in salt marsh/wetland areas.

3.08 TEMPORARY SANITARY SEWAGE FLOW REDUCTION

A. Contractor may request sewer service customers upstream of the Work area to reduce or curtail sewer flow.

1. First Notice: Not less than 1 week nor more than 2 weeks prior to when sewer flow deduction or curtailment is requested.
2. Second Notice: Not more than 24 hours nor less than 12 hours prior to when sewer flow deduction or curtailment is requested.

B. When service lateral must be disconnected from main for more than 1 day, lateral shall be positively drained or pumped a minimum of once every 24 hours. Monitor status of flow and storage. Pump lateral more frequently where flows exceed storage capacity of lateral or temporary storage as may be provided by Contractor.

C. Temporarily restore full flow services in uncompleted sections during nonwork hours.

D. Promptly notify sewer service customers that were requested to reduce or curtail sewer flow when the Work is complete and full uninterrupted service restored.

E. Contractor shall be responsible for control of sewage flows and under no circumstances be entitled to rely on flow reduction or curtailment by upstream sewer service customers.

3.09 DRAINING EXISTING PIPELINE

A. Before initiating shutdown, ensure required materials, equipment, and labor are available onsite. Excavate and expose portions of existing pipeline to be removed.

B. Provide tap and piping in place to drain sewage from existing pipeline before it is cut and to capture contents that may drain out when pipe is cut.

C. Sewage drained from pipeline shall be conveyed and discharged to a downstream sanitary sewer manhole.

3.10 FIELD QUALITY CONTROL

A. Hydrostatic Pressure Test for Pump Bypass Systems:

1. Prior to operation, test each section of discharge piping with maximum pressure equal to 1.5 times maximum operating pressure of system.
2. Notify Contracting Officer 24 hours prior to testing.

END OF SECTION

SECTION 01 67 00
PRODUCT REQUIREMENTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for selection of products for use in Project; product delivery, storage, and handling; manufacturers' standard warranties on products; special warranties; and environmental requirements.

1.2 DEFINITIONS

A. Definitions Pertaining to Sustainable Development: As defined in ASTM E2114.

B. Biobased Materials: As defined in Farm Security and Rural Investment Act, for purposes of Federal procurement of biobased products, "biobased" means a "commercial or industrial product (other than food or feed) composed, in whole or in significant part, of biological products or renewable domestic agricultural materials (including plant, animal, and marine materials) or forestry materials." Biobased materials also include fuels, chemicals, building materials, or electric power or heat produced from biomass as defined by The Biomass Research and Development Act of 2000.

1. Biobased Content: Amount of biobased carbon in material or product as a percentage of weight (mass) of total organic carbon in material or product.

C. Chain-of-Custody: Process whereby a product or material is maintained under physical possession or control during its entire life cycle.

D. Environmentally Preferable Products: Products and services with lesser or reduced effect on the environment in comparison to conventional products and services. Refer to Environmental Protection Agency's (EPA) Final Guidance on Environmentally Preferable Purchasing for more information.

E. Products: Items purchased for incorporating into Work, whether purchased for Project or taken from previously purchased stock. The term "product" includes "material," "equipment," "system," and terms of similar intent.

1. Named Products: Items identified by manufacturer's product name, including make or model number and other designation shown or listed in manufacturer's published product literature, current as of date of Contract Documents.
2. New Products: Items that have not previously been incorporated into another project or facility, except that products consisting of recycled-content materials are allowed, unless explicitly stated otherwise. Products salvaged or recycled from other projects are not considered new products.

3. Approved Equals: Product demonstrated and approved through submittal process, or where indicated as a product substitution, to have indicated qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics that equal or exceed those of specified product.

F. Stewardship: Responsible use and management of resources in support of sustainability.

G. Sustainability: Maintenance of ecosystem components and functions for future generations.

1. Recycled Content Materials: Products containing pre-consumer or post-consumer materials as all or part of their feedstock. Recycled content claim shall be consistent with International Organization for Standardization (ISO) 140001 Standard for the Use of Environmental Marketing Claims.
2. Rapidly Renewable Material: Material made from plants typically harvested within a 10-year cycle.
3. Regional Materials: Materials manufactured and extracted, harvested, or recovered within a radius of 500 miles from Project location.

1.3 SUBMITTALS

A. Material Safety Data Sheets (MSDS):

1. For each product required by OSHA to have a MSDS, submit an MSDS. MSDS shall be prepared within the previous 5 years. Include information for MSDS Sections 1 to 16 in accordance with ANSI Z400.1 and as follows:

a. Section 1: Chemical Product and Company Identification.
b. Section 2: Composition/Information on Ingredients.
c. Section 3: Hazards Identification.
d. Section 4: First Aid Measures.
e. Section 5: Fire Fighting Measures.
f. Section 6: Accidental Release Measures.
g. Section 7: Handling and Storage.
h. Section 8: Exposure Controls/Person Protection.
i. Section 9: Physical and Chemical Properties.
j. Section 10: Stability and Reactivity Data.
k. Section 11: Toxicological Information. Include data used to determine the hazards cited in Section 3. Identify acute data, carcinogenicity, reproductive effects, and target organ effects. Provide written description of the process used in evaluating chemical hazards relative to preparation of the MSDS.
l. Section 12: Ecological Information. Include data regarding environmental impacts during raw materials acquisition, manufacture,

and use. Include data regarding environmental impacts in event of accidental release.

m. Section 13: Disposal Considerations. Include data regarding proper disposal of the chemical. Include information regarding recycling and reuse. Indicate whether or not product is considered to be “hazardous waste” according to United States EPA Hazardous Waste Regulations 40 CFR 261 (Code of Federal Regulations).

n. Section 14: Transportation Information. Identify hazard class for shipping.

o. Section 15: Regulatory Information. Identify federal, state, and local regulations applicable to the material.

p. Section 16: Other Information. Include additional information relative to recycled content, biobased content, and other information regarding environmental and health impacts. Identify the date MSDS was prepared.

1.4 QUALITY ASSURANCE

A. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1.5 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle products using means and methods that prevent damage, deterioration, and loss, including theft. Comply with manufacturer’s written instructions.

B. Delivery and Handling:

1. Schedule delivery to minimize long-term storage at Project site and prevent overcrowding of construction spaces.
2. Coordinate delivery with installation time to ensure minimum holding time for items that are flammable, hazardous, easily damaged, or sensitive to deterioration, theft, and other losses.
3. Deliver products to Project site in undamaged condition; in manufacturer’s original sealed container or other packaging system; complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
4. Inspect products on delivery to ensure compliance with Contract Documents. Ensure products are undamaged and properly protected.
5. Obtain materials in biodegradable or recyclable/reusable packaging which uses minimum amount of packaging possible.

C. Storage:

1. Allow for inspection and measurement of quantity or counting of units.
2. Store materials in manner to not endanger Project structure.

3. Store products subject to damage by the elements, under cover in weather tight enclosure above ground, with ventilation adequate to prevent condensation.
4. Store cementitious products and materials on elevated platforms.
5. Store foam plastic from exposure to sunlight, except to extent necessary for period of installation and concealment.
6. Comply with product manufacturer's written instructions for temperature, humidity, ventilation, and weather-protection requirements for storage.
7. Protect stored products from damage and liquids from freezing.
8. Store loose granular materials in well-drained area on solid surfaces to prevent mixing with foreign matter.

1.6 PACKAGING

A. Where Contractor has option to provide one of listed products or equal, preference shall be given to products with minimal packaging and easily recyclable packaging as defined in ASTM D5834.

B. Maximize use of source reduction and recycling procedures outlined in ASTM D5834.

1.7 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Provide environmentally preferable products when feasible.

1. Provide products and materials with a lesser or reduced effect on the environment considering raw materials acquisition, production, manufacturing, packaging, distribution, reuse, operation, maintenance, and/or disposal of the product.
2. Eliminate use of ozone depleting compounds during and after construction where alternative environmentally preferable products are available, consistent with either Montreal Protocol and Title VI or Clean Air Act Amendments of 1990, or equivalent overall air quality benefits that take into account life cycle impacts.
3. Use products meeting or exceeding EPA's recycled content recommendations for EPA-designated products. Use materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10 percent (based on cost) of total value of the materials in project.

1.8 PRODUCT WARRANTIES

A. Warranties specified in other sections shall be in addition to, and run concurrent with, other warranties required by Contract Documents. Manufacturer's disclaimers and

limitations on product warranties do not relieve Contractor of obligations under requirements of Contract Documents.

1. Manufacturer's Warranty: Preprinted written warranty published by individual manufacturer for product specifically endorsed by manufacturer to Owner.
2. Special Warranty: Written warranty required by or incorporated into Contract Documents, either to extend time limit provided by manufacturer's warranty or to provide more rights for Owner.

B. Special Warranties: Prepare written document containing appropriate terms and identification, ready for execution. Submit draft for approval before final execution.

1. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed.
2. Specified Form: When specified forms are included with the Specifications, prepare written document using appropriate form properly executed.
3. Refer to Division 02 through Division 49 Sections for specific content requirements and particular requirements for submitting special warranties.

C. Submittal Time: Comply with requirements in Section 01 77 00, Closeout Procedures.

PART 2 PRODUCTS

2.1 PRODUCT SELECTION PROCEDURES

A. General Product Requirements: Provide products to comply with Contract Documents, undamaged and, unless otherwise indicated, new at time of installation.

1. Provide products complete with accessories, trim, finish, fasteners, and other items needed for a complete installation and indicated use and effect.
2. Standard Products: If available, and unless custom products or nonstandard options are specified, provide standard products of types produced and used successfully in similar situations on other projects.
3. Government reserves right to limit selection to products with warranties not in conflict with requirements of Contract Documents.
4. Where products are accompanied by term "as selected," Contracting Officer will make selection.
5. Where products are accompanied by term "match sample," sample to be matched is Governments.
6. Descriptive, performance, and reference standard requirements in the Specifications establish "salient characteristics" of products.

B. Product Selection Procedures:

1. Product: Where the Specifications name single product and manufacturer, provide named product that complies with requirements, or approved equal.
2. Manufacturer/Source: Where the Specifications name single manufacturer or source, provide product by named manufacturer or source that complies with requirements, or approved equal.
3. Products: Where the Specifications include list of names of both products and manufacturers, provide one of the products listed that complies with requirements, or approved equal.
4. Manufacturers: Where the Specifications include list of manufacturers' names, provide a product by one of the manufacturers listed that complies with requirements, or approved equal.
5. Available Products: Where the Specifications include list of names of both products and manufacturers, provide one of the products listed, or an unnamed product, that complies with requirements. Comply with provisions in Part 2 Products articles for consideration of an unnamed product.
6. Available Manufacturers: Where the Specifications include list of manufacturers, provide a product by one of the manufacturers listed, or an unnamed manufacturer, that complies with requirements. Comply with provisions in Part 2 Products articles for consideration of an unnamed product.
7. Product Options: Where the Specifications indicate sizes, profiles, and dimensional requirements on the Drawings are based on a specific product or system, provide specified product, system, or approved equal.
8. Visual Matching Specification: Where the Specifications require matching an established Sample, select product that complies with requirements and matches Architect's sample. Contracting Officers decision will be final on whether a proposed product matches.
9. Visual Selection Specification: Where the Specifications include phrase "as selected from manufacturer's colors, patterns, textures" or a similar phrase, select a product that complies with other specified requirements.

    a. Standard Range: Where the Specifications include phrase "standard range of colors, patterns, textures" or similar phrase, Contracting Officer will select color, pattern, density, or texture from manufacturer's product line that does not include premium items.
    b. Full Range: Where the Specifications include phrase "full range of colors, patterns, textures" or similar phrase, Contracting Officer will select color, pattern, density, or texture from manufacturer's product line that includes both standard and premium items.

2.2 APPROVED EQUAL PRODUCTS

A. Conditions:

1. Contracting Officer will consider Contractor's request when the following conditions are satisfied. If following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:

a. Evidence proposed product does not require revisions to Contract Documents, that it is consistent with Contract Documents and will produce indicated results and is compatible with other portions of Work.
b. Detailed comparison of significant qualities of proposed product with those named in the Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
c. Evidence proposed product provides specified warranty.
d. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
e. Samples, if requested.

PART 3 EXECUTION

3.1 PROTECTION AFTER INSTALLATION

A. Provide adequate coverings as necessary to protect installed materials from damage resulting from natural elements, traffic, and subsequent construction. Remove when no longer needed.

3.2 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Affirmative Procurement Reporting Form.
2. Manufacturer's Certificate of Proper Installation.
3. Manufacturer's Certificate of Compliance.

END OF SECTION

AFFIRMATIVE PROCUREMENT REPORTING FORM
Recycled Content Materials & Biobased Content Materials

Project Name: _____ Project Number: _____

Contractor Name: _____ License Number: _____

Contractor Address: _____

Product	Total $ value provided	Total $ value with recycled content Pre-consumer	Total $ value with recycled content Post-consumer	Total $ value with biobased content	Exempted indicate 1,2,3,4	Comments
Hydraulic Mulch (paper based)						
Hydraulic Mulch (wood based)						
Compost						
Parking Stops (Concrete w/ fly ash, slag cement or low cement content)						
Parking Stops (Plastic/Rubber)						
Patio Blocks/Rubber						
Patio Blocks/Plastic						
Playground Surfaces						
Concrete with fly ash						
Concrete with slag cement						
Concrete with low cement content						
Plastic lumber						
Building Insulation						
Rock Wool						
Fiber glass						
Cellulose						
Perlite Comp Board						
Plastic Rigid Foam						
Glass Fiber Reinforced Foam						
Phenolic Rigid Foam						
Ceramic tile						
Resilient flooring						
Floor Tiles/Rubber						
Floor Tiles/Plastic						
Running Tracks						
Carpet (PET)						
Paint						

Product	Total $ value provided	Total $ value with recycled content Pre-consumer	Total $ value with recycled content Post-consumer	Total $ value with biobased content	Exempted indicate 1,2,3,4	Comments
Reprocessed Latex Paint White & Light Colors						
Reprocessed Latex Dark Colors						
Consolidated Latex Paint						
Toilet/Shower partitions (plastic or steel)						
Other						

CERTIFICATION

I hereby certify the information provided herein is accurate and that the requisition/procurement of all materials listed on this form comply with current EPA standards for recycled/recovered materials content. The following exemptions may apply to the non-procurement of recycled/recovered content materials:

1. The product does not meet appropriate performance standards.
2. The product is not available within a reasonable time frame.
3. The product is not available competitively (from two or more sources).
4. The product is only available at an unreasonable price (compared with a comparable non-recycled content product.)

Signature: _____ Date: _____

END OF
AFFIRMATIVE PROCUREMENT REPORTING FORM
Recycled Content Materials & Biobased Content Materials

MANUFACTURER'S CERTIFICATE OF PROPER INSTALLATION

OWNER _____ EQPT SERIAL NO: _____

EQPT TAG NO: _____ EQPT/SYSTEM: _____

PROJECT NO: _____ SPEC. SECTION: _____

I hereby certify that the above-referenced equipment/system has been:

(Check Applicable)

- ☐ Installed in accordance with Manufacturer's recommendations.
- ☐ Inspected, checked, and adjusted.
- ☐ Serviced with proper initial lubricants.
- ☐ Electrical and mechanical connections meet quality and safety standards.
- ☐ All applicable safety equipment has been properly installed.
- ☐ Functional tests.
- ☐ System has been performance tested, and meets or exceeds specified performance requirements. (When complete system of one manufacturer)

Note: Attach any performance test documentation from manufacturer.

Comments: _____

_____

_____

_____

I, the undersigned Manufacturer's Representative, hereby certify that I am (i) a duly authorized representative of the manufacturer, (ii) empowered by the manufacturer to inspect, approve, and operate their equipment and (iii) authorized to make recommendations required to ensure equipment furnished by the manufacturer is complete and operational, except as may be otherwise indicated herein. I further certify that all information contained herein is true and accurate.

Date: _____, 20__

Manufacturer:_____

By Manufacturer's Authorized Representative: _____

(Authorized Signature)

MANUFACTURER'S CERTIFICATE OF COMPLIANCE

OWNER: _____

PROJECT NAME: _____

PROJECT NO: _____

PRODUCT, MATERIAL, OR SERVICE SUBMITTED: _____

Comments: _____

_____

_____

_____

_____

_____

I hereby certify that the above-referenced product, material, or service called for by the Contract for the named Project will be furnished in accordance with all applicable requirements. I further certify that the product, material, or service are of the quality specified and conform in all respects with the Contract requirements, and are in the quantity shown.

Date of Execution: _____, 20___

Manufacturer: _____

Manufacturer's Authorized Representative *(print)*: _____

_____

(Authorized Signature)

SECTION 01 73 29
CUTTING AND PATCHING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes procedural requirements for cutting and patching on buildings that do not contain Historic Fabric.

1.2 SUBMITTALS

A. Cutting and Patching Plan:

1. Submit Plan describing procedures at least 10 days before cutting and patching will be performed, requesting approval to proceed. Include:

   a. Extent: Describe cutting and patching, show how performed, and indicate why they cannot be avoided.
   b. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building's appearance and other significant visual elements.
   c. Products: List products to be used and firms or entities that will perform Work.
   d. Dates: Indicate when cutting and patching will be performed.
   e. Utility Services and Mechanical/Electrical Systems: List services/systems that cutting and patching procedures will disturb or affect. List services/systems that will be relocated and those that will be temporarily out of service. Indicate how long services/systems will be disrupted.
   f. Structural Elements: Where cutting and patching involve adding reinforcement to structural elements, submit details and engineering calculations showing integration of reinforcement with original structure. Do not cut and patch structural elements in a manner that could change their load carrying capacity or increase deflection.
   g. Contracting Officer’s (CO) Approval: Obtain approval of cutting and patching plan before cutting and patching. Approval does not waive right to later require removal and replacement of unsatisfactory work.

1.3 QUALITY ASSURANCE

A. Structural Elements: Do not cut and patch structural elements in a manner that could change their load-carrying capacity or load-deflection ratio.

B. Operational Elements: Do not cut and patch operating elements and related components in a manner that results in reducing their capacity to perform as intended or that results in increased maintenance or decreased operational life or safety.

C. Miscellaneous Elements: Do not cut and patch miscellaneous elements or related components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety.

D. Visual Requirements: Do not cut and patch construction in a manner that results in visual evidence of cutting and patching. Do not cut and patch construction exposed on exterior or in occupied spaces in a manner that would, in Contracting Officer’s opinion, reduce the building's aesthetic qualities. Remove and replace construction that has been cut and patched in a visually unsatisfactory manner.

PART 2 PRODUCTS

2.1 MATERIALS

A. General: Comply with requirements specified in other sections.

B. In-Place Materials: Use materials identical to in-place materials. For exposed surfaces, use materials that visually match in-place adjacent surfaces to the fullest extent possible.

1. If identical materials are unavailable or cannot be used, use materials that will match the visual and functional performance of in-place materials when installed.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine surfaces to be cut and patched and conditions under which cutting and patching are to be performed.

1. Compatibility: Before patching, verify compatibility with and suitability of substrates, including compatibility with in-place finishes or primers.
2. Proceed with installation only after unsafe or unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Temporary Support: Provide temporary support of Work to be cut.

B. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.

C. Adjoining Areas: Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.

D. Existing Utility Services and Mechanical/Electrical Systems: Where existing services/systems are required to be removed, relocated, or abandoned, bypass such services/systems before cutting to minimize interruption to occupied areas.

3.3 PERFORMANCE

A. General: Employ skilled workers to perform cutting and patching. Proceed with cutting and patching at earliest feasible time. Complete without delay.

1. Cut in-place construction to provide for installation of other components or performance of other construction subsequently. Patch as required to restore surfaces to original condition.

B. Cutting: Cut in-place construction by sawing, drilling, breaking, chipping, grinding, and similar operations, including excavation, using methods least likely to damage elements retained or adjoining construction. If possible, review proposed procedures with original Installer and original Installer's written recommendations.

1. In general, use hand or small power tools designed for sawing and grinding, not hammering and chopping. Cut holes and slots as small as possible, neatly to size required, and with minimum disturbance of adjacent surfaces. Temporarily cover openings when not in use.
2. Finished Surfaces: Cut or drill from exposed or finished side into concealed surfaces.
3. Concrete and Masonry: Cut using an abrasive saw or a diamond-core drill.
4. Excavating and Backfilling: Comply with requirements in applicable Division 31 Sections where required by cutting and patching operations.
5. Mechanical and Electrical Services: Cut off pipe or conduit in walls or partitions to be removed. cap, valve, or plug and seal remaining portion of pipe or conduit to prevent entrance of moisture or other foreign matter after cutting.
6. Proceed with patching after construction operations cutting are complete.

C. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams as invisible as possible. Provide materials and comply with installation requirements specified in other sections.

1. Inspection: Where feasible, test and inspect patched areas after completion to demonstrate integrity of installation.
2. Exposed Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
3. Floors and Walls: Where walls or partitions that are removed extend one finished area into another. Patch and repair floor and wall surfaces in new space.

Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance.

4. Ceilings: Patch, repair, or re-hang in-place ceilings as necessary to provide an even-plane surface of uniform appearance.
5. Exterior Building Enclosure: Patch components in a manner that restores enclosure to a weather tight condition.

D. Cleaning: Clean areas and spaces where cutting and patching are performed. Remove paint, mortar, oils, putty, and similar materials.

END OF SECTION

SECTION 01 73 40
EXECUTION

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general procedural requirements governing execution of Work including:

1. Coordination with utility service providers.
2. Construction layout.
3. Field engineering and surveying.
4. General installation of products.
5. Progress cleaning.
6. Starting and adjusting.
7. Protection of installed construction.
8. Correction of the Work.

1.2 SUBMITTALS

A. Certificates: Submit certificate signed by professional land surveyor licensed in the State of New Mexico certifying location and elevation of as-built improvements comply with requirements.

B. Landfill Receipts: Submit copy of receipts issued by landfill facility, licensed to accept hazardous materials, for hazardous waste disposal.

C. Certified As-built Surveys: Submit two copies signed by land surveyor.

1.3 QUALITY ASSURANCE

A. Land Surveyor Qualifications: Professional land surveyor legally qualified to practice in New Mexico and is experienced in providing land-surveying services of kind indicated.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.1 EXAMINATION

A. Existing Conditions: Existence and location of site improvements and other construction indicated as existing are not guaranteed.

1. Before beginning work, investigate and verify the existence and location of mechanical and electrical systems and other construction affecting the Work.

2. Before construction, verify the location and points of connection of utility services.

B. Existing Utilities: Existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify existence and location of underground utilities and other construction affecting Work.

1. Before construction, verify location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping, natural gas, and underground electrical services.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project Site.

C. Acceptance of Conditions: Examine substrates, areas, and conditions, with Installer or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.

1. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
2. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
3. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
4. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

3.2 COORDINATION WITH UTILITY SERVICE PROVIDERS

A. Coordination with Utility Service Providers: Contact following Utility Service providers, sufficiently in advance to avoid delaying the work, to coordinate Contractor's portion of Work, testing requirements, and inspections.

1. Electrical:

a. Service Contact: Contact Los Alamos County (LAC) Department of Public Utilities, Mike Salazar, (505) 662-8035, Michael.salazar@lacnm.us and Los Alamos National Laboratories (LANL), Zachary Krehlik, zkrehlik@lanl.gov, to coordinate Electrical service requirements. LAC supplies electrical service to LANL, who owns and maintains the distribution system to which NPS connects.

1) Construction Contractor Responsibilities: Contractor is responsible for coordination of new connection to LANL, by notifying both LANL and LAC. As shown on the Drawings.

2. Water Service Contact:

   a. Contact LAC Clay Mosely, clay.moseley@lacnm.us or Philo Shelton, philo.shelton@lacnm.us, and LANL, Mark Trujillo, Trujillo_mark@lanl.gov, to coordinate Water service requirements. LAC supplies water service to LANL, who owns and maintains the distribution system to which NPS connects.

      1) Construction Contractor Responsibilities: Contractor is responsible for coordination of new connection to LANL, by notifying both LANL and LAC. As shown on the Drawings.

3. Wastewater Service Contact: Contact Contracting Officer to coordinate Wastewater service requirements.

   a. Construction Contractor Responsibilities: Contractor is responsible for coordination with Contracting Officer.

4. Natural Gas Service Contact: Contact LAC, Lucas Montoya, lucas.montoya@lacnm.us, (505) 662-8135, and LANL, Michael Gallegos, Michael_g@lanl.gov, to coordinate natural gas service requirements. LAC supplies natural gas service to LANL, who owns and maintains the distribution system to which NPS connects.

   a. Construction Contractor Responsibilities: Contractor is responsible for coordination with LANL and LAC. As shown on the Drawings.

3.3 PREPARATION

A. Field Measurements: Take field measurements as required to fit Work properly. Recheck measurements before installing each product. Where portions of Work are indicated fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying Work.

B. Space Requirements: Verify space requirements and dimensions of items shown diagrammatically on the Drawings.

C. Review of Contract Documents and Field Conditions: Immediately on discovery of need for clarification of the Contract Documents caused by differing field conditions outside control of Contractor, submit request for information to Contracting Officer in accordance with Section 01 31 00, Project Management and Coordination.

3.4 CONSTRUCTION LAYOUT

A. Verification: Verify layout information shown on the Drawings, in relation to the existing benchmarks before proceeding to lay out Work. Notify Contracting Officer promptly if discrepancies are discovered.

B. General: Engage a professional land surveyor to lay out Work using accepted surveying practices.

1. Establish benchmarks and control points to set lines of construction and elsewhere as needed to locate each element of Project.
2. Establish dimensions within tolerances indicated. Do not scale the Drawings to obtain required dimensions.
3. Inform installers of lines and levels to which they must comply.
4. Check location, level and plumb, of every major element as Work progresses.
5. Notify Contracting Officer when deviations from required lines and levels exceed allowable tolerances.

C. Site Improvements: Locate and lay out site improvements, including pavements, grading, fill and topsoil placement, utility slopes, and invert elevations.

D. Building Lines and Levels: Locate and lay out control lines and levels for structures, building foundations, column grids, and floor levels, including those required for mechanical and electrical work. Transfer survey markings and elevations for use with control lines and levels. Level foundations and piers from two or more locations.

E. Record Log: Maintain log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make log available for review by National Park Service (NPS).

3.5 FIELD ENGINEERING

A. Reference Points: Locate existing permanent benchmarks, control points, and similar reference points before beginning Work. Preserve and protect permanent benchmarks and control points during construction operations. Controls destroyed by Contractor will be replaced by Contractor at their expense.

1. Existing Monuments: All benchmarks, land corners, and triangulation points, established by other surveys, existing within construction area shall be preserved. If existing monuments interfere with Work, secure written permission before removing them.

B. Benchmarks: Establish and maintain a minimum of two permanent benchmarks on Project Site, referenced to data established by survey control points. Comply with NPS requirements for type and size of benchmark.

1. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.

C. Certified Survey: On completion of foundation walls, major site improvements, and other work requiring field-engineering services, prepare a certified survey showing dimensions, locations, angles, and elevations of construction and sitework.

3.6 INSTALLATION

A. General: Locate Work and components of Work accurately in correct alignment and elevation, as indicated.

1. Make vertical work plumb and make horizontal work level.
2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
3. Conceal pipes, ducts, and wiring in finished areas, unless otherwise indicated.

B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

C. Install products at the time and under conditions for best possible results. Maintain conditions required for product performance until Substantial Completion.

D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

E. Tools and Equipment: Do not use tools or equipment that produce harmful noise levels.

F. Templates: Obtain and distribute to parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm adequate provisions are made for locating and installing products to comply with indicated requirements.

G. Anchors and Fasteners: Provide anchors and fasteners as required to anchor each component securely in place, accurately located and aligned with other portions of Work.

1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by Contracting Officer.
2. Allow for building movement, thermal expansion, and contraction.

3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors to be embedded in concrete or masonry. Deliver to Project Site in time for installation.

H. Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for best visual effect. Fit exposed connections together to form hairline joints.

I. Hazardous Materials: Use products, cleaners, and installation materials not considered hazardous.

J. Quantity Surveys: Shall be conducted, and data derived from these surveys shall be used in computing quantities of work performed and actual construction completed and in place.

1. Contractor shall conduct original and final surveys and surveys for any periods for which progress payments are requested. These surveys shall be conducted under direction of a representative of the Contracting Officer, unless Contracting Officer waives requirement in a specific instance. Government shall make such computations as are necessary to determine quantities of work performed or finally in place. Contractor shall make computations based on surveys for any periods for which progress payments are requested.
2. Promptly upon completing a survey, Contractor shall furnish originals of field notes and other records relating to survey or layout of Work to Contracting Officer. Contractor shall retain copies of all such material furnished to Contracting Officer.

3.7 PROGRESS CLEANING

A. General: Clean Project Site, work areas, and common areas daily. Coordinate progress cleaning for joint-use areas where more than one Installer has worked. Enforce requirements strictly. Dispose of materials lawfully.

1. Comply with requirements in National Fire Protection Association (NFPA) 241 for removal of combustible waste materials and debris at the end of every work session.
2. Do not hold materials more than 7 days during normal weather or 3 days if the temperature is expected to rise above 80 degrees F (27 degrees C).
3. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.

B. Site: Maintain Project Site free of waste materials and debris.

C. Work Areas: Clean areas where work is in progress to level of cleanliness necessary for proper execution of Work.

1. Remove liquid spills promptly.
2. Where dust would impair proper execution of Work, broom-clean or vacuum entire work area, as appropriate.
3. Contractor shall provide progress cleaning that minimizes sources of food, water, and harborage available to pests.

D. Installed Work: Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials not hazardous to health or property and will not damage exposed surfaces.

1. Utilize non-toxic cleaning materials and methods.

a. Comply with Green Seal Standard (GS) 37 for general purpose cleaning and bathroom cleaning.
b. Use natural cleaning materials where feasible. Natural cleaning materials include:

1) Abrasive Cleaners: Substitute 1/2 lemon dipped in borax.
2) Ammonia: Substitute vinegar, salt and water mixture, or baking soda and water.
3) Disinfectants: Substitute 1/2 cup borax in gallon water.
4) Drain Cleaners: Substitute 1/4 cup baking soda and 1/4 cup vinegar in boiling water.
5) Upholstery Cleaners: Substitute dry cornstarch.

E. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

F. Exposed Surfaces in Finished Areas: Clean exposed surfaces and protect from damage and deterioration at time of Substantial Completion.

G. Waste Disposal: Do not bury or burn waste materials on-site. Do not wash waste materials down sewers or into waterways.

H. Clean and protect construction in progress and adjoining materials already in place during handling and installation. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.

I. Clean and provide maintenance on completed construction as frequently as necessary through remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.

J. Limiting Exposures: Supervise construction operations so that no part of construction completed or in progress, is subject to harmful, dangerous, damaging, or deleterious exposure during construction period.

K. Final Cleaning: At completion of Work, remove remaining waste materials, rubbish, tools, equipment, machinery, and surplus materials. Clean exposed surfaces and leave Project clean and ready for occupancy.

1. Provide final cleaning in accordance with ASTM E1971.

3.8 STARTING AND ADJUSTING

A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.

B. Adjust operating components for proper operation without binding. Adjust equipment for proper operation.

C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Manufacturer’s Field Service: If factory-authorized service representative is required to inspect field-assembled components and equipment installation, comply with qualification requirements in Section 01 40 00, Quality Requirements.

3.9 PROTECTION OF INSTALLED CONSTRUCTION

A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

B. Comply with manufacturer’s written instructions for temperature and relative humidity.

3.10 CORRECTION OF THE WORK

A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in Section 01 73 29, Cutting and Patching.

1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.

B. Restore permanent facilities used during construction to specified condition.

C. Remove and replace damaged surfaces exposed to view if surfaces cannot be repaired without visible evidence of repair.

D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.

E. Remove and replace chipped, scratched, and broken glass or reflective surfaces.

END OF SECTION

SECTION 01 74 19
CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for:

1. Salvaging nonhazardous demolition and construction waste.
2. Recycling nonhazardous demolition and construction waste.
3. Disposing of nonhazardous demolition and construction waste.

1.2 DEFINITIONS

A. Construction Waste: Building and site improvement materials and other solid waste resulting from construction, remodeling, renovation, or repair operations. Construction waste includes packaging.

B. Debris: Non-hazardous solid waste generated during construction, demolition, or renovation of a structure which exceeds 2.5-inch (60-millimeter) particle size that is: a manufactured object; plant or animal matter; or natural geologic material (e.g., cobbles and boulders). A mixture of debris and other material such as soil or sludge is also subject to regulation as debris if mixture is comprised primarily of debris by volume, based on visual inspection.

C. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

D. Disposal: Removal offsite of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

E. Environmental Pollution and Damage: Presence of chemical, physical, or biological elements or agents which adversely affect human health or welfare; unfavorably alter ecological balances; or degrade utility of environment for aesthetic, cultural, or historical purposes.

F. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

G. Hazardous Materials: Material regulated as a hazardous material in accordance with 49 CFR 173 (Code of Federal Regulations), requires a Material Safety Data Sheet (MSDS) in accordance with 29 CFR 1910.1200, or which during end use, treatment, handling, storage, transportation or disposal meets or has components which meet or

have potential to meet the definition of Hazardous Waste in accordance with 40 CFR 261.

H. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

I. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

J. Single-use Plastic Products: Plastic items intended to be disposed of immediately after use, including plastic and polystyrene food and beverage containers, bottles, straws, cups, cutlery, and disposable plastic bags.

K. Solid Waste: Garbage, debris, sludge, or other discharged material (except hazardous waste) including solid, liquid, semisolid, or contained gaseous materials resulting from domestic, industrial, commercial, mining, or agricultural operations.

1.3 PERFORMANCE REQUIREMENTS

A. General: Project shall minimize creation of construction, deconstruction, and demolition waste to protect and restore natural habitat and resources. Minimize factors contributing to waste such as over packaging, improper storage, ordering error, poor planning, breakage, mishandling, single-use plastic products, and contamination. A Waste Management Plan shall be developed to ensure that existing site and building materials are reused, salvaged, or recycled. Minimize waste disposal in landfills.

B. Salvage /Recycle Requirements:

1. Develop waste management plan resulting in end-of-Project rates for salvage/recycling of 50 percent by weight of total waste generated by the Work. The following waste categories, at a minimum, shall be diverted from a landfill:

   a. Land clearing debris (chipped debris can be used onsite for mulch or erosion control).
   b. Clean dimensional wood, palettes.
   c. Plywood, OSB (oriented strand board), and particle board.
   d. Concrete, deliver to an offsite recycler).
   e. Asphaltic concrete (can be ground and used onsite, or delivered to an offsite recycler).
   f. Cardboard, paper, packaging, newsprint.
   g. Metals (from banding, stud trim, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze).
   h. Gypsum Drywall: Unpainted.
   i. Non-hazardous paint and paint cans.
   j. Beverage Containers: Aluminum, glass, and plastic containers.

k. Insulation.
l. Ceiling grid and tiles.
m. Ductwork.
n. Wiring.
o. Other mixed construction and demolition waste as appropriate.

C. If waste materials encountered during deconstruction/demolition or construction phase are found to contain lead, asbestos, polychlorinated biphenyls (PCBs), (such as fluorescent lamp ballasts), or other harmful substances, they are to be handled and removed in accordance with local, state, and federal laws and requirements concerning hazardous waste.

D. Existing items and material to be removed during deconstruction/demolition phase shall be reused in construction phase of the Project. Items that cannot be reused shall be recycled. Items considered for reuse must be in refurbishable condition and must meet quality standards set forth in these specifications. Contractor shall ensure quality of the item(s) in question will meet or exceed accepted industry or trade standards for first quality commercial grade application. During construction, deconstruction, or demolition Contracting Officer (CO) may designate other objects or materials for reuse.

E. Salvage/Recycle Requirements: Government goal is to salvage and recycle as much nonhazardous demolition and construction waste as possible.

1.4 SUBMITTALS

A. Waste Management Plan: After award of contract and prior to scheduled Pre-Construction Conference, Contractor shall submit a draft Waste Management Plan to Contracting Officer for approval. Submit three copies of plan. Revise and resubmit Plan as required by Contracting Officer. Approval of Contractor's Plan will not relieve Contractor of responsibility for compliance with applicable environmental regulations.

B. Progress Documentation: Supplemental to Waste Management Plan, document solid waste disposal, diversion, and cost/revenue analysis and submit completed worksheet on a monthly basis. See Project Waste Management Plan Worksheet Sample, attached to the end of the Division 01 Specifications, and report totals to date for column headings.

C. Waste Reduction Calculations: Before request for Substantial Completion, submit three copies of calculated end-of-Project rates for salvage, recycling, and disposal as a percentage of total waste generated by the Work.

D. Records of Donations: Indicate receipt and acceptance of salvageable waste donated to individuals and organizations. Indicate whether organization is tax exempt.

E. Records of Sales: Indicate receipt and acceptance of salvageable waste sold to individuals and organizations. Indicate whether organization is tax exempt.

F. Recycling and Processing Facility Records: Indicate receipt and acceptance of recyclable waste by recycling and processing facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

G. Landfill and Incinerator Disposal Records: Indicate receipt and acceptance of waste by landfills and incinerator facilities licensed to accept them. Include manifests, weight tickets, receipts, and invoices.

H. Qualification Data: For Waste Management Coordinator and refrigerant recovery technician.

I. Statement of Refrigerant Recovery: Signed by refrigerant recovery technician responsible for recovering refrigerant, stating refrigerant that was present was recovered and recovery was performed according to Environmental Protection Agency (EPA) regulations. Include name and address of technician and date refrigerant was recovered.

J. Progress Payment Requirements:

1. With each Application for payment, submit an updated Project Waste Management Plan worksheet for solid waste disposal and diversion.
2. With each Application for Payment, submit manifests, weight tickets, receipts, and invoices specifically identifying the Project and waste material.

K. Closeout Submittals: With Closeout Submittals, submit a summary of a Project Waste Management Plan worksheet for solid waste disposal and diversion.

1.5 QUALITY ASSURANCE

A. Waste Management Coordinator Qualifications: Experienced firm, with record of successful waste management coordination of projects with similar requirements.

B. Refrigerant Recovery Technician Qualifications: Certified by EPA-approved certification program.

C. Regulatory Requirements: Comply with hauling and disposal regulations of authorities having jurisdiction.

D. Waste Management Meeting:

1. Conduct separate meeting or cover in Pre-Construction Conference and comply with requirements in Section 01 31 00, Project Management and Coordination. Review methods and procedures related to waste management including:

   a. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
   b. Review requirements for documenting quantities of each type of waste and its disposition.
   c. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
   d. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
   e. Review procedures for reduction of single-use plastic products on site.
   f. Review waste management requirements for each trade.

PART 2 PRODUCTS

2.1 WASTE MANAGEMENT PLAN

A. General: Develop plan consisting of waste identification and waste reduction work plan. Include separate sections in plan for demolition and construction waste. Indicate quantities by weight or volume but use same units of measure throughout waste management plan.

B. Waste Identification: Indicate anticipated types and quantities of demolition, and construction waste generated by the Work. Include estimated quantities and assumptions for estimates.

C. Waste Reduction Work Plan: List each type of waste and whether it will be salvaged, recycled, or disposed of in landfill or incinerator. Include points of waste generation, total quantity of each type of waste, quantity for each means of recovery, and handling and transportation procedures.

   1. Salvaged Materials for Reuse: For materials salvaged and reused in Project, describe methods for preparing salvaged materials before incorporation into the Work.
   2. Salvaged Materials for Sale: For materials sold to individuals and organizations, include list of names, addresses, and telephone numbers.
   3. Salvaged Materials for Donation: For materials donated to individuals and organizations, include list of names, addresses, and telephone numbers.
   4. Recycled Materials: Include list of local receivers and processors and type of recycled materials each will accept. Include names, addresses, and telephone numbers.

5. Disposed Materials: Indicate how and where materials will be disposed of. Include name, address, and telephone number of each landfill and incinerator facility.
6. Handling and Transportation Procedures: Include method used for separating recyclable waste including sizes of containers, container labeling, and designated location on Project Site where materials separation will be located.
7. Reduction of Single-Use Plastic Products: Include methods for water distribution to include bottle refilling stations if available for personnel.

D. Cost/Revenue Analysis:

1. Indicate total cost of waste disposal as if there was no waste management plan and net additional cost or net savings resulting from implementing waste management plan. Include:

a. Landfill tip fees per ton.
b. If diverted, tip fee savings from landfill diversion.
c. Costs of recycling, salvage, or reuse.
d. Revenue from recycling, salvage, or reuse.
e. Total cost or savings from diversion. (Calculate by using tip fee savings and subtracting costs of recycling or adding revenue from recycling.)

PART 3 EXECUTION

3.1 PLAN IMPLEMENTATION

A. General: Implement waste management plan as approved by Contracting Officer. Provide handling, containers, storage, signage, transportation, and other items as required to implement waste management plan during entire duration of Contract.

B. Waste Management Coordinator: Engage waste management coordinator responsible for implementing, monitoring, and reporting status of waste management work plan. Coordinator shall be present at Project Site full time for duration of Project.

C. Contractor shall establish contacts with local recycling and reuse companies to set up lines of responsibility. Contractor shall be responsible for coordination in terms of identifying materials, pickup schedules, and standard quality for recycled materials.

D. Training: Train workers, subcontractors, and suppliers on proper waste management procedures, as appropriate for the Work occurring at Project Site.

1. Distribute waste management plan to everyone concerned within 3 days of submittal return.
2. Distribute waste management plan to entities when they begin work onsite. Review plan procedures and locations established for salvage, recycling, and disposal.

E. Site Access and Temporary Controls: Conduct waste management operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.

F. Separation Facilities:

1. Contractor shall designate and Contracting Officer shall approve specific area or areas to facilitate separation of materials for potential reuse, salvage, recycling, and return.
2. Place waste and recycling bins near each other, and close to point of waste generation but out of traffic pattern.
3. Keep recycling and waste bin areas neat, clean, and clearly marked in order to avoid co-mingling of materials.
4. Protect bins during non-working hours from offsite contamination.
5. Check garbage dumpsters periodically for recyclables being thrown away and undocumented materials that could be recycled.

G. Materials Handling Procedures: Material to be recycled shall be protected from contamination and shall be handled, stored, and transported in a manner that meets requirements set by designated facilities for acceptance. Establish defined area for operations of each trade, especially woodcutting so off-cuts are kept in one area and can be sorted by dimension for future reuse.

3.2 SALVAGING DEMOLITION WASTE

A. Salvaged Items for Reuse in the Work:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in secure area until installation.
4. Protect items from damage during transport and storage.
5. Install salvaged items to comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make items functional for use indicated.

B. Salvaged Items for Sale and Donation: Not permitted on Project Site.

C. Salvaged Items for Governments Use:

1. Clean salvaged items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Allow for inspection if necessary.
4. Store items in secure area until delivery to Government.
5. Transport items to storage area onsite designated by the Contracting Officer.
6. Protect items from damage during transport and storage.

3.3 RECYCLING DEMOLITION AND CONSTRUCTION WASTE, GENERAL

A. General: Recycle paper and beverage containers used by onsite workers.

B. Recycling Receivers and Processors:

1. List below is provided for information only; available recycling receivers and processors include:

a. Los Alamos County Eco Station.

C. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

D. Procedures: Separate recyclable waste from other waste materials, trash, and debris. Separate recyclable waste by type at Project Site to maximum extent practical.

1. Provide appropriately marked containers or bins for controlling recyclable waste until removed from Project Site. Include list of acceptable and unacceptable materials at each container and bin.

a. Inspect containers and bins for contamination and remove contaminated materials if found.

2. Stockpile processed materials onsite without intermixing with other materials. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
3. Stockpile materials away from construction area. Do not store within drip line of remaining trees.
4. Store components off ground and protect from weather.
5. Remove recyclable waste off Government property and transport to recycling receiver or processor.

3.4 RECYCLING DEMOLITION WASTE

A. Asphaltic Concrete Paving: Break up and transport paving to asphalt-recycling facility, or reuse onsite.

1. If reused onsite, crush and screen to comply with requirements in Section 32 12 16, Asphalt Paving.

B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum 4-inch (100-millimeter) size.

C. Masonry: Remove metal reinforcement, anchors, and ties from masonry and sort with other metals.

1. Clean and stack undamaged, whole masonry units on wood pallets.

D. Wood Materials: Sort and stack members according to size, type, and length. Separate lumber, engineered wood products, panel products, and treated wood materials.

E. Metals: Separate metals by type.

1. Structural Steel: Stack members according to size, type of member, and length.
2. Remove and dispose of bolts, nuts, washers, and other rough hardware.

F. Asphalt Shingle Roofing: Separate organic and glass-fiber asphalt shingles and felts. Remove and dispose of nails, staples, and accessories.

G. Gypsum Board: Stack large clean pieces on wood pallets and store in a dry location. Remove edge trim and sort with other metals. Remove and dispose of fasteners.

H. Acoustical Ceiling Panels and Tile: Stack large clean pieces on wood pallets and store in dry location.

1. Separate suspension system, trim, and other metals from panels and tile and sort with other metals.

I. Carpet and Pad: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet and pad in closed container or trailer provided by Carpet Reclamation Agency or carpet recycler.

J. Equipment: Drain tanks, piping, and fixtures. Seal openings with caps or plugs. Protect equipment from exposure to weather.

K. Plumbing Fixtures: Separate by type and size.

L. Piping: Reduce piping to straight lengths and store by type and size. Separate supports, hangers, valves, sprinklers, and other components by type and size.

M. Lighting Fixtures: Separate lamps by type and protect from breakage.

N. Electrical Devices: Separate switches, receptacles, switchgear, transformers, meters, panelboards, circuit breakers, and other devices by type.

O. Conduit: Reduce conduit to straight lengths and store by type and size.

P. Electronic Products: Ensure non-usable electronic products are reused, donated, sold, or recycled using environmentally sound management practices at end of life.

3.5 RECYCLING CONSTRUCTION WASTE

A. Packaging:

1. Cardboard and Boxes: Break down packaging into flat sheets. Bundle and store in dry location.
2. Polystyrene Packaging: Separate and bag materials.
3. Pallets: As much as possible, require deliveries using pallets to remove pallets from Project Site. For pallets that remain onsite, break down pallets into component wood pieces and comply with requirements for recycling wood.
4. Crates: Break down crates into component wood pieces and comply with requirements for recycling wood.

B. Site-Clearing Wastes: Chip brush, branches, and trees at landfill facility.

C. Wood Materials:

1. Clean Cut-Offs of Lumber: Grind or chip into small pieces.
2. Clean Sawdust: Bag sawdust not containing painted or treated wood.

D. Gypsum Board: Stack large clean pieces on wood pallets and store in dry location.

1. Clean Gypsum Board: Grind scraps of clean gypsum board using small mobile chipper or hammer mill. Screen out paper after grinding.

3.6 DISPOSAL OF WASTE

A. General: Except for items or materials to be salvaged, recycled, or otherwise reused, remove waste materials from Project Site and legally dispose in landfill or incinerator acceptable to authorities having jurisdiction.

1. Except as otherwise specified, do not allow waste materials to accumulate onsite.
2. Remove and transport debris in manner preventing spillage on adjacent surfaces and areas.

B. Burning: Burning of waste materials is prohibited.

C. Disposal: Transport waste materials off Government property and legally dispose of them.

3.7 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Project Waste Management Plan Worksheet Sample.

END OF SECTION

Project Waste Management Plan Worksheet Sample

National Park Service (NPS) - Denver Service Center (DSC) | 10-13-21

	A	B	C	D	E	F	G	H	I	J
Material	**Quantity Recycled (in tons)**	**Quantity Salvaged or Reused (in tons)**	**A + B = Total Quantity Diverted from Landfill**	**Quantity to Landfill (in tons)**	**C + D = Total Quantity Generated (in tons)**	**Tip Fee/Ton at Landfill**	**C x F = Tip Fee Savings resulting from Landfill Diversion**	**Cost of Recycling (R), Salvage (S), or Reuse (Re)** (Specify R, S, or Re)	**Revenue from Recycling (R), Salvage (S), or Reuse (Re)** (Specify R, S, or Re)	**G - H + I = Total Cost (-) or Savings (+) from Diversion**
Asphalt/Concrete										
Brick/Masonry/Tile										
Building Materials (doors, windows, fixtures, shingles, lumber, insulation, sheet goods, etc.)										
Carpet										
Carpet Padding, Foam Only										
Cardboard										
Ceiling Tile										
Drywall										
Glass										
Scrap Metal Aluminum										
Copper										
Steel										
Unpainted Wood & Pallets										
Yard Trimmings, Brush, Trees, Stumps, etc.										
Garbage/Trash										
Other										
Column Totals										
	Total Quantity Recycled	Total Quantity Reused or Salvaged	Total Quantity Diverted from Landfill	Total Quantity to Landfill	Total Quantity Generated		Tip Fee Savings from Diversion	Total Cost of Recycling, Salvage, or Reuse	Revenue from Recycling, Salvage, or Reuse	Total Cost (-) or Savings (+) from Diversion

Percentage Diverted = _____ (C divided by E from Column Totals). Should meet 60% diversion goal.

SECTION 01 77 00
CLOSEOUT PROCEDURES

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for contract closeout, including:

1. Project Record Drawings.
2. Closeout Submittals.
3. Substantial Completion and Final Inspection.
4. Permit Closure and Transfer.
5. Final Acceptance of the Work.
6. Warranties.
7. Final Cleaning.

1.2 PROJECT RECORD DRAWINGS

A. Maintain one complete full-size set of the Drawings and one full-size set of vendor-supplied drawings. Clearly mark changes, deletions, and additions using National Park Service (NPS) drafting standards to show actual construction conditions. Show additions in red, deletions in green and special instructions in blue.

B. Keep Record Drawings current. Make Record Drawings available to Contracting Officer for inspection at the time of monthly progress payment requests. If Project Record Drawings are not current, Contracting Officer may retain an appropriate amount of progress payment.

C. Submit complete Record Drawings on completion of total project. Include:

1. Shop Drawings.
2. Sketches.
3. Segments of abandoned and demolished utilities.
4. Canyon mechanical building and Entrance Road Water Tank.
5. Additional drawings to be included in final set, with clear instructions showing the location of these drawings.

D. Maintain a copy of the Record Drawings in digital format and submit to the Contracting Officer. Canyon mechanical building and Entrance Road Water Tank, new utilities plus abandoned and demolished utilities, must be provided in GIS format.

1.3 CLOSEOUT SUBMITTALS

A. A list of closeout requirements has been attached at the end of the Division 01 Specifications for your convenience. The intent is to provide an overall summary of requirements and not a comprehensive list. Terms and conditions of the contract require satisfaction of requirements of individual specification sections regardless of what is shown on the list. Submit the following before requesting final inspection:

1. Specific warranties, guarantees, workmanship bonds, final certifications, and similar documents.
2. Project Record Documents, Record Drawings, operation and maintenance manuals, final completion construction digital images.

    a. Recorded on CD-R (compact disc-recordable) or DVD-R (digital video disc-recordable) with index and descriptions, and similar final record information.
    b. Or uploaded to NPS construction document management system.

3. Environmental Record Documents:

    a. As specified in Division 01, General Requirements, and as follows:

        1) Material Safety Data Sheet (MSDS) Data: As specified in Section 01 67 00, Product Requirements.
        2) Final Summary of Solid Waste Disposal and Diversion: As specified in Section 01 74 19, Construction Waste Management and Disposal.
        3) Commissioning Report: As specified in Section 01 91 14, Total System Commissioning.

4. Posted Operating Instructions: As specified in individual sections. Furnish operating instructions attached to or posted adjacent to equipment. Include wiring diagrams, control diagrams, control sequence, start-up, adjustment, operation, lubrication, shut-down, safety precautions, procedures in the event of equipment failure, and other items of instruction recommended by manufacturer.
5. Deliver tools, spare parts, extra materials, and similar items to location designated by Contracting Officer. Label with manufacturer's name and model number where applicable.

    a. Special Tools: One set of special tools required to operate, adjust, dismantle, or repair equipment. Special tools are those not normally found in possession of mechanics or maintenance personnel.

6. Keys and Keying Schedule: Submit keys including duplicates. Wire keys for each lock securely together. Tag and plainly mark with lock number, equipment

identification, or panel or switch number, and indicate location, building, and room name or number.

7. Make final changeover of permanent locks and deliver keys to Contracting Officer. Advise Park personnel of changeover in security provisions.
8. Approved pre-functional checklists and functional performance testing reports from commissioning documentation.

    a. Equipment start-up requires coordination with commissioning process. Refer to Section 01 91 14, Total System Commissioning. Equipment shall not be “temporarily” started for commissioning.

9. Test and balance report.
10. Terminate and remove temporary facilities, mockups, construction tools, and similar elements from Project Site, complete final cleaning requirements, including touchup painting.
11. Touch up and repair and restore marred exposed finishes to eliminate visual defects.
12. Instruct NPS personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training videos.

1.4 FINAL INSPECTION, SUBSTANTIAL COMPLETION AND ACCEPTANCE PROCEDURES

A. Request final inspection in writing when Project or designated portion of Project is substantially complete. Contracting Officer will proceed with inspection within 10 days of receipt of written request or will advise Contractor of items that prevent Project from being substantially complete.

B. If work is determined substantially complete, following final inspection, Contracting Officer will prepare Punch List and issue a Letter of Substantial Completion.

C. If work is not determined substantially complete following final inspection, Contracting Officer will notify Contractor in writing. Contractor shall request new final inspection after completing work. Re-inspection costs may be charged against Contractor in accordance with Inspection of Construction contract clause.

D. Contractor shall complete Punch List within 30 calendar days, documented weather permitting.

    1. Prior to requesting final inspection: Complete commissioning requirements of Section 01 91 14, Total Building Commissioning, unless approved in writing by Contracting Officer.

E. If Contractor completes items of work on Punch List and contractually required items, Contracting Officer will issue Letter of final acceptance of work.

F. If Contractor fails to complete work within the time frame, Contracting Officer may correct work with an appropriate reduction in contract price or charge for re-inspection costs in accordance with Inspection of Construction contract clause.

1.5 PERMIT CLOSURE AND TRANSFER

A. When work covered by the permits is complete, create list of tasks required to close or transfer permits to Park. Submit to Contracting Officer for approval.

B. After substantial completion and Punch List completion, permits shall be closed and documented by Agency(ies) with Jurisdiction for the permit.

C. If responsibility for permits is to be transferred to Park, Park shall be informed of permit provisions completed and responsibilities transferring to Park staff.

1.6 WARRANTIES

A. Submittal Time: Submit written warranties on request of Contracting Officer for designated portions of Work where commencement of warranties other than date of Substantial Completion is indicated.

B. Organize warranty documents into an orderly sequence based on table of contents of Project Manual.

1. Bind warranties and bonds in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2 by 11-inch (215 by 280-millimeters) paper.
2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify product or installation. Provide typed description of product or installation, including name of product and name, address, and telephone number of Installer.
3. Identify each binder on front and spine with typed or printed title “WARRANTIES,” Project name, and name of Contractor.
4. Warranty Electronic File: Scan warranties and bonds and assemble complete warranty and bond submittal package into a single indexed electronic PDF (portable document format) file with links enabling navigation to each item. Provide bookmarked table of contents at beginning of document.

C. Provide additional copies of each warranty in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 MATERIALS

A. See Division 01, General Requirements, Section 01 73 40, Execution, for information on cleaning agents.

PART 3 EXECUTION

3.1 FINAL CLEANING

A. General: Conduct final cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.

B. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.

1. Complete following cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project:

   a. Clean Project Site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
   b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
   c. Rake grounds that are neither planted nor paved to smooth, even-textured surface.
   d. Remove tools, construction equipment, machinery, and surplus material from Project Site.
   e. Remove snow and ice to provide safe access to building.
   f. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of stains, films, and foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to original condition.
   g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
   h. Sweep concrete floors broom clean in unoccupied spaces.
   i. Vacuum carpet and similar soft surfaces, removing debris and excess nap; shampoo, soil or stains remain.
   j. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and vision-obscuring materials. Replace chipped or broken glass and transparent materials. Polish mirrors and glass.
   k. Remove labels that are not permanent.

l. Touch up, repair, and restore marred, exposed finishes and surfaces. Replace finishes and surfaces that cannot be satisfactorily repaired or restored or that already show evidence of repair or restoration.

1) Do not paint over UL and similar labels, including mechanical and electrical nameplates.

m. Wipe surfaces of mechanical and electrical equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.

n. Replace parts subject to unusual operating conditions.

o. Clean plumbing fixtures to sanitary condition, free of stains, including stains resulting from water exposure.

p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.

q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency. Replace burned-out and noticeably dimmed bulbs, and defective or noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

r. Leave Project clean and ready for occupancy.

C. Pest Control: Engage experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Provide Government with report.

D. Waste Disposal: Comply with requirements of Section 01 74 19, Construction Waste Management and Disposal.

3.2 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Closeout and Operation & Maintenance (O&M) Requirements.

END OF SECTION

Closeout and Operation & Maintenance (O&M) Requirements **BAND 266697**

National Park Service (NPS) - Denver Service Center (DSC) | 1-27-21

Topic	Specification Section	Requirement	Submittal Date	Completed	Received by Park
Project Record Drawings	01 77 00	Complete Record Drawings			
	01 77 00	Project Record Documents, Record Drawings, operation and maintenance manuals, final completion construction digital images recorded on CD-R (compact disc-recordable) or DVD-R (digital video disc-recordable) with index and descriptions, and similar final record information			
	33 05 23.13	Record drawing plan and profile showing as constructed position of pipeline			
System Demonstration and Training	01 35 23	Provide training to personnel to ensure prompt and efficient first aid			
	01 35 23	Train and instruct each employee exposed to hazardous material in safe and approved methods of handling and storage			
	01 91 14	Total building commissioning plan training			
	23 81 00	Training for specified equipment			
	26 23 13	Prestart up Training			
	26 23 13	Facility Startup Training			
	26 23 13	Post Start-up Training			
	33 13 00	Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training			
	40 90 00	Training on operation of I&C components			
	40 90 00	Training for routine maintenance of PIC. Training to be provided for each type of component and function provided.			
Tools Spare Parts Equipment	01 77 00	Deliver tools, spare parts, extra materials, and similar items to location designated by Contracting Officer. Label with manufacturer's name and model number where applicable			
	01 77 00	One set of special tools required to operate, adjust, dismantle, or repair equipment			
	08 71 00	Special Tools: Two sets for installation and maintenance of hardware			
	26 05 04	Fuses, 0 Volt to 600 Volts: Six of each type and each current rating installed			
	26 23 13.16	One complete set of air cleaner filter element			
	26 23 13.16	One complete set of auxiliary jacket water pump packing/seals			
	26 23 13.16	Two complete sets of cooling fan drive belt (if applicable)			
	26 23 13.16	One hydrometer			
	26 23 13.16	One two-pronged battery voltmeter			
	26 23 13.16	One complete set spare fuses, if used in control panel			
	26 23 13.16	Four each type used of spare indicating lamps (if applicable)			
	26 23 13.16	One quart each color touch up paint			
	26 23 13.16	One complete set special tools required to maintain or dismantle engine generator set			
	31 46 00	Maintain sufficient quantities of spare gauge savers, pressure gauges, stop valves, and other wear parts onsite			
	40 90 00	No less than two DC power supplies			
	40 90 00	No less than five fuses			
	40 90 00	No less than three relays			
	40 90 00	No less than ten terminal blocks			
	40 90 00	No less than two 120V ac Isolation Transformers			
	40 90 00	No less than two surge suppressors			
	40 95 80	Furnish, tag, and box for shipment and storage the 25 percent spare parts			
	40 95 80	100 percent spare conduit capacity required for buried conduit only			
Extra Stock	23 81 00	One complete set of filters per unit.			
	26 12 02	One quart of paint to match color and quality of equipment final shop finish			
	26 24 16	One half-pint container of touch-up paint for panelboards			

Topic	Specification Section	Requirement	Submittal Date	Completed	Received by Park
Reports	01 32 16	Critical Path Method Reports			
	01 32 16	Concurrent Schedule Revisions Reports			
	01 35 23	Accident/Property Damage Report			
	01 40 00	Test Reports			
	01 40 00	Accessibility Inspection Reports			
	01 10 00	Offsite Inspection Report			
	01 57 19.11	Inspection and Test Reports			
	01 67 00	Affirmative Procurement Reporting Form			
	01 91 14	Commissioning Report			
	01 91 14	Test and Inspection Reports			
	01 91 14	Testing, Adjusting and Balancing Report			
	01 91 14	Deficiency Report and Resolution Record			
	02 82 00	Asbestos Disposal Quality Report			
	26 05 70	Arc Flash Study Report			
	26 23 13.16	Field Test Report			
	26 50 00	IESNA LM-80 Test Reports			
	40 90 00	Loop Status Report			
	40 95 80	Test Reports			
Keys & Keying Schedule	01 50 00	Maintain security by limiting number of keys and restricting distribution to authorized personnel. Provide Contracting Officer with one set of keys			
	01 77 00	Submit keys including duplicates. Wire keys for each lock securely together. Tag and plainly mark with lock number, equipment identification, or panel or switch number, and indicate location, building, and room name or number			
	08 71 00	Two per lock; tag with schedule information			
	08 71 00	Master Keys: Four; send by registered mail to Contracting Officer			
	08 71 00	Change Keys: Pack in separately identified envelopes and ship			
	08 71 00	Construction Keys: Pack in cartons marked “packing list” and ship			
	08 71 00	Construction Insert Extractor Keys, Master Keys, and Grand Master Keys: Ship by registered mail to Contracting Officer			
	08 71 00	On completion of job, deliver construction keys to Contracting Officer			
O&M Data	01 26 01	Performance and Payment Bonds			
Warranties	01 77 00	Specific warranties, guarantees, workmanship bonds, final certifications, and similar documents			
	05 50 00	Special guarantee shall provide for correction, or at option of Owner, removal and replacement of sidewalk doors found defective during a period of 5 years after date of Substantial Completion			
Guarantees	08 16 13	Special guarantee shall provide for correction, or at option of Owner, removal and replacement of Work specified in this specification section found defective during a period of 10 years after date of Substantial Completion			
	10 44 00	Submit test, refill or recharge schedules and recertification requirements.			
	13 34 20	Structural Warranty: 20 years; Finish & Watertightness Warranty: 5 years			
	26 23 13.16	Special guarantee shall provide for correction of the work found defective during a period of 2 years after the date of Substantial Completion			
	26 50 00	Warranty: 5 years minimum			
	40 91 00	For Titanium Sensors Only: 5-year corrosion warranty, replace sensor if it fails due to corrosion			

SECTION 01 78 23
OPERATION AND MAINTENANCE DATA

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including:

1. Manuals, general.
2. Emergency manuals.
3. Operation manuals for systems, subsystems, and equipment.
4. Maintenance manuals for care and maintenance of systems and equipment.

B. See Division 02 through Division 49 Sections for additional operation and maintenance manual requirements for Work in those Sections.

1.2 SUBMITTALS

A. Manual: Submit two copies of each manual in draft form or one electronic copy at least 15 days before final inspection. Contracting Officer (CO) will return copy or edit version with comments within 15 days of receipt.

B. Format:

1. Submit operations and maintenance manuals in following format:

   a. PDF (portable document format) electronic file. Assemble each manual into composite electronically indexed file. Submit on digital media acceptable to Contracting Officer.

      1) Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
      2) Enable inserted reviewer comments on draft submittals.

2. Hard Copy Manual: In accordance with Part 2 of this section.
3. Correct or modify each manual to comply with Contracting Officers comments. Submit four copies of each corrected manual within 15 days of receipt of Contracting Officers comments.

1.3 QUALITY ASSURANCE

A. Coordinate with Section 01 91 14, Total System Commissioning. Commissioning Agent shall review Operation and Maintenance Manuals for commissioned systems.

PART 2 PRODUCTS

2.1 MANUALS, GENERAL

A. Organization: Unless otherwise indicated, organize manual into separate sections for each system and subsystem, and separate sections for each piece of equipment not part of a system. Manual shall contain title page, table of contents, and manual contents.

B. Title Page:

1. Enclose title page in transparent plastic sleeve. Include:

a. Project Title.
b. Location.
c. Park.
d. Contract Number.
e. Prime Contractors Name and Address.
f. Date of Substantial Completion.
g. Binder Volume Number.

C. Table of Contents: List each product included in manual, identified by product name, indexed to content of the volume, and cross-referenced to specification section number in Project Manual.

D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. Assemble instructions for subsystems, equipment, and components of one system into a single binder if needed.

1. Binders: White, commercial quality, hard back, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2 by 11-inch (215 by 280-millimeter) paper; with clear plastic window sleeve on front and spine to hold label describing contents and pockets inside covers to hold folded oversize sheets.

a. Cover Sheet: Identify binders on front and spine, with Project title, location, park, contract number, prime contractor's name and address, date of substantial completion, and binder volume number. Insert cover sheet into clear plastic view pocket on front of binder. Insert sheet into clear plastic view pocket on spine with title "OPERATION AND MAINTENANCE MANUAL," Project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.

2. Data: Fill binders to no more than 75 percent of capacity. Punch holes shall not obscure any data. When contents of a single tabbed section cover more than one item, provide colored paper sheets to separate the data for each item.

    a. Manufacturers' Data: Provide originals for color or copyrighted data. Black and white data may be originals or clean, good quality reproductions. No copies produced by facsimile transmission and sheets with stamps, such as submittal approval stamps. Include only sheets that apply to items installed; cross out inapplicable data.
    b. Vendor Furnished As-Built Drawings: Maximum 24-inch by 36-inch sheets with minimum character or lettering size of 1/8 inch. Reduced-size reproductions may be provided instead of full-size drawings if reproductions are clear and legible. If reduced-size drawings are used, identify as "REDUCED SIZE" and provide graphic scales, if applicable.
    c. Custom Data: Data supplemented by drawings and schematics necessary to describe systems adequately.
    d. Equipment Data Sheet: Data, using form at end of this section.
    e. Schedules: Schedules reflecting final, as-installed conditions.
    f. Poorly reproduced or illegible data will be rejected.

3. Dividers: Divider sheets with Mylar reinforced edges and pre-printed numbered tabs aligned with numbers and title lines on index sheet. Include typed list of products and major components of equipment included in section on each divider, cross-referenced to specification section number and title of Project Manual.
4. Protective Plastic Sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

    a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    b. If Drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

2.2 EMERGENCY MANUALS

A. Content: Organize manual into separate section for type of emergency, emergency instructions, and emergency procedures.

B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component for fire, flood, gas leak, water leak, power failure, water outage, equipment failure, and chemical release or spill.

C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of National Park Service (NPS) operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.

D. Emergency Procedures: Include instructions on stopping, shutdown instructions for each type of emergency, operating instructions for conditions outside normal operating limits, and required sequences for electric or electronic systems.

2.3 OPERATION AND MAINTENANCE MANUALS

A. Operation Requirements:

1. Content: In addition to requirements in section, include operation data required in individual specification sections and equipment descriptions, operating standards, operating procedures, operating logs, wiring and control diagrams, and license requirements.
2. Descriptions:

a. Include:

1) Product name and model number.
2) Manufacturer's name.
3) Equipment identification with serial number of each component.
4) Equipment function.
5) Operating characteristics.
6) Limiting conditions.
7) Performance curves.
8) Engineering data and tests.
9) Complete nomenclature and number of replacement parts.

3. Operating Procedures: Include start-up, break-in, and control procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; and required sequences for electric or electronic systems.
4. Systems and Equipment Controls: Describe sequence of operation, and diagram controls as installed.
5. Piped Systems: Diagram piping as installed and identify color-coding where required for identification.

B. Maintenance Requirements for Systems and Equipment:

1. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, and equipment data sheets as described below.

2. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual.
3. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including maintenance instructions, drawings and diagrams for maintenance, nomenclature of parts and components, and recommended spare parts for each component part or piece of equipment.
4. Maintenance Procedures: Test and inspection instructions, troubleshooting guide, disassembly instructions, and adjusting instructions, and demonstration and training videotape if available, detailing essential maintenance and environmental procedures.
5. Maintenance and Service Schedules: Service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
6. Spare Parts List and Source Information: Lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.
7. Warranties and Bonds: Copies of warranties and bonds and lists of circumstances and conditions that affect validity of warranties or bonds.

2.4 PRODUCT MAINTENANCE MANUAL

A. Content: Organize manual into separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.

B. Source Information: List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual.

C. Product Information:

1. Include:

a. Product name and model number.
b. Manufacturer's name.
c. Color, pattern, and texture.
d. Material and chemical composition.
e. Reordering information for specially manufactured products.

D. Environmental Requirements:

1. Identify environmentally preferable products incorporated into Project. Include: product model; manufacturer's name, address, phone, and website; and local technical representative.

   a. Verify plastic products to be incorporated into Project are labeled in accordance with ASTM D1972. Where products are not labeled, provide product data indicating polymeric information in Operation and Maintenance Manual.

      1) Type 1: Polyethylene Terephthalate (PET, PETE).
      2) Type 2: High Density Polyethylene (HDPE).
      3) Type 3: Vinyl (Polyvinyl Chloride or PVC).
      4) Type 4: Low Density Polyethylene (LDPE).
      5) Type 5: Polypropylene (PP).
      6) Type 6: Polystyrene (PS).
      7) Type 7: Other. Use of this code indicates that package in question is made with a resin other than the six listed above or is made of more than one resin listed above and used in a multi-layer combination.

   b. Describe maintenance procedures associated with environmentally preferable materials and systems. Provide cleaning recommendations in accordance with ASTM E1971 and approved Integrated Pest Management (IPM) plan.

      1) Include potential environmental impacts of recommended maintenance procedures and materials.
      2) Include potential indoor air quality impacts of recommended maintenance procedures and materials.
      3) Where proposed maintenance procedures incorporate composting of plastics, assess potential effect of each type of plastic to be included in composting process in accordance with ASTM D5509 or ASTM D6002.

   c. Identify take-back programs, green leases, and appropriate contact information for:

      1) Carpet.
      2) Ceiling Tile.
      3) Office Equipment.

   d. Material Safety Data Sheets (MSDS): Include MSDSs as specified.

2. Develop environmental management programs for facility as follows:

a. Waste management program: Develop in accordance with ASTM E1609. Maximize use of source reduction and recycling procedures outlined in ASTM D5834.
b. Indoor Air Quality (IAQ) management program: Provide for evaluation of indoor Carbon Dioxide concentrations in accordance with ASTM D6245. Provide for evaluation of VOCs (volatile organic compounds) in indoor air in accordance with ASTM D6345.
c. Water Management Program: Develop water monitoring program for surface and ground water on Project Site in accordance with ASTM D5851 and consistent with water management program utilized during construction operations.

E. Maintenance Procedures: Include manufacturer's written recommendations and inspection procedures, types of cleaning agents, methods of cleaning, schedule for cleaning and maintenance, and repair instructions.

F. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

G. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that affect validity of warranties or bonds.

2.5 SYSTEMS AND EQUIPMENT MAINTENANCE MANUALS

A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.

B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual and drawing or schedule designation or identifier where applicable.

C. Manufacturers' Maintenance Documentation:

1. Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

a. Standard maintenance instructions and bulletins.
b. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.

c. Identification and nomenclature of parts and components.
d. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures:

1. Include the following and items detailing essential maintenance procedures:

a. Test and inspection instructions.
b. Troubleshooting guide.
c. Precautions against improper maintenance.
d. Disassembly; component removal, repair, and replacement; and reassembly instructions.
e. Aligning, adjusting, and checking instructions.
f. Demonstration and training video recording.

E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.

1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.

F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that affect validity of warranties or bonds.

1. Include procedures and required notifications for warranty claims.

PART 3 EXECUTION

3.1 GENERAL

A. At start of Project, begin accumulating operation and maintenance data and initiate index. Install and index data in binders within 30 days after delivery of items. As custom written data and test results are produced, add to operation and maintenance data file.

B. List of Operation and Maintenance requirements has been attached at end of the Division 01 Specifications for your convenience. Intent is to provide an overall

summary of requirements and not a comprehensive list. Terms and conditions of the contract require satisfaction of requirements of individual specification sections regardless of what is shown on the list.

C. Keep operation and maintenance data current. Make operation and maintenance binders available to Contracting Officer for inspection at time of monthly progress payment requests. If operation and maintenance binders are not current, Contracting Officer may retain an appropriate amount of the progress payment.

3.2 MANUAL PREPARATION

A. Manual Types:

1. Emergency Manual: Assemble complete set of emergency information indicating procedures for use by emergency personnel and by NPS operating personnel for types of emergencies indicated.
2. Product Maintenance Manual: Assemble complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into Work.
3. Operation and Maintenance Manuals: Assemble complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.

B. Manual Contents, Including:

1. Manufacturers' Data: Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark sheet to identify product or component incorporated into Work. If data include more than one item in a tabular format, identify each item using appropriate references from Contract Documents. Identify data applicable to Work and delete references to information not applicable.
2. Custom Written Data: For data not in manufacturer's standard literature, provide text, drawings, and schematics specifically applicable to installed systems. Include step-by-step descriptions of operating procedures; identification of individual components and their functions; descriptions of how system components relate to one another and operate together to accomplish a common process or function; and sequence of operation for system control circuits. For seasonally operated systems, provide start-up and shutdown instructions.
3. Equipment Data Sheets: For each item of equipment included in operation and maintenance data, provide Equipment Data Sheet using form at the end of this section. For equipment consisting of a driven machine and a driver (for example, a pump and a motor), equipment data shall cover both the driven machine and the driver. For similar type equipment (for example, multiple

exhaust fans of the same model and type), provide a single equipment data sheet with an attached schedule listing individual equipment items.

4. Vendor Furnished As-Built Drawings: Provide for each electrical and each mechanical control system.

    a. For each control system, provide control circuit schematic drawings. Identify each wire and terminal block number. Show terminal numbers on control devices. Show control wires and devices remote from control panel.
    b. For each control panel, provide general arrangement drawing showing location of each control component and terminal block on the panel front and interior. Include materials list of panel-mounted control components as well as field-installed control components remote from the panel, identifying components, manufacturer, model number, and initial set points or sensing ranges of devices where applicable.
    c. For packaged equipment systems, provide general arrangement drawings showing interrelationships of the various items of equipment and components.
    d. In addition to control wiring schematic, provide power wiring schematic drawing showing power flow to each motor. Identify each power conductor. Show over-current protection and motor starting devices.

C. Comply with Section 01 77 00, Closeout Procedures, for schedule for submitting operation and maintenance documentation.

3.3 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Equipment Data Sheet.

END OF SECTION

EQUIPMENT DATA SHEET	
Equipment Item: _____ Designation: _____ Function: _____ Location: _____ Project: _____ Model Number: _____ Serial Number: _____	
Manufacturer Address and Phone:	Supplier Address and Phone:
Preventive Maintenance Tasks:	
Nameplate Data:	
Spare Parts Furnished and Other Information:	

SECTION 01 79 00
DEMONSTRATION AND TRAINING

PART 1 GENERAL

1.1 SUMMARY

A. Section includes administrative and procedural requirements for instructing National Park Service (NPS) personnel, including:

1. Demonstration of operation of systems, subsystems, and equipment.
2. Training in operation and maintenance of systems, subsystems, and equipment, including environmental considerations.
3. Demonstration and training video.

B. See Division 02 through Division 49 Sections for specific requirements for demonstration and training for products in those Sections.

1.2 GENERAL REQUIRMENTS

A. List of System Demonstration and Training requirements has been attached at end of Division 01, General Requirements, specifications for your convenience. Intent is to provide overall summary of requirements and not a comprehensive list. Terms and conditions of contract still require satisfaction of requirements of individual specification sections regardless of what is shown on list.

1.3 SUBMITTALS

A. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module.

1. For each training session, Contractor shall submit for approval a proposed outline of subjects to be covered. Training shall not be conducted until outline is approved.

B. Demonstration and Training Video: Submit two copies of each DVD (digital video disc) for training sessions within 7 days of end of each training module.

1. Label each DVD with date of demonstration or training, instructor's name, and provide an index of contents. Index shall list start and end time of each subject covered during training session. Sequence of training subjects shall follow sequence listed in approved training outline or as actually conducted.

1.4 QUALITY ASSURANCE

A. Facilitator Qualifications: Firm or individual experienced in training or educating maintenance personnel in training program similar in content and extent for this Project, and whose work has resulted in training or education with a record of successful learning performance.

B. Instructor Qualifications: Factory-authorized service representative, complying with requirements in Section 01 40 00, Quality Requirements, experienced in operation and maintenance procedures and training.

C. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by Contracting Officer (CO).

PART 2 PRODUCTS

2.1 INSTRUCTION PROGRAM

A. Program Structure:

1. Develop instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual specification sections, and:

a. Utility System Operations:

1) Water.
2) Electrical.
3) Gas.
4) Communication.
5) Utility Monitoring.

b. Environmental Topics:

1) Overview of environmental issues related to building industry.
2) Overview of environmental issues related to Project.
3) Review of site-specific procedures and management plans implemented during construction:

a) Regulatory Requirements.
b) Noise and Acoustics Management.
c) Environmental Management.
d) Construction Waste Management.

4) Review of site-specific procedures and management plans to be implemented during operation and maintenance.

a) Include review of environmentally related aspects of Operations and Maintenance Manual.
b) Integrated Pest Management (IPM).

B. Training Modules:

1. Develop a learning objective and teaching outline for each module. Include description of specific skills and knowledge that participant is expected to master. For each module, include instruction for:

a. Basis of System Design, Operational Requirements, and Criteria: Include system and equipment descriptions, operating standards, regulatory requirements, equipment function, operating characteristics, limiting conditions, and performance curves.
b. Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.
c. Emergencies: Instructions on stopping; shutdown instructions; operating instructions for conditions outside normal operating limits; instructions on meaning of warnings, trouble indications, and error messages; and required sequences for electric or electronic systems.
d. Operations: Startup, break-in, control, and safety procedures; stopping and normal shutdown instructions; routine, normal, seasonal, and weekend operating instructions; operating procedures for emergencies and equipment failure; and required sequences for electric or electronic systems.
e. Adjustments: Alignments and checking, noise, vibration, economy, and efficiency adjustments.
f. Troubleshooting: Diagnostic instructions and test and inspection procedures.
g. Maintenance: Inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
h. Repairs: Diagnosis, repair, and disassembly instructions; instructions for identifying parts; and review of spare parts needed for operation and maintenance.

PART 3 EXECUTION

3.1 INSTRUCTION

A. Facilitator: Engage qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and Contracting Officer for number of participants, instruction times, and location.

B. Engage qualified instructors to instruct NPS personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

1. Schedule training with NPS through Contracting Officer with at least 7 days' advance notice.
2. Conduct training sessions after equipment or system has been accepted and turned over to Government. Coordinate with commissioning requirements.
3. Coordinate with Integrated pest management requirements. Refer to specifications section and approved IPM plan.
4. Individual sections specify duration of training required. If no duration is listed, provide training of sufficient duration to adequately cover subjects.

3.2 DEMONSTRATION AND TRAINING VIDEO

A. General: Engage qualified commercial photographer to record demonstration and training video. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.

1. At beginning of training module, record each chart containing learning objective and lesson outline.

B. Video Format: Digital Video Disc (DVD).

C. Video Recording: Record sessions with high resolution equipment. Instructor's voice shall be clearly audible and understandable on DVD. Utilize supplemental microphone worn by instructor.

D. Narration: Describe scenes on video by audio narration by microphone while dubbing audio narration offsite after video is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.

1. DVDs with poor video or audio quality will be rejected and training recorded again.

END OF SECTION

SECTION 01 81 13
SUSTAINABLE DESIGN REQUIREMENTS FOR NON-LEED™ PROJECTS

PART 1 GENERAL

1.1 SUMMARY

A. Section includes general requirements and procedures for compliance with Federal Sustainability requirements. This Project is not seeking Leadership in Energy & Environmental Design (LEED™) certification but shall comply with applicable Federal Sustainability requirements. Requirements include laws (Executive Orders (EO) and regulations), management policies, building codes and standards, Federal directives, and National Park Service (NPS) guidelines.

B. Many Federal requirements can be achieved only through intelligent and integrated design of the Project and are beyond control of the Contractor. Certain requirements relate to the products and procedures used for construction; therefore, full cooperation of the Contractor and Subcontractors is essential to successful compliance with Federal requirements.

C. Contractors shall familiarize themselves with relevant requirements and provide necessary information and instruction to subcontractors and installers.

1. Some requirements involve quantifying percentages by weight; these require careful recordkeeping and reporting by Contractor.
2. See Denver Service Center (DSC) Workflows Sustainability Standards for a list of Federal Sustainability requirements. Applicable Federal Sustainability requirements are also summarized on the Project's NPS Project Sustainability Checklist. Contractor is responsible for ensuring the elements in the NPS Project Sustainability Checklist, identified by the Architect/Engineer (A/E) team, are incorporated into the construction of the Project.

D. Related Sections: See Division 01 through Division 49 Sections for sustainability requirements specific to work of each of these Sections.

1.2 DEFINITIONS

A. Biopreferred Products: Commercial or industrial products (other than food or feed) composed in whole, or in significant part, of biological products, renewable agricultural materials (including plant, animal, and marine materials), or forestry materials and includes biobased intermediate ingredients or feedstocks.

B. Chain-of-Custody Certificates: Certificates signed by manufacturers certifying wood used to make products was obtained from forests certified by a Forest Stewardship Council (FSC)-accredited certification body to comply with FSC Standard STD-01-001, "FSC Principles and Criteria for Forest Stewardship." Certificates shall

include evidence manufacturer is certified for chain of custody by an FSC-accredited certification body.

C. LEED™: Leadership in Energy & Environmental Design. Sustainability rating system developed by United States Green Building Council (USGBC). This Project will not be LEED certified. References to LEED are guidelines and industry standards.

D. Rapidly Renewable Materials: Materials made from plants typically harvested within 10-year or shorter cycle. Rapidly renewable materials include products made from bamboo, cotton, flax, jute, straw, sunflower seed hulls, vegetable oils, or wool.

E. Recycled Content: Recycled content value of a material assembly shall be determined by weight.

1. "Post-consumer" material: Waste material generated by households or by commercial, industrial, and institutional facilities in their role as end users of product, which can no longer be used for intended purpose.
2. "Pre-consumer" material: Material diverted from waste stream during manufacturing process. Reutilization of materials such as rework, regrind, or scrap generated in a process and capable of being reclaimed within the same process that generated it is excluded.

1.3 FEDERAL SUSTAINABILITY DOCUMENTATION SUBMITTALS

A. Most of Federal sustainability documentation submittals are aggregations of submittals already required in relevant technical specifications. They are mentioned here to ensure they are collected and organized together to efficiently document compliance with sustainability requirements.

B. Provide preliminary submittals to NPS indicating how the following Federal requirements will be met:

1. Recycled Content: List of specified/proposed materials with recycled content. Indicate cost, post-consumer recycled content, and pre-consumer recycled content for each product having recycled content.
2. Certified Wood: Product data and/or chain-of-custody certificates for products containing certified wood. Include statement indicating cost for each certified wood product.
3. Low Emitting Materials - Adhesives and Sealants: Product data for adhesives and sealants used inside weatherproofing system indicating Volatile Organic Compound (VOC) content of each product used. Indicate VOC content in g/L (grams per liter) calculated according to 40 CFR 59 Subpart D (Code of Federal Regulations).
4. Low Emitting Materials - Paints and Coatings: Product data for paints and coatings used inside weatherproofing system indicating chemical composition

and VOC content of each product used. Indicate VOC content in g/L calculated according to 40 CFR 59 Subpart D.

5. Low Emitting Materials - Flooring: Product data for products containing composite wood or agrifiber products or wood glues indicating they do not contain urea-formaldehyde resin.
6. Biopreferred Products: Provide list of bio-based products used on Project.

PART 2 PRODUCTS

2.1 RECYCLED CONTENT OF MATERIALS

A. Recycled Content: Provide preference to materials with recycled content. Include recycled content within product submittals, when applicable.

2.2 BIOPREFERRED PRODUCTS

A. Use bio-based products found on United States Department of Agriculture (USDA) Biopreferred Products list where applicable on Project.

2.3 LOW-EMITTING MATERIALS

A. For applications inside the weatherproofing system, use adhesives and sealants that comply with VOC content limits in Specification Division 02 through Division 49.

B. For field applications inside the weatherproofing system, use paints and coatings that comply with VOC content limits in Specification Division 02 through Division 49.

C. Do not use composite wood or agrifiber products or adhesives that contain urea-formaldehyde resin.

PART 3 EXECUTION

3.1 MEASUREMENT AND VERIFICATION

A. Coordinate with Division 02 through Division 49 for Project requirements regarding installation of building level metering equipment to measure energy, water, and electric usage.

END OF SECTION

SECTION 01 88 15
ANCHORAGE AND BRACING

PART 1 GENERAL

1.01 SUMMARY

A. This section covers requirements for anchorage and bracing of equipment, distribution systems, and other nonstructural components required in accordance with the ICC 2021 International Building Code (IBC), for seismic, wind, gravity, soil, and operational loads.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Institute of Steel Construction (AISC) 360, Specification for Structural Steel Buildings.
2. American Society of Civil Engineers (ASCE): ASCE 7, Minimum Design Loads for Buildings and Other Structures.
3. International Code Council (ICC): International Building Code (IBC).
4. National Fire Protection Association (NFPA): 13, Standard for the Installation of Sprinkler Systems.

1.03 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Permitting building agency; may be a federal, state, local, or other regional department, or individual including building official, fire chief, fire marshal, chief of a fire prevention bureau, labor department, or health department, electrical inspector; or others having statutory authority. AHJ may be Contracting Officer when authorized to be self-permitting by governmental permitting agency or when no governmental agency has authority.

B. Designated Seismic System: Architectural, electrical, and mechanical system or their components for which component importance factor is greater than 1.0.

1.04 DESIGN AND PERFORMANCE REQUIREMENTS

A. General:

1. Anchorage and bracing systems shall be designed by a qualified professional engineer registered in the State of New Mexico.

2. Design anchorage into concrete including embedment in accordance with ACI 318-19; Chapter 17 (or other industry standard approved by Contracting Officer), and Project Specifications.
    a. Unless otherwise noted, design for cracked concrete condition.
3. Design anchorage and bracing of architectural, mechanical, and electrical components and systems in accordance with this section, unless a design is specifically provided within Contract Documents or where exempted hereinafter.
4. Design attachments, braces, and anchors for equipment, components, and distribution systems to structure for gravity, seismic, wind, and operational loading.
5. Anchor and brace piping and ductwork, whether exempt or not exempt for this section, so that lateral or vertical displacement does not result in damage or failure to essential architectural, mechanical, or electrical equipment.
6. Architectural Components: Includes, but are not limited to, nonstructural walls and elements, partitions, cladding and veneer, access flooring, signs, cabinets, suspended ceilings, and glass in glazed curtain walls and partitions.
7. Provide supplementary framing where required to transfer anchorage and bracing loads to structure.
8. Adjust equipment pad sizes or provide additional anchorage confinement reinforcing to provide required anchorage capacities.
9. Design anchorage and bracing for:
    a. Equipment and components that weigh more than 400 pounds.
    b. Equipment weighing more than 20 pounds that has center of mass located more than 4 feet above adjacent finished floor.
    c. Mechanical and electrical components that are not provided with flexible connections between components and associated ductwork, piping, or conduit.
    d. Distribution systems that weigh more than 5 pounds per foot that have center of mass located more than 4 feet above adjacent finished floor.
10. For components exempted from design requirements of this section, provide bolted, welded, or otherwise positively fastened attachments to supporting structure.

B. Design Loads:

1. Gravity: Design anchorage and bracing for self-weight and superimposed loads on components and equipment.
2. Wind: Design anchorage and bracing for wind criteria provided on General Structural Notes on the Drawings for exposed architectural components and exterior and wind-exposed mechanical and electrical equipment. Alternately, manufacturer certification may be provided for

components such as roofing and flashing to verify attachments meet Project-specific design criteria.

3. Operational:
   a. For loading supplied by equipment manufacturer for IBC required load cases.
   b. Loads may include equipment vibration, torque, thermal effects, effects of internal contents (weight and sloshing), water hammer, and other load-inducing conditions.
   c. Locate braces to minimize vibration to or movement of structure.
   d. For vibrating loads, use anchors meeting requirements of Section 05 50 00, Metal Fabrications or Section 05 05 19, Post-Installed Anchors, for anchors with designated capacities for vibratory loading per manufacturer's ICC-ES report.
4. Hydraulic: Design of anchorage for submerged gates and other mechanical equipment shall include hydrostatic and hydrodynamic loads determined in accordance with Chapter 15 of ASCE 7-16.
5. Seismic:
   a. In accordance with IBC, Section 1613, and Chapter 13 of ASCE 7.
   b. Design anchorage and bracing for design criteria listed on General Structural Notes on the Drawings.
   c. Design forces for anchors in concrete or masonry shall be in accordance with ASCE 7, Section 13.4.2 as applicable for Project Seismic Design Category.

C. Seismic Design Requirements:

1. Nonstructural Components: Design as nonbuilding structures for components with weights greater than or equal to 25 percent of effective seismic weight of overall structure.
2. Analyze local region of body of nonstructural component for load transfer of anchorage attachment if component Ip equals 1.5.
3. The following are exempt from requirements for provision of seismic anchorages and bracing, in addition to those items specifically exempted in ASCE 7, Part 13.5 for architectural components and Part 13.6 for electrical and mechanical equipment:
   a. Furniture, except storage cabinets and bookshelves over 6 feet tall.
   b. Temporary or movable equipment.
4. Fire protection sprinkler systems designed and constructed in accordance with NFPA 13 shall be considered to meet requirements of Chapter 13 of ASCE 7.
5. Provide support drawings and calculations for electrical distribution components if any of the following conditions apply:
   a. Conduit diameter is greater than 2.5-inch trade size.
   b. Total weight of bus duct, cable tray, or conduit supported by trapeze assemblies exceeds 10 pounds per foot.

6. Other seismic design and detailing information identified in ASCE 7, Chapter 13, is required to be provided for new architectural, mechanical, and electrical components, systems, or equipment.

1.05 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. List of architectural, mechanical, and electrical equipment requiring Contractor-designed anchorage and bracing, unless specifically exempted.
   b. Manufacturers' engineered seismic and non-seismic hardware product data.
   c. Attachment assemblies' drawings including seismic attachments; include connection hardware, braces, and anchors or anchor bolts for nonexempt components, equipment, and systems.
   d. Submittal will be rejected if proposed anchorage method would create excessive stress to supporting member. Revise anchorages and strengthen structural support to eliminate overstressed condition.

B. Informational Submittals:

1. Anchorage and Bracing Calculations: For attachments, braces, and anchorages, include IBC and Project-specific criteria as noted on General Structural Notes on the Drawings, in addition to manufacturer's specific criteria used for design; sealed by professional engineer registered in the State of New Mexico.
2. Manufacturer's hardware installation requirements.

C. Deferred Submittals:

1. Submitted seismic anchorage drawings and calculations are identified as deferred submittals and will be submitted to and must be accepted by AHJ prior to installation of component, equipment, or distribution system.
2. Submit deferred Action Submittals such as Shop Drawings with supporting deferred informational submittals such as calculations no less than 4 weeks in advance of installation of component, equipment, or distribution system to be anchored to structure.

1.06 SOURCE QUALITY CONTROL

A. Contractor and supplier responsibilities to accommodate Contracting Officer-furnished shop fabrication related special inspections and testing are provided

in Project's Statement of Special Inspections on the Drawings, and Section 01 45 33, Special Inspection, Observation, and Testing.

B. Provide all other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 40 00, Quality Requirements.

C. Provide Source Quality Control for welding and hot-dip galvanizing of anchors in accordance with Section 05 50 00, Metal Fabrications.

PART 2 PRODUCTS

2.01 GENERAL

A. Design and construct attachments and supports transferring seismic and non-seismic loads to structure of materials and products suitable for application and in accordance with design criteria shown on the Drawings and nationally recognized standards.

B. Provide anchor bolts for anchorage of equipment to concrete or masonry in accordance with Section 05 50 00, Metal Fabrications. Provide anchor bolts of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Contracting Officer.

C. Provide post-installed concrete and masonry anchors for anchorage of equipment to concrete or masonry in accordance with Section 05 05 19, Post-Installed Anchors. Provide post-installed anchors of the size, minimum embedment, and spacing designated in calculations submitted by Contractor and accepted by Contracting Officer.

D. Do not use powder-actuated fasteners or sleeve anchors for seismic attachments and anchorage where resistance to tension loads is required. Do not use expansion anchors, other than undercut anchors, for nonvibration isolated mechanical equipment rated over 10 hp.

PART 3 EXECUTION

3.01 GENERAL

A. Make attachments, bracing, and anchorage in such a manner that component lateral force is transferred to lateral force resisting system of structure through a complete load path.

B. Design, provide, and install overall seismic anchorage system to provide restraint in all directions, including vertical, for each component or system so anchored.

C. Provide snubbers in each horizontal direction and vertical restraints for components mounted on vibration isolation systems where required to resist overturning.

D. Provide piping anchorage that maintains design flexibility and expansion capabilities at flexible connections and expansion joints.

1. Piping and ductwork suspended more than 12 inches below supporting structure shall be braced for seismic effects to avoid significant bending of hangers and their attachments, unless high- or limited-deformability piping is used per ASCE 7, Section 13.6.8 or HVAC ducts have a cross-sectional area of less than 6 square feet or weigh 17 pounds per foot or less.

E. Anchor tall and narrow equipment such as motor control centers and telemetry equipment at base and within 12 inches from top of equipment, unless approved otherwise by Contracting Officer.

F. Do not attach architectural, mechanical, or electrical components to more than one element of a building structure at a single restraint location where such elements may respond differently during a seismic event. Do not make such attachments across building expansion and contraction joints.

3.02 INSTALLATION

A. Do not install components or their anchorages or restraints prior to review and acceptance by Contracting Officer and AHJ.

B. Notify Contracting Officer upon completion of installation of seismic restraints in accordance with Section 01 45 33, Special Inspection, Observation, and Testing.

3.03 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. In accordance with Section 05 50 00, Metal Fabrications, and Section 05 05 19, Post-Installed Anchors.

B. Contracting Officer-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

C. Provide any other specified, regulatory required, or required repair verification inspection and testing that is not listed in Statement of Special Inspections in accordance with Section 01 40 00, Quality Requirements.

END OF SECTION

SECTION 01 91 14
TOTAL SYSTEM COMMISSIONING

PART 1 GENERAL

1.1 SUMMARY

A. Section Includes:

1. General requirements for coordinating and scheduling commissioning.
2. Commissioning meetings.
3. Commissioning reports.
4. Use of test equipment, instrumentation, and tools for commissioning.
5. Construction checklists, including, but not limited to, installation checks, startup, and performance tests.
6. Commissioning tests.
7. Adjusting, verifying, and documenting identified systems and assemblies.

B. Work included under this section includes a complete and thorough investigation of equipment and systems indicated in Part 3 of section. To ensure proper installation and operation of components and systems. Contractor shall perform commissioning as described herein to accomplish the tasks, and goals of commissioning. Systems to be evaluated include but are not limited to:

1. Mesa Top Blue Water Tank Valve Vaults:

    a. Valves.
    b. Billing meter.

2. Mesa Top Comfort Stations: Hydropneumatic tank with pumps.
3. Canyon Mechanical Building: Coordinate list with list produced by the Commissioning Authority.

    a. HVAC (Heating, Ventilation, and Air Conditioning) components and equipment.
    b. Plumbing components and equipment.
    c. Lighting System.
    d. Building Envelope (walls, roof, windows, infiltration).
    e. Electrical Systems.
    f. Lightning Protection.
    g. Mechanical system components and equipment including valves, and flowmeter.
    h. SCADA.

4. Canyon 24,000-Gallon Entrance Road Water Tank:

   a. Mechanical components including mixer and valves.
   b. Inlet and outlet, and overflow.
   c. Level sensors.

5. Telemetry: Blue Water Tank, Canyon Mechanical Building, PRV vaults, Main Lift Station.

C. Building commissioning activities and documentation are described in the American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) Guideline 0-2005, The Commissioning Process, and National Institute of Building Sciences (NIBS) Guidelines.

D. National Park Service (NPS) personnel, Green Consultant, and Architect/Engineer, are not responsible for construction means, methods, job safety, or management function related to commissioning on Job Site.

E. Related Sections:

1. Section 01 31 00, Project Management and Coordination.
2. Section 01 33 23, Submittal Procedures.
3. Section 01 40 00, Quality Requirements.
4. Section 01 57 19.12, Noise and Acoustics Management.
5. Section 01 77 00, Closeout Procedures.
6. Section 01 78 23, Operation and Maintenance Data.
7. Section 01 79 00, Demonstration and Training.
8. Section 01 81 13, Sustainable Design Requirements for Non-LEED™ Projects.

1.2 DEFINITIONS

A. Acceptance Criteria: Threshold of acceptable work quality or performance specified for a commissioning activity.

B. Basis-of-Design Document: Document prepared by Designer that records concepts, calculations, decisions, and product selections used to comply with Owner's Project Requirements and to suit applicable regulatory requirements, standards, and guidelines.

C. Commissioning Plan (CCxP): Plan that provides structure, schedule and coordination planning for commissioning process proposed specifically for this Project. CCxP includes Personnel, activities, and a description of Infrastructure, and list of instruments and logging devices that will be used during Commissioning.

D. Construction Checklist: Form used by Contractor to verify appropriate components are onsite, ready for installation, correctly installed and functional.

E. Contractor's Commissioning Representative: (CCxR) Contractor's designated individual to coordinate, manage, and execute commissioning processes of the contracting organizations.

F. Deficiency: Condition in the installation or function of a component, piece of equipment or system not in compliance with Contract Documents, does not perform properly or is not complying with Basis of Design.

G. Functional Performance Test (FPT): Test of dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional testing is the dynamic testing of systems (rather than just components) under full operation (e.g., the chiller pump is tested interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are tested under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water test and balancing (TAB) is not functional performance testing, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional testing is verifying that which has already been set up. The CCxR develops the sequentially written functional test procedure forms, and oversees and documents the actual testing, which is performed by the installing contractor or vendor. The CCxR creates worksheets from these forms which include procedures required to accommodate actual equipment, means and methods used in the Project. Functional Performance Tests are performed after pre-functional checklists and startup is complete.

H. Manual Test: Using hand-held instruments, control system readouts or direct observation to verify performance (contrasted to analyzing electronically monitored data taken over time to make the "observation").

I. Monitoring: Recording of parameters (flow, current, status, pressure) of equipment operation using data loggers or the trending capabilities of control systems.

J. Owner's Project Requirements: Document originated by Designer that details functional requirements of Project and expectations of use and operation, including Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information. Document is updated, with input from Contracting Officer (CO) as required as Project is finished.

K. Pre-functional Checklist: List of items to inspect and elementary component tests to conduct to verify proper installation of equipment. Pre-functional checklists are primarily static inspections and procedures to prepare equipment or system for initial operation (e.g., belt tension, oil levels ok, labels affixed, gages in place, sensors calibrated, etc.). However, some pre-functional checklist items entail simple testing

of the function of a component, a piece of equipment or system (such as measuring voltage imbalance on a three-phase pump motor of a chiller system). “Pre-functional” refers to “before” functional testing. Pre-functional checklists augment and are combined with the equipment manufacturer’s start-up checklist.

L. Seasonal Performance Tests: Functional Performance Tests deferred until system(s) will experience seasonal conditions closer to their design conditions.

M. Systems Manual: System focused composite document that includes operational manual, maintenance manual, and additional information of use to Government during Occupancy and Operation Phase.

N. Total Building Commissioning (TBC): Quality-focused process for verifying and documenting that facility, systems and assemblies are planned, designed, installed, and tested to comply with Owner’s Project Requirements. Requirements specified here are limited to construction phase commissioning activities.

1.3 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action.

1. CCxR (Contractor’s Commissioning Representative):

a. CCxR shall be approved by Contracting Officer and satisfy as many of the following requirements as possible:

1) Certified in Commissioning by nationally accredited organization (i.e., Associated Air Balance Council (AABC), Association of Energy Engineers (AEE), Building Commissioning Association (BCA), and National Environmental Balancing Bureau (NEBB)).
2) Acted as principal Commissioning Authority where total building commissioning approach (including building envelope) was used for at least three projects of comparable size, type, and scope.
3) Technical training in Mechanical, Electrical, and/or fire protection engineering.
4) Past commissioning experience.
5) Knowledge of national codes.
6) Leadership in Energy and Environmental Design (LEED) Accredited Professional.
7) Experience in energy-efficient design and control strategy optimization.
8) Specific experience with specialty systems relative to particular facility type (i.e., Federal blast and progressive collapse requirements, security systems).

2. Contractor Quality Control (CQC) Supervisor.
3. Other Representatives may include Project superintendents, installers, suppliers, and specialists.

B. Members Appointed by Contracting Officer:

1. Representatives of facility user and operation and maintenance personnel.
2. Architect and engineering design professionals.

1.4 CONTRACTOR'S RESPONSIBILITIES

A. Each Contractor shall assign representatives with expertise and authority to act on its behalf to participate in and perform commissioning process activities including:

1. Perform commissioning tests, as required by technical specifications. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
2. Record and resolve commissioning issues.
3. Attend commissioning team meetings held on variable basis.
4. Integrate and coordinate commissioning process activities with overall Project schedule.
5. Review Construction Checklist attached at end of specification section.
6. Complete electronic construction checklists as contract work is completed and provide to Contracting Officer on a as applicable basis.
7. Complete commissioning process test procedures.
8. Provide maintenance orientation and inspection for systems, assemblies, equipment, and components based on contract requirements.
9. Provide Commissioning Plan and documentation for final commissioning documentation.
10. Provide measuring instruments and logging devices to record test data and provide data acquisition equipment to record data for complete range of testing for required test period.

1.5 COMMISSIONING DOCUMENTATION

A. Provide the following information:

1. Review of systems manual, submittals, documents, and other commissioning reports.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Commissioning Plan including Process activities and schedule for completing construction checklists and manufacturer's pre-start and startup checklists for systems, assemblies, equipment, and components to be verified and tested.
4. Certificate of readiness certifying systems, subsystems, equipment, and associated controls are ready for testing.

5. Test and inspection reports and certificates.
6. Corrective action documents.
7. Testing, adjusting, and balancing reports.

1.6 SUBMITTALS

A. Two-Week Look-Ahead Schedules: Schedule showing the next 2 weeks of commissioning related construction activity to include completion dates for each element of commissioning documentation for each major system or subsystem as identified in Article Summary.

B. Certificates of readiness.

C. Contractor's Commissioning Representative Qualifications.

D. Commissioning Plan: Submit within 30 calendar days of authorization to proceed.

1. Update as necessary during the work to reflect progress on components and systems.

E. Pre-functional checklists.

F. Owner's Project requirements.

G. Functional Performance Test Forms: Submit minimum 30 calendar days prior to testing.

H. List of test instrumentation, equipment, and monitoring devices. Include:

1. Make, model, serial number, and application for each instrument, equipment, and monitoring device.
2. Brief description of intended use.
3. Calibration record showing the following:

a. Calibration agency, including name and contact information.
b. Last date of calibration.
c. Range of values for which calibration is valid.
d. Certification of accuracy.
e. National Institute of Standards and Technology (NIST) traceability certification for calibration equipment.
f. Due date of the next calibration.

I. Deficiency Report and Resolution Record: Document items of non-compliance in materials, installation or operation. Document results from start-up/pre-functional checklists, functional performance testing, and short-term diagnostic monitoring. Include details of components or systems found to be non-compliant with the Drawings and the Specifications. Identify adjustments and alterations required to

correct system operation and identify who is responsible for making corrective changes.

1. Update as necessary during work to reflect progress on components and systems. Submit updated versions monthly.

J. Closeout Documentation:

1. Closeout documents for commissioned equipment and systems shall be submitted prior to functional performance testing. These include:

   a. Record Documents and Drawings.
   b. Start-up certificates for commissioned equipment with start-up requirements.
   c. Systems Manual.
   d. Include TAB, startup, and Control System check-out reports.
   e. Other documents required by Section 23 81 00, Unitary Air Conditioning Equipment, Section 26 08 00, Commissioning of Electrical Systems, and Section 40 90 00, Instrumentation and Control for Process Systems.

2. Operation and Maintenance (O&M) Submittals (refer to requirements of technical specifications):

   a. Training Plan:

      1) Include for each training session:

         a) Dates, start and finish times, and locations.
         b) Outline of the information to be presented.
         c) Names and qualifications of presenters.
         d) List of texts and materials required to support training.

PART 2 PRODUCTS

2.1 TEST EQUIPMENT

A. Instrumentation shall:

1. Be of sufficient quality and accuracy to test and measure system performance within tolerances required to determine adequate performance.
2. Be calibrated on manufacturer’s recommended intervals calibration tags permanently affixed to instrument being used.
3. Be maintained in good repair and operation condition throughout duration of use on this Project.

B. Standard testing equipment required to perform startup and initial checkout and required functional performance testing shall be provided by Contractor for equipment being tested.

C. Required commissioning equipment (sensors, transducers, data loggers) not integral to the systems or equipment installed shall be provided by Contractors Commissioning Representative and shall not become property of the Government.

2.2 PRE-FUNCTIONAL CHECKLIST

A. Prepare pre functional checklists for equipment and systems to be commissioned.

B. Pre-functional checklists shall be complementary to Commissioning Plan and Commissioning Schedule.

2.3 FUNCTIONAL TEST PROCEDURE FORMS

A. Prepare functional test procedure forms for each piece of equipment and each system to be commissioned.

2.4 FUNCTIONAL PERFORMANCE WORKSHEETS

A. Prepare Functional Performance worksheets, consisting of test procedures and expected results of testing.

2.5 REPORT FORMAT AND ORGANIZATION

A. General Format and Organization:

1. Bind report in three-ring binders.
2. Label front cover and spine of each binder with report title, volume number, Project name, Contractor's name, and date of report.
3. Record report on compact disk.
4. Electronic Data: Portable document format (PDF); a single file with outline-organized bookmarks for major and minor tabs and tab contents itemized for specific reports.

B. Commissioning Report:

1. Include table of contents and an index to each test.
2. Include major tabs for each specification section.
3. Include minor tabs for each test.
4. Within each minor tab, include:

a. Test specification.
b. Pre-startup reports.
c. Approved test procedures.
d. Test data forms, completed and signed.

e. Commissioning issue reports, showing resolution of issues, and documentation related to resolution of issues pertaining to a single test. Group data forms, commissioning issue reports showing resolution of issues, and documentation related to resolution of issues for each test repetition together within minor tab, in reverse chronological order (most recent on top).

PART 3 EXECUTION

3.1 COMMISSIONING PROCESS

A. Following activities outline general commissioning tasks (requiring development and execution) and order in which they occur. Specific Commissioning requirements are found in technical specification sections listed in Paragraph Closeout Documentation.

1. Commissioning Scoping Meeting.
2. Finalize Owner's Project Requirements.
3. Commissioning Plan.
4. Prepare pre-functional checklists.
5. Prepare functional performance worksheets.
6. Perform Start-Up/Pre-Functional Checks in accordance with manufacturer's recommendations and pre-functional checklists.
7. Functional Performance Testing in accordance with functional performance worksheets.
8. Deficiency Report and Resolution Record.
9. Operation and Maintenance Documentation.
10. Operations and Maintenance Training.
11. Deferred Testing.

3.2 TOTAL BUILDING COMMISSIONING (TBC) REQUIREMENTS

A. TBC during construction, acceptance, and warranty phases is intended to achieve following specific objectives:

1. Verify that systems and equipment meet Owner's Project Requirements.
2. Verify equipment is what was submitted and approved.
3. Verify and document equipment is installed and started per manufacturer's recommendations, industry accepted minimum standards, and Contract Documents.
4. Verify and document equipment and systems receive complete operational checkout by installing contractors.
5. Verify and document equipment capacity and system efficiency.
6. Verify performance of building envelope. Document testing and conformance to Contract Documents.
7. Verify completeness of operations and maintenance materials.
8. Ensure Governments operating personnel are adequately trained on operation and maintenance of building equipment.

3.3 COMMISSIONING SCOPING MEETING

A. Commissioning Scoping Meeting:

1. Schedule, coordinate, and facilitate a scoping meeting.
2. Review each building system to be commissioned, including intended operation, commissioning requirements, and completion and start-up schedules.
3. Establish scope of work, tasks, schedules, deliverables, and responsibilities for implementation of Commissioning Plan.
4. Attendance: Commissioning Team members.

3.4 COMMISSIONING PLAN

A. Commissioning Plan: Develop commissioning plan to identify how commissioning activities will be integrated into general construction and trade activities. Commissioning plan shall identify how commissioning responsibilities are distributed. Intent of plan is to evoke questions, expose issues, and resolve issues with input from entire commissioning team early in construction.

1. Identify who will be responsible for producing various procedures, reports, Contracting Officer notifications and forms.
2. Include commissioning tasks and activities in overall project schedule. Tag individual activities so they can be filtered at later date.
3. List and describe each test/acceptance procedure, including acceptance criteria.

3.5 START-UP/PRE-FUNCTIONAL CHECKLISTS

A. Start-Up/Pre-Functional Checklists: Complete pre-functional checklists prior to start up. Checklist shall help verify that systems are complete and operational, so functional performance testing can be scheduled.

1. Verify equipment installed is what was approved on Submittal.
2. Manufacturer’s start-up checklists and other technical documentation guidelines may be used as basis for pre-functional checklists.

3.6 FUNCTIONAL PERFORMANCE TESTING

A. Functional Performance Testing: Test procedures fully describe system configuration and steps required for each test.

1. Test Methods: Functional performance testing and verification may be achieved by direct manipulation of system inputs (i.e., heating or cooling sensors), manipulation of system inputs with building automation system (i.e., software override of sensor inputs), trend logs of system inputs and outputs using building automation system, or short-term monitoring of system inputs and outputs using standalone data loggers. A combination of methods may be

required to completely test complete sequence of operations. CCxR shall determine which method or combination of methods is most appropriate.

2. Setup: Each test procedure shall be performed under conditions that simulate normal operating conditions as closely as possible. Where equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met, functional performance test procedures shall demonstrate actual performance of safety shutoffs in real or closely simulated conditions of failure.
3. Sampling: Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. If, after three attempts at testing the specified sample percentage, failures are still present, remaining units shall be tested at Contractors' expense.

B. Prepare functional performance test procedure forms to accommodate actual installed equipment and systems.

C. Coordinate, execute, and record results of functional performance testing.

1. Coordinate retesting as necessary until satisfactory performance is verified.
2. Verify intended operation of individual components and system interactions under various conditions and modes of operation.

3.7 DEFICIENCY REPORT AND RESOLUTION RECORD

A. Deficiency Report and Resolution Record: Document items of non-compliance in materials, installation or operation.

B. Non-Conformance. Non-conformance and deficiencies observed shall be addressed immediately. Notify responsible parties and provide recommended actions to correct deficiencies.

1. Corrections of minor deficiencies identified may be made during tests at discretion of CCxR. In such cases the deficiency and resolution shall be documented on procedure form.
2. For identified deficiencies:

a. If no dispute on deficiency and responsibility to correct it:

1) CCxR documents deficiency and adjustments or alterations required to correct it. Contractor corrects deficiency and notifies CCxR that equipment is ready to be retested.
2) CCxR reschedules test and test is repeated until satisfactory performance is achieved.

b. If there is a dispute about a deficiency or who is responsible:

1) Deficiency is documented CCxR on non-compliance form.
2) Resolutions are made at lowest management level possible. Additional parties are brought into discussions as needed. Contractor shall have responsibility for resolving construction deficiencies. If a design revision is deemed necessary and approved by Contracting Officer, Architect/Engineer (A/E) shall have responsibility for providing design revision. CCxR documents resolution process.
3) Once interpretation and resolution have been decided, appropriate party corrects deficiency and notifies CCxR that equipment is ready to be retested. CCxR reschedules test and test is repeated until satisfactory performance is achieved.

3. Cost of Retesting: Costs for retesting shall be charged to Contractor.

3.8 OPERATIONS AND MAINTENANCE TRAINING

A. Training: Develop Training Plan. Coordinate and execute training programs with CxA.

1. Stress and enhance importance of system interactions, troubleshooting, and long-term preventive maintenance and operation programs.

3.9 DEFERRED TESTING

A. Unforeseen Deferred Tests: If test cannot be completed due to building structure, required occupancy condition, or other deficiency, functional testing may be delayed upon recommendation of CCxR and approval of Contracting Officer. These tests are conducted in same manner as the seasonal tests, as soon as possible.

B. Seasonal Testing:

1. Schedule, coordinate, execute, and document additional testing for seasonal variation in operations and control strategies during appropriate season to verify performance of HVAC system and controls. Complete testing during warranty period to fully test sequences of operation.
2. Update O&M manuals and Project Record Drawings as necessary due to testing.

3.10 EQUIPMENT AND SYSTEM SCHEDULE

A. Commissioned Equipment and Systems List: Following is a list of systems and equipment to be commissioned organized by system. It includes the percentage of each category that will undergo testing. The intent is to provide an overall summary

of commissioned equipment and systems, and not a comprehensive list. Refer to applicable specification sections for more information.

COMMISSIONED EQUIPMENT AND SYSTEMS LIST			
SYSTEM	**EQUIPMENT**	**CC** (Commissioning Coordinator)	**FPT** (Functional Performance Test)

COMMISSIONED EQUIPMENT AND SYSTEMS LIST			
SYSTEM	**EQUIPMENT**	**CC** (Commissioning Coordinator)	**FPT** (Functional Performance Test)

END OF SECTION

SECTION 02 41 00
DEMOLITION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): Guideline K, Containers for Recovered Non-flammable Fluorocarbon Refrigerants.
2. American National Standards Institute (ANSI): A10.6, Safety Requirements for Demolition Operations.
3. Occupational Safety and Health Administration (OSHA), U.S. Code of Federal Regulations (CFR) Title 29 Part 1926—Occupational Safety and Health Regulations for Construction.
4. Environmental Protection Agency (EPA), U.S. Code of Federal Regulations (CFR), Title 40:
   a. Part 61—National Emission Standards for Hazardous Air Pollutants.
   b. Part 82—Protection of Stratospheric Ozone.
   c. Part 273—Standards for Universal Waste Management.

1.02 DEFINITIONS

A. ACM: Asbestos-containing material.

B. Demolition: Dismantling, razing, destroying, or wrecking of any fixed building or structure or any part thereof. Demolition also includes removal of pipes, manholes tanks, conduit, and other underground facilities, whether as a separate activity or in conjunction with construction of new facilities.

C. Modify: Provide all necessary material and labor to modify an existing item to the condition indicated or specified.

D. Relocate: Remove, protect, clean and reinstall equipment, including electrical, instrumentation, and all ancillary components required to make the equipment fully functional, to the new location identified on the Drawings.

E. Salvage/Salvageable: Remove and deliver, to the specified location(s), the equipment, building materials, or other items so identified to be saved from destruction, damage, or waste; such property to remain that of Contracting Officer. Unless otherwise specified, title to items identified for demolition shall revert to Contractor.

F. Universal Waste Lamp: In accordance with 40 CFR 273, the bulb or tube portion of an electric lighting device, examples of which include, but are not limited to, fluorescent, high-intensity discharge, neon, mercury vapor, high-pressure sodium, and metal halide lamps.

G. Universal Waste Thermostat: A temperature control device that contains metallic mercury in an ampule attached to a bimetal sensing element, and mercury-containing ampules that have been removed from these temperature control devices in compliance with the requirements of 40 CFR 273.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit proposed Demolition Plan, in accordance with requirements specified herein, for approval before such Work is started.
2. Submit copies of any notifications, authorizations and permits required to perform the Work.
3. Copies of reports and other documentation required for abandoning wells.
4. Submit a shipping receipt or bill of lading for all containers of ACM shipped.
5. Submit a shipping receipt or bill of lading for all universal waste shipped.

1.04 REGULATORY AND SAFETY REQUIREMENTS

A. When applicable, demolition Work shall be accomplished in strict accordance with 29 CFR 1926-Subpart T.

B. Comply with federal, state, and local hauling and disposal regulations. In addition to the requirements of the General Conditions, Contractor’s safety requirements shall conform to ANSI A10.6.

C. Furnish timely notification of this demolition project to applicable federal, state, regional, and local authorities in accordance with 40 CFR 61-Subpart M.

1.05 DEMOLITION PLAN

A. Demolition Plan shall provide for safe conduct of the Work and shall include:

1. Detailed description of methods and equipment to be used for each operation;
2. The Contractor’s planned sequence of operations, including coordination with other work in progress;
3. Procedures for removal and disposition of materials specified to be salvaged.

4. Disconnection schedule of utility services.
5. Procedures for loading and unloading of native material transport to fill Canyon Tank being demolished.

1.06 SEQUENCING AND SCHEDULING

A. The Work of this specification shall not commence until Contractor's Demolition Plan has been approved by Contracting Officer.

B. Include the Work of this specification in the progress schedule, as specified in Section 01 32 16, Construction Schedule.

C. Areas in which the Work is to be accomplished will be available in accordance with the following schedule:

1. Construct new utilities, structures and appurtenances per Contract and successfully pass hydrostatic, bacteriological testing and commissioning requirements.
2. Obtain approval of Contracting Officer to place new utilities, structures and appurtenances into service.
3. Obtain approval of Contracting Officer to begin demolition of existing utilities, structures and appurtenances specified to be demolish and removed.

1.07 USE OF EXPLOSIVES

A. Use of explosives is not allowed for demolition.

1.08 ENVIRONMENTAL PROTECTION

A. Contractor will comply with all permits issued for the Project.

B. Contractor will comply with all applicable federal, state, regional, and local environmental protection regulations.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 WASTE MANAGEMENT

A. Contractor will comply with requirements for the following:

1. Section 01 74 19, Construction Waste Management and Disposal.
2. Section 02 61 00, Removal and Disposal of Contaminated Soil.
3. Section 02 82 00, Asbestos Remediation.

3.02 VERIFICATION OF CONDITIONS

A. Before beginning Work, Contractor shall verify existing conditions.

1. Verification of existing conditions shall include potholing to locate utilities to perform the Work.

3.03 EXISTING FACILITIES TO BE DEMOLISHED

A. Structures: Refer to Section 01 11 00, Summary of Work, and the Drawings for specific demolition requirements.

1. Existing abovegrade structures indicated shall be removed to grade.
2. Interior walls, other than retaining walls and partitions, shall be removed to 1 foot below grade or to top of concrete slab on ground unless otherwise shown on the Drawings.
3. Core drill concrete slabs and other concrete improvements scheduled to remain in place below ground to allow water to freely migrate through.

B. Utilities and Related Equipment:

1. Notify Contracting Officer or appropriate utilities to turn off affected services at least 48 hours before starting demolition activities.
2. Remove existing utilities as indicated and terminate in a manner conforming to the nationally recognized code covering the specific utility and approved by Contracting Officer.
3. When utility lines are encountered that are not indicated on the Drawings, notify Contracting Officer prior to further work in that area.
4. Excavate and remove utility lines serving buildings to be demolished to a distance of 3 feet beyond the outside perimeter of the demolition.
5. Provide a permanent leak-proof closure for water and gas lines. Fire hydrants, and water and gas isolation valves to be removed.
6. Plug sewer lines specified to be abandoned in place with concrete to a minimum plug length of 3 feet to prevent groundwater infiltration.

C. Tanks and Vessels: Demolish Canyon potable water tank in accordance with the Drawings.

D. Paving and Slabs:

1. Remove concrete and asphaltic concrete paving and slabs including aggregate base as indicated.
2. Provide neat sawcuts at limits of pavement removal as indicated.

E. Patching:

1. Where removals leave holes and damaged surfaces exposed in the finished Work, patch and repair to match adjacent finished surfaces texture and finish.
2. Where new Work is to be applied to existing surfaces, perform removals and patching in a manner to produce surfaces suitable for receiving new Work.
3. Patching shall be as specified and indicated, and shall include:
   a. Fill holes and depressions as a result of removals in existing masonry walls with an approved patching material, applied in accordance with the manufacturer's printed instructions.

F. Electrical:

1. Cut off concealed or embedded conduit, boxes, or other materials a minimum of 3/4 inch below final finished surface.
2. When removing designated equipment, conduit, and wiring may require rework to maintain service to other equipment.
3. Rework existing circuits, or provide temporary circuits as necessary during renovation to maintain service to existing lighting and equipment not scheduled to be renovated. Existing equipment and circuiting shown are based upon limited field surveys. Verify existing conditions, make all necessary adjustments, and record the Work on the Record Drawings. This shall include, but is not limited to, swapping and other adjustments to branch circuits and relocation of branch circuit breakers within panelboards as required to accomplish the finished work.
4. Reuse of existing luminaires, devices, conduits, boxes, or equipment will be permitted only where specifically indicated.
5. Raceways and cabling not scheduled for reuse.
6. Inaccessibly Concealed: Cut off and abandon in place.
7. Exposed or Concealed Above Accessible Ceilings: Remove.
8. Raceways and Cabling Scheduled for Future Use: Cap/seal and tag.
9. Relocating Equipment: Extend existing wiring or run new wiring from the source.
10. Where the existing raceway is concealed, the outlet box shall be cleaned, and a blank cover plate installed.
11. Where the concealed raceway is uncovered remove raceway (or extended to new location if appropriate).
12. Provide new typewritten panelboard circuit directory cards.

G. Universal Waste Lamps and Thermostats: Manage, contain, package, and label in strict accordance with 40 CFR 273.

3.04 PROTECTION

A. Dust and Debris Control:

1. Prevent the spread of dust and debris to occupied portions of the building and avoid the creation of a nuisance in the surrounding area. Do not use water if it results in hazardous or objectionable conditions such as, but not limited to, ice, flooding, or pollution.
2. Sweep pavements as often as necessary to control the spread of debris that may result in foreign object damage potential to vehicular traffic.

B. Traffic Control Signs: Where pedestrian and driver safety is endangered in the area of removal Work, use traffic barricades with flashing lights.

C. Existing Work:

1. Survey the site and examine the Drawings and Specifications to determine the extent of the Work before beginning any demolition.
2. Take necessary precautions to avoid damage to existing items scheduled to remain in place, to be reused, or to remain the property of Contracting Officer; any Contractor-damaged items shall be repaired or replaced as directed by Contracting Officer.
3. Provide temporary weather protection during interval between removal of existing exterior surfaces and installation of new to ensure that no water leakage or damage occurs to structure or interior areas of existing building.
4. Ensure that structural elements are not overloaded as a result of or during performance of the Work. Responsibility for additional structural elements or increasing the strength of existing structural elements as may be required as a result of any Work performed under this Contract shall be that of the Contractor. Repairs, reinforcement, or structural replacement must have Contracting Officer approval.
5. Do not overload pavements to remain.

D. Weather Protection: For portions of the building scheduled to remain, protect building interior and materials and equipment from weather at all times. Where removal of existing roofing is necessary to accomplish the Work, have materials and workers ready to provide adequate and temporary covering of exposed areas so as to ensure effectiveness and to prevent loss.

E. Trees: Protect trees within the Site that might be damaged during demolition and are indicated to be left in place, by orange security fencing. The fence shall be securely erected a minimum of 5 feet from the trunk of individual trees or follow the outer perimeter of branches or clumps of trees. Any tree designated to remain that is damaged during the Work shall be replaced in kind, as approved by the Contracting Officer.

F. Facilities:

1. Protect electrical and mechanical services and utilities. Where removal of existing utilities and pavement is specified or indicated, provide approved barricades, temporary covering of exposed areas, and temporary services or connections for electrical and mechanical utilities.
2. Floors, roofs, walls, columns, pilasters, and other structural elements that are designed and constructed to stand without lateral support or shoring, and are determined by Contractor to be in stable condition, shall remain standing without additional bracing, shoring, or lateral support until demolished, unless directed otherwise by the Contracting Officer.
3. Protect all facility elements not scheduled for demolition.
4. Provide interior shoring, bracing, or support to prevent movement, settlement, or collapse of structure or element to be demolished and adjacent facilities.

G. Protection of Personnel:

1. During demolition, continuously evaluate the condition of the structure being demolished and take immediate action to protect all personnel working in and around the demolition site.
2. Provide temporary barricades and other forms of protection to protect Contracting Officer's personnel and the general public from injury due to demolition Work.
3. Provide protective measures as required to provide free and safe passage of Contracting Officer's personnel and the general public to occupied portions of the structure.

3.05 BURNING

A. Burning at the Site for the disposal of refuse and debris is prohibited.

3.06 RELOCATIONS

A. Perform the removal and reinstallation of relocated items as indicated with workers skilled in the trades involved. Clean all items to be relocated prior to reinstallation, to the satisfaction of Contracting Officer. Repair items to be relocated which are damaged or replace damaged items with new undamaged items as approved by Contracting Officer.

3.07 BACKFILL

A. Do not use demolition debris as backfill material, unless otherwise shown on the Drawings.

B. Fill excavations and other hazardous openings to existing ground level in accordance with Section 31 23 23, Fill and Backfill.

3.08 TITLE TO MATERIALS

A. All salvaged equipment and materials specified to be salvaged will remain the property of Contracting Officer unless directed otherwise by the Contracting Officer.

B. Title to equipment and materials resulting from demolition is vested in the Contractor upon approval by Contracting Officer Contractor's Demolition Plan, and the resulting authorization by Contracting Officer to begin demolition.

3.09 DISPOSITION OF MATERIAL

A. Do not remove equipment and materials without approval of Contractor's Demolition Plan by the Contracting Officer.

B. Remove materials and equipment that are specified to be removed by Contractor and deliver to a storage site as directed on the Site.

C. Contracting Officer will not be responsible for the condition or loss of, or damage to, property scheduled to become Contractor's property after Contracting Officer's authorization to begin demolition.

D. Materials and equipment shall not be viewed by prospective purchasers or sold on the Site.

3.10 REUSE OF MATERIALS AND EQUIPMENT

A. Remove and store materials and equipment listed in Article Title To Materials to be reused or relocated to prevent damage, and reinstall as the Work progresses.

B. Properly store and maintain equipment and materials in same condition as when removed.

C. Store equipment and material designated to be reused in a location designated by Contracting Officer.

D. Equipment and material designated to be reused shall be cleaned, serviced and checked for proper operability before being put back into service.

E. Contracting Officer will determine condition of equipment and materials prior to removal.

3.11 SPECIALIZED SALVAGE

A. Historical Items:

1. Minimize removal to the extent possible and in a manner to prevent damage.
2. The following historical items shall be temporarily removed during construction activities and re-installed following construction per NPS requirements:
   a. Flagstone pathways.
   b. As identified on the Drawings.

B. Fire Suppression Containers: Fire suppression system cylinders and canisters with electrical charges or initiators shall be deactivated prior to shipment. Also, safety caps shall be used to cover exposed actuation mechanisms and discharge ports on these special cylinders.

3.12 UNSALVAGEABLE MATERIAL

A. Concrete, masonry, and other noncombustible material, except concrete permitted to remain in place, shall be disposed offsite and in compliance with local and state regulations.

B. Combustible material shall be disposed of off the Site.

C. Universal Waste Lamps and Thermostats: Dispose of in strict accordance with 40 CFR 273.

3.13 CLEANUP

A. Debris and rubbish shall be removed from basement and similar excavations. Debris and rubbish shall be removed and transported in a manner that prevents spillage on streets or adjacent areas. Local regulations regarding hauling and disposal shall apply.

END OF SECTION

SECTION 02 61 00
REMOVAL AND DISPOSAL OF CONTAMINATED SOIL

PART 1 GENERAL

1.01 SUMMARY

A. This section describes the Work involved in removal, handling, testing, and disposal of hazardous and nonhazardous soil, debris, excavated waste, and wastewater if such material is encountered or generated during performance of the Work.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. New Mexico Hazardous Waste Disposal Regulations.
2. Resources Conservation and Recovery Act (RCRA).
3. Toxic Substances Control Act (TSCA).
4. U.S. Code of Federal Regulations (CFR):
   a. Title 29, Labor, Chapter XVII Occupational Safety and Health Administration (OSHA), Part 1910, Occupational Safety and Health Standards: Part 1910.120, Hazardous Waste Operations and Emergency Response.
   b. Title 40, Protection of Environment, Chapter I Environmental Protection Agency (EPA), Part 261, Identification and Listing of Hazardous Waste.

1.03 DEFINITIONS

A. ACM: Asbestos-containing materials.

B. DDT: 4,4-Dichlorodiphenyltrichloroethane.

C. Excavated Waste: Buried solid waste, refuse, demolition waste, construction waste, and special waste as defined in US EPA regulations. Excavated waste does not include demolition debris, solid waste, refuse, construction waste, or special waste created by Contractor incidental to the Work.

D. Free Product: Free-standing petroleum or chemical liquid product present in excavation or floating on water in excavation.

E. Hazardous Soil and Debris: Material which qualifies as a hazardous or toxic waste as defined by the Resources Conservation and Recovery Act (RCRA) or the Toxic Substances Control Act (TSCA).

F. Nonhazardous Soil and Debris: Material which does not qualify as a hazardous or toxic waste as defined by RCRA or TSCA and includes excavated waste as defined above.

G. Wastewater: Water produced by Contractor's operation, including groundwater removed, stormwater entering excavation pits despite controls, washdown water, used decontamination water, and other water that requires handling by Contractor to accomplish the Work. Wastewater may be hazardous or nonhazardous and shall require special handling and testing.

1.04 SUBMITTALS

A. Informational Submittals:

1. Prior to commencement of the Work submit the following:
   a. Permits and certification for soil, debris, and waste haulers.
   b. Permits, certification, and acceptance requirements for proposed soil, debris, and wastewater disposal or treatment facilities.
   c. Qualifications:
      1) Contractor or Subcontractor documentation of experience.
      2) Contractor's Personnel: Documentation personnel proposed for Work with contaminated materials have been 40-hour trained in accordance with 29 CFR 1910.120.
      3) Contractor's Licensed Site Professional's documentation of experience and registration.
      4) Waste Transporter: Documentation of licensing and equipment capabilities.
      5) Offsite Disposal and Treatment Facilities: Documentation of licensing, disposal requirements, and acceptance of waste.
   d. Soil and Debris Analytical and Physical Characterization Testing Plan within 12 weeks after Notice to Proceed.
   e. Inspection reports, including photographs, and other items requested by Contracting Officer.
   f. Excavation and Water Control Plan demonstrating controls for migration of water into active excavation areas.
   g. Site-specific Health and Safety Plan:
      1) In accordance with 29 CFR 1910.120.
      2) Include Contractor-proposed monitoring, personnel protective gear, worker training and certifications, and emergency procedures.
      3) State criteria or measures when air monitoring and work by HAZWOPER-trained personnel are no longer necessary.
   h. Emergency Response Plan: Details how to handle an emergency during execution of the Work (for example, encountering drums with unknown contents; encountering pockets of hazardous atmospheres; response to spills caused by excavation of materials

by Contractor or Contractor's equipment; response to fire or injured personnel).

2. During excavation and removal activities submit the following:
   a. Daily job progress log detailing information on review of progress with respect to previously established milestones and schedules, major problems, corrective actions, injury reports, equipment breakdown, and sampling results.
   b. Weekly excavation plans.
   c. Copies of manifests or bills of lading, and waste disposal or treatment facility receipts, including weight or volume tickets, for waste materials, solid or liquid, removed from Site and transported to disposal facilities.

1.05 QUALITY ASSURANCE

A. Qualifications:

1. Contractor or Subcontractor:
   a. Proven history of successfully executing similar projects for a minimum of 3 years.
   b. Certifications or licenses if required by state or local authorities.
   c. Proper equipment and personnel experienced in similar work.
      1) Personnel shall be formally trained in procedures for contaminated soil and water removal (for example, HAZWOPER training).
2. Contractor's Licensed Site Professional, Licensed in the State of New Mexico: shall have minimum of 3 years' experience in planning, sampling, and performing quality control in remediation of contaminated sites.
3. Waste Transporter: Licensed waste haulers with trucks equipped with containment and cover systems to transport solid and liquid waste materials on public streets and roads without spillage.
4. Offsite Disposal and Treatment Facilities: Proposed facilities shall be licensed to accept the various waste types and quantities to be generated during the Work.

B. Codes and Regulations:

1. Comply with federal, state, and local regulations in handling, testing, transporting, and disposing materials and in performing the Work.
2. Prior to commencing removal operations, obtain applicable local, state, and federal permits and licenses that directly impact Contractor's ability to perform the Work.

PART 2 PRODUCTS

2.01 MATERIALS

A. Plastic Sheeting:

1. Physical Characteristics:
   a. Nylon-reinforced polyethylene sheeting, opaque/frosted.
   b. Thickness: Minimum 10 mils.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

B. Tape and Glue:

1. Physical Characteristics: None.
2. Functional Characteristics: Capable of sealing joints of adjacent sheets of plastic and capable of adhering under wet conditions.
3. Performance Characteristics: None.

C. Ballast:

1. Physical Characteristics: None.
2. Functional Characteristics: Sandbags or other ballast materials of sufficient weight and quantity to maintain polyethylene sheeting securely in place.
3. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

A. Contractor shall be responsible for the following:

1. Providing means, methods, and equipment necessary for sampling, excavating, collecting, handling, processing, loading, and disposing of hazardous and nonhazardous soil, debris, excavated waste, and wastewater generated as part of the Work.
2. Selecting, providing, and coordinating with qualified transporters, disposal facilities, and treatment facilities for transporting, disposing, and documenting hazardous and nonhazardous waste transportation and disposal in accordance with this specification.
3. Complying with federal, state, and local requirements for transporting solid and liquid materials from Site through applicable jurisdictions, and be responsible for associated fines, penalties, and other costs for noncompliance.

4. Obtaining and submitting acceptance letters and receipts for materials disposed at each facility.
5. Including provisions in its construction sequence and schedule for sampling, analysis, and review of sampling results.

B. Excavation and Water Control Plan:

1. Plan shall include, but not be limited to, the following:
   a. Means and sequencing of excavation.
   b. Proposed locations, layout, and controls for materials stockpile areas.
   c. Numbers and types of proposed equipment.
   d. Methods of handling, segregating, and stockpiling excavated materials.
   e. Methods of controlling water and sediment in excavation and proposed stockpile areas.
   f. Proposed locations, types, and capacities of temporary water storage facilities, if required.
   g. Sheeting, shoring, and bracing, as required.

C. Soil and Debris Analytical and Physical Characterization Testing Plan:

1. Plan shall include, but not be limited to, the following:
   a. Plan view showing proposed sample locations, depths, and number of samples for characterization and disposal facility acceptance testing, and for confirmatory testing, if required.
   b. Sampling and analysis of areas found to contain hazardous materials. Results shall be used to determine if material should be handled and disposed of as hazardous and to define extent of this material.
   c. Detail sampling and characterization of other materials excavated from Site.
   d. Testing requirements shall include chemical and physical analyses necessary to access the material's environmental and geotechnical characteristics where appropriate.
   e. Sampling plan shall characterize materials as required by RCRA and/or TSCA and conform to treatment and disposal facility acceptance requirements, if any.
   f. Proposed testing laboratory, analyses required, and testing methods.

D. Provide qualified Licensed Site Professional to oversee and supervise sampling, excavation, and waste handling operations at Site and to coordinate with proposed disposal and treatment facilities.

3.02 WASTE CHARACTERIZATION SAMPLING AND ANALYSIS

A. Prior to commencing excavation and waste removal from Site, perform onsite sampling and laboratory testing to screen Site for potential hazardous waste and to conform to acceptance criteria of proposed disposal or treatment facilities. Sampling and testing shall be done in accordance with approved Soil and Debris Analytical and Physical Characterization Testing Plan.

B. Allow a minimum of 4 weeks in schedule for testing and review by disposal facility and Contracting Officer.

3.03 WASTE EXCAVATION

A. Hazardous soil containing 4,4-Dichlorodiphenyltrichloroethane (DDT) will be encountered during excavation for facilities along Entrance Road near the Visitor Center parking lot as specified on the Drawings. The top 3 feet of the soil removed from the area indicated in the drawings shall be placed directly adjacent to the utilities trench and immediately returned to the excavated trench after utilities have been placed, or necessary excavation work has been completed. Any soil that is stockpiled outside of the immediate excavation area, mixed with other soil, or not returned to the utilities trench shall be containerized and shipped offsite for disposal as hazardous waste.

B. The Contractor is considered the generator if any hazardous waste that requires shipment offsite for disposal. Material shall be disposed in accordance with local, state, and federal environmental regulations.

C. Perform waste excavation in accordance with requirements of Section 31 23 16, Excavation, unless otherwise specified in this section and approved Excavation and Water Control Plan.

D. Water control shall be provided in accordance with Section 31 23 19.01, Dewatering, and approved Excavation and Water Control Plan.

E. Sheeting, shoring, and bracing required to support excavation operations shall be provided in accordance with Section 31 41 00, Shoring, and approved Excavation and Water Control Plan.

F. Conduct Work in excavated area in accordance with Contractor’s Site-specific safety plan.

G. Excavate methodically and submit weekly excavation plans no later than Thursday of week preceding the Work.

H. Excavations shall proceed in lifts no greater than 2 feet thick. At Contracting Officer’s request, excavate test pits no greater than 5 feet deep in advance of excavation for purpose of sampling and delineating material to be excavated.

I. Immediately stop excavation and notify Contracting Officer upon encountering material unanticipated or outside scope of this specification. This may include, but is not limited to, free product, tanks, ACM, or solid material other than excavated waste.

J. Overexcavation:

1. Excavate only amount of soil required to construct the Work shown on the Drawings.
2. Overexcavation of additional hazardous soil/debris, solid waste, or soil beyond amount required for construction of foundation and subgrade preparation shall not be performed without written authorization by Contracting Officer.
3. Overexcavation of hazardous soil/debris, solid waste, or soil that is not authorized by Contracting Officer shall be disposed and replaced at Contractor's own expense.

3.04 WASTE HANDLING AND DISPOSAL

A. To extent possible, schedule and coordinate Work such that excavated waste and wastewater can be loaded and removed from Site with minimal handling or storage requirements.

B. No waste stockpile or storage areas are available at Site. Schedule operations in a manner such that excavated materials and wastewater shall be removed immediately from Site to approved disposal facility or treatment facility.

C. Provide labor, equipment, and materials to stabilize or process waste materials as necessary to meet minimum requirements for offsite transport and disposal.

D. Transportation:

1. Provide sealed or lined vehicles and other measures necessary to prevent spillage or tracking of waste materials, mud, or other debris on local streets or roads.
2. Inspect and document vehicles and containers for proper operation and covering.
3. Inspect vehicles and containers for proper markings, manifests, and other requirements for waste shipment.
4. Perform and document decontamination procedures prior to leaving Site and again before leaving disposal or treatment facility.
5. Obtain and submit receipts of confirmation from disposal or treatment facilities that solid and liquid wastes were accepted for disposal or treatment, including weight tickets or other confirmation of quantities received.

3.05 EQUIPMENT DECONTAMINATION

A. Decontaminate equipment that has come into contact with hazardous soil or debris, solid waste, or impacted water by methods approved by Licensed Site Professional.

B. Wastewater and sediment generated by decontamination activities shall be contained and treated or disposed of in accordance with provisions stated in this section.

END OF SECTION

SECTION 02 82 00
ASBESTOS REMEDIATION

PART 1 GENERAL

1.01 SUMMARY

A. This section applies to removal and disposal of asbestos cement utility pipe segments.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Safety Professionals (ASSP): Z9.2, Fundamentals Governing the Design and Operation of Local Exhaust Ventilation Systems.
2. ASTM International (ASTM):
   a. C732, Aging Effects of Artificial Weathering on Latex Sealants.
   b. D522/D522M, Mandrel Bend Test of Attached Organic Coatings.
   c. D2794, Standard Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
   d. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.
   e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   f. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   g. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   h. E736/E736M, Standard Test Method for Cohesion/Adhesion of Sprayed Fire-Resistive Materials Applied to Structural Members.
   i. E1368, Visual Inspection of Asbestos Abatement Projects.
   j. E1494, Encapsulants for Spray- or Trowel-Applied Friable Asbestos-Containing Building Materials.
3. Compressed Gas Association (CGA): G-7, Compressed Air for Human Respiration; 6th Edition.
4. International Safety Equipment Association (ISEA): ANSI/ISEA Z87.1, Occupational and Educational Personal Eye and Face Protection Devices.
5. National Fire Protection Association (NFPA): 701, Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.
6. National Institute for Occupational Safety and Health (NIOSH): NMAM, NIOSH Manual of Analytical Methods.
7. New Mexico Environment Department: 20 NMAC 2.781, Emission Standards for Hazardous Air Pollutants.

8. UL: 586, UL Standard for Safety High-Efficiency Particulate, Air Filter Units.
9. U.S. Environmental Protection Agency (EPA):
   a. 340/1-90/018, Asbestos/NESHAP Regulated Asbestos Containing Materials Guidance.
   b. 560/5-85-024, Guidance for Controlling Asbestos-Containing Materials in Buildings (Purple Book).
10. U.S. National Archives and Records Administration (NARA):
   a. 29 CFR 1910.147, The Control of Hazardous Energy (Lock Out/Tag Out).
   b. 29 CFR 1926.51, Sanitation.
   c. 29 CFR 1926.59, Hazard Communication.
   d. 29 CFR 1926.103, Respiratory Protection.
   e. 29 CFR 1926.200, Accident Prevention Signs and Tags.
   f. 29 CFR 1926.1101, Asbestos.
   g. 40 CFR 61-Subpart A, General Provisions.
   h. 40 CFR 61-Subpart M, National Emission Standard for Asbestos.
   i. 40 CFR 763, Asbestos.
   j. 42 CFR 84, Approval of Respiratory Protective Devices.
   k. 49 CFR 107, Hazardous Materials Program Procedures.
   l. 49 CFR 171, General Information, Regulations, and Definitions.
   m. 49 CFR 172, Hazardous Materials Table, Special Provisions, Hazardous Materials Communications, Emergency Response Information, and Training Requirements.
   n. 49 CFR 173, Shippers - General Requirements for Shipments and Packagings.

1.03 DEFINITIONS

A. ACM: Asbestos-containing materials.

B. Amended Water: Water containing a wetting agent or surfactant with a maximum surface tension of 0.00042 psi.

C. Area Sampling: Sampling of asbestos fiber concentrations which approximates the concentrations of asbestos in the theoretical breathing zone but is not actually collected in the breathing zone of an employee.

D. Asbestos: The term asbestos includes chrysotile, amosite, crocidolite, tremolite asbestos, anthophyllite asbestos, and actinolite asbestos and any of these minerals that has been chemically treated or altered. Materials are considered to contain asbestos if the asbestos content of the material is determined to be at least 1 percent.

E. Asbestos Control Area: That area where asbestos removal operations are performed which is isolated by physical boundaries which assist in the prevention of the uncontrolled release of asbestos dust, fibers, or debris.

F. Asbestos Fibers: Those fibers having an aspect ratio of at least 3:1 and longer than 5 micrometers as determined by National Institute for Occupational Safety and Health (NIOSH) Method 740.

G. Asbestos Permissible Exposure Limit: 0.1 fiber per cubic centimeter of air as an 8-hour time weighted average measured in the breathing zone as defined by 29 CFR 1926.1101 or other federal legislation having legal jurisdiction for the protection of workers health.

H. Authorized Person: Any person authorized by the Contractor and required by work duties to be present in the regulated areas.

I. Background: The ambient airborne asbestos concentration in an uncontaminated area as measured prior to any asbestos hazard abatement efforts. Background concentrations for other (contaminated) areas are measured in similar but asbestos free locations.

J. Competent Person (CP): A person meeting the requirements for competent person as specified in 29 CFR 1926.1101 including a person capable of identifying existing asbestos hazards in the workplace and selecting the appropriate control strategy for asbestos exposure, who has the authority to take prompt corrective measures to eliminate them, and is specifically trained in a training course which meet the criteria of EPA's Model Accreditation Plan (40 CFR 763) for project designer or supervisor, or its equivalent. The competent person must have a current New Mexico asbestos contractor's or supervisor's license.

K. Contractor: The Contractor is that individual, or entity under contract to perform the herein listed Work.

L. Disposal Bag: A 6-mil thick, leak-tight plastic bag, pre-labeled in accordance with 29 CFR 1926.1101, used for transporting asbestos waste from containment to disposal site.

M. Disturbance: Activities that disrupt the matrix of ACM, crumble or pulverize ACM, or generate visible debris from ACM. Disturbance includes cutting away small amounts of ACM, no greater than the amount that can be contained in one standard sized glovebag or waste bag, not larger than 60 inches in length and width in order to access a building component.

N. Encapsulation: The abatement of an asbestos hazard through the appropriate use of chemical encapsulants.

O. Friable Asbestos Material: A term defined in 40 CFR 61-Subpart M and EPA 340/1-90/018 meaning any material which contains more than 1 percent asbestos, as determined using the method specified in 40 CFR 763, polarized light microscopy (PLM), that when dry, can be crumbled, pulverized, or reduced to powder by hand pressure.

P. Glovebag Technique: Those asbestos removal and control techniques put forth in 29 CFR 1926.1101.

Q. Government Consultant (GC): That qualified person employed directly by the Government to monitor, sample, inspect the work or in some other way advise the Contracting Officer. The GC is normally a private consultant, but can be an employee of the Government.

R. HEPA Filter Equipment: High efficiency particulate air (HEPA) filtered vacuum and exhaust ventilation equipment with a filter system capable of collecting and retaining asbestos fibers. Filters must retain 99.97 percent of particles 0.3 micron or larger as indicated in UL 586.

S. Model Accreditation Plan (MAP): USEPA training accreditation requirements for persons who work with asbestos as specified in 40 CFR 763.

T. NESHAP: National Emission Standards for Hazardous Air Pollutants. The USEPA NESHAP regulation for asbestos is at 40 CFR 61-Subpart M.

U. Nonfriable Asbestos Material: Material that contains asbestos in which the fibers have been immobilized by a bonding agent, coating, binder, or other material so that the asbestos is well bound and will not normally release asbestos fibers during any appropriate use, handling, storage or transportation. It is understood that asbestos fibers may be released under other conditions such as demolition, removal, or mishap.

V. Permissible Exposure Limits (PELs):

1. PEL-time Weighted Average (TWA): Concentration of asbestos not in excess of 0.1 fiber per cubic centimeter of air (f/cc) as an 8-hour TWA.
2. PEL-excursion Limit: An airborne concentration of asbestos not in excess of 1.0 f/cc of air as averaged over a sampling period of 30 minutes.

W. Personal Sampling: Air sampling which is performed to determine asbestos fiber concentrations within the breathing zone of a specific employee, as performed in accordance with 29 CFR 1926.1101.

X. TEM: Refers to transmission electron microscopy.

Y. Time Weighted Average (TWA): The TWA is an 8-hour time weighted average airborne concentration of asbestos fibers.

Z. Transite: A generic name for asbestos cement wallboard and pipe.

AA. Wetting Agent: A chemical added to water to reduce the water's surface tension thereby increasing the water's ability to soak into the material to which it is applied. An equivalent wetting agent must have a surface tension of at most 0.00042 psi.

BB. Worker: Individual (not designated as the CP or a supervisor) who performs asbestos work and has completed asbestos worker training required by 29 CFR 1926.1101, to include EPA Model Accreditation Plan (MAP) "Worker" training; accreditation, if required by the OSHA class of work to be performed or by the state where the work is to be performed. The worker must be appropriately licensed in the State of New Mexico.

1.04 REQUIREMENTS

A. Description of Work: The Work covered by this section includes the handling and control of asbestos-containing materials and describes some of the resultant procedures and equipment required to protect workers, the environment and occupants of the building or area, or both, from contact with airborne asbestos fibers. The Work also includes disposal of any asbestos-containing materials generated by the Work. More specific operational procedures must be outlined in the asbestos hazard abatement plan called for elsewhere in this Specification. The asbestos work includes the removal of asbestos cement sewer pipes. Under normal conditions non-friable or chemically bound materials containing asbestos, such as asbestos in cement pipe, would not be considered hazardous; however, this material may release airborne asbestos fibers during removal and therefore must be handled in accordance with the removal and disposal procedures as specified herein. The work area will be evacuated during the asbestos abatement work. A competent person must supervise asbestos removal work as specified herein.

B. Unexpected Discovery of Asbestos: Notify the Contracting Officer if any previously untested building components suspected to contain asbestos are impacted by the Work.

C. Medical Requirements: Provide medical requirements including but not limited to medical surveillance and medical record keeping as listed in 29 CFR 1926.1101.

1. Medical Examinations: Before exposure to airborne asbestos fibers, provide workers with a comprehensive medical examination as required by 29 CFR 1926.1101 or other pertinent state or local directives. This requirement must have been satisfied within the 12 months prior to the

start of work on this Contract. The same medical examination must be given on an annual basis to employees engaged in an occupation involving asbestos and within 30 calendar days before or after the termination of employment in such occupation. Specifically identify x-ray films of asbestos workers to the consulting radiologist and mark medical record jackets with the word “ASBESTOS”.

2. Medical Records: Maintain complete and accurate records of employees’ medical examinations, medical records, and exposure data for a period of 50 years after termination of employment and make records of the required medical examinations and exposure data available for inspection and copying to: The Assistant Secretary of Labor for Occupational Safety and Health (OSHA), or authorized representatives of them, and an employee’s physician upon the request of the employee or former employee.

D. Employee Training: Submit certificates, prior to the start of work but after the main abatement submittal, signed by each employee indicating that employee has received training in the proper handling of materials and wastes that contain asbestos in accordance with 40 CFR 763; understands health implications and risks involved, including illnesses possible from exposure to airborne asbestos fibers; understands the use and limits of respiratory equipment to be used; and understands the results of monitoring of airborne quantities of asbestos as related to health and respiratory equipment as indicated in 29 CFR 1926.1101 on an initial and annual basis. Organize certificates by individual worker, not grouped by type of certification. Train personnel involved in the asbestos control work in accordance with United States Environmental Protection Agency (USEPA) Asbestos Hazard Emergency Response Act (AHERA) training criteria or state training criteria, whichever is more stringent. Document the training by providing: Dates of training, training entity, course outline, names of instructors, and qualifications of instructors upon request by the Contracting Officer. Furnish each employee with respirator training and fit testing as required by 29 CFR 1926.1101 and 29 CFR 1926.103. Fully cover engineering and other hazard control techniques and procedures. Asbestos workers must have a current State of New Mexico asbestos worker’s license.

E. Permits and Notifications: Prior to the start of work, obtain necessary permits in conjunction with asbestos removal, encapsulation, hauling, and disposition, and furnish notification of such actions required by federal, state, regional, and local authorities. Notify the New Mexico Environment Department Air Quality Board and the Contracting Officer in writing 10 working days prior to commencement of Work in accordance with 40 CFR 61-Subpart M and New Mexico 20 NMAC 2.78. Notify the Contracting Officer and other appropriate Government agencies in writing 20 working days prior to the start of asbestos work as indicated in applicable laws, ordinances, criteria, rules, and regulations. Submit copies of all notifications to the Contracting Officer.

Links to New Mexico reporting forms are at: https://www.env.nm.gov/air-quality/asbestos/.

F. Environment, Safety and Health Compliance: In addition to detailed requirements of this specification, comply with those applicable laws, ordinances, criteria, rules, and regulations of federal, state, regional, and local authorities regarding handling, storing, transporting, and disposing of asbestos waste materials. Comply with the applicable requirements of the current issue of, 29 CFR 1926.1101, 40 CFR 61-Subpart A, 40 CFR 61-Subpart M, 40 CFR 763 and COMAR 26.11.21. Submit matters of interpretation of standards to the appropriate administrative agency for resolution before starting the Work. Where the requirements of this specification, applicable laws, rules, criteria, ordinances, regulations, and referenced documents vary, the most stringent requirement as defined by the Government apply.

G. Respiratory Protection Program: Establish and implement a respirator program as required by 29 CFR 1926.1101, and 29 CFR 1926.103. Submit a written description of the program to the Contracting Officer. Submit a written program manual or operating procedure including methods of compliance with regulatory statutes.

1. Respirator Program Records: Submit records of the respirator program as required by 29 CFR 1926.103, and 29 CFR 1926.1101.
2. Respirator Fit Testing: The Contractor's PQP must conduct a qualitative or quantitative fit test conforming to 29 CFR 1926.103 for each worker required to wear a respirator, and any authorized visitors who enter a regulated area where respirators are required to be worn. A respirator fit test must be performed prior to initially wearing a respirator and every 12 months thereafter. If physical changes develop that will affect the fit, a new fit test must be performed. Functional fit checks must be performed each time a respirator is put on and in accordance with the manufacturer's recommendation.
3. Respirator Selection and Use Requirements: Provide respirators, and ensure that they are used as required by 29 CFR 1926.1101 and in accordance with CGA G-7 and the manufacturer's recommendations. Respirators must be approved by the National Institute for Occupational Safety and Health (NIOSH), under the provisions of 42 CFR 84, for use in environments containing airborne asbestos fibers. For air-purifying respirators, particulate filter must be high-efficiency particulate air (HEPA)/(N-,R-,P-100). The initial respirator selection and decisions regarding the upgrading or downgrading of respirator type must be made by the Contractor's designated IH based on the measured or anticipated airborne asbestos fiber concentrations to be encountered.

H. Asbestos Hazard Control Supervisor: The Contractor must be represented on site by a supervisor, trained using the model Contractor accreditation plan as indicated in the federal statutes for all portions of the herein-listed Work.

I. Hazard Communication: Adhere to all parts of 29 CFR 1926.59 and provide the Contracting Officer with a copy of the Safety Data Sheets (SDS) for all materials brought to the Site.

J. Asbestos Hazard Abatement Plan: Submit a detailed plan of safety precautions such as lockout, tagout, tryout, fall protection, and confined space entry procedures and equipment and work procedures to be used in the removal of materials containing asbestos. The plan must include but not be limited to the precise personal protective equipment (PPE) to be used including, but not limited to, respiratory protection, type of whole-body protection, the location of asbestos control areas including clean and dirty areas, buffer zones, showers, storage areas, change rooms, removal method, interface of trades involved in the construction, sequencing of asbestos related work, disposal plan, type of wetting agent and asbestos sealer to be used, locations of local exhaust equipment, planned air monitoring strategies, and a detailed description of the method to be employed in order to control environmental pollution. The plan must also include (both fire and medical emergency) response plans and activity hazard analyses (AHAs) in accordance with EM 385-1-1. The asbestos hazard abatement plan must be approved in writing prior to starting any asbestos work. The Contractor, asbestos hazard control supervisor, CP, and PQP must meet with the Contracting Officer prior to beginning Work, to discuss in detail the asbestos hazard abatement plan, including work procedures and safety precautions. Once approved by the Contracting Officer, the plan will be enforced as if an addition to the specification. Any changes required in the specification as a result of the plan must be identified specifically in the plan to allow for free discussion and approval by the Contracting Officer prior to starting Work.

K. Testing Laboratory: If materials suspected to contain asbestos are sent for analytical testing, submit the name, address, and telephone number of each testing laboratory selected for the sampling, analysis, and reporting of airborne concentrations of asbestos fibers along with evidence that each laboratory selected holds the appropriate State license and permits and certification that each laboratory is American Industrial Hygiene Association (AIHA) accredited and that persons counting the samples have been judged proficient by current inclusion on the AIHA Asbestos Analysis Registry (AAR) and successful participation of the laboratory in the proficiency analytical testing (PAT) program. Where analysis to determine asbestos content in bulk materials or transmission electron microscopy is required, submit evidence that the laboratory is accredited by the National Institute of Science and Technology (NIST) under National Voluntary Laboratory Accreditation Program (NVLAP) for asbestos analysis. The testing laboratory

firm must be independent of the asbestos contractor and must have no employee or employer relationship which could constitute a conflict of interest.

L. Landfill Approval: Submit written evidence that the landfill is approved for asbestos disposal by the New Mexico Environment Department Solid Waste Bureau or applicable state or local agency if the waste is shipped for disposal out of state. Within 3 working days after delivery, submit detailed delivery tickets, prepared, signed, and dated by an agent of the landfill, certifying the amount of asbestos materials delivered to the landfill. Submit a copy of the waste shipment records within 1 day of the shipment leaving the Project Site.

M. Transporter Certification: Submit written evidence that the transporter is approved to transport asbestos waste in accordance with the DOT requirements of 49 CFR 171, 49 CFR 172, and 49 CFR 173 as well as registration requirements of 49 CFR 107 and all other state and local regulatory agency requirements.

N. Medical Certification: Provide written certification for each worker and supervisor, signed by a licensed physician indicating that the worker and supervisor has met or exceeded all of the medical prerequisites listed herein and in 29 CFR 1926.1101 and 29 CFR 1926.103 as prescribed by law. Submit certificates prior to the start of Work but after the main abatement submittal.

1.05 SUBMITTALS

A. Action Submittals:

1. Product Data: Safety Data Sheets (SDS) for all materials.
2. Test Reports:
   a. Air sampling results.
   b. Asbestos disposal quantity report.
3. Certificates:
   a. Employee training.
   b. Notifications.
   c. Respiratory protection program.
   d. Asbestos hazard abatement plan.
   e. Testing laboratory.
   f. Landfill approval.
   g. Delivery tickets.
   h. Waste shipment records.
   i. Transporter certification.
   j. Medical certification.
   k. Designated CP.
   l. Worker’s license.

m. Contractor's license.
n. Federal, state or local citations on previous projects.

B. Informational Submittals:

1. Product Data: Respirators.
2. Certificates: Equipment used to contain airborne asbestos fibers.

1.06 QUALITY ASSURANCE

A. Designated CP Documentation: The designated CP must be experienced in the administration and supervision of asbestos abatement projects including exposure assessment and monitoring, work practices, abatement methods, protective measures for personnel, setting up and inspecting asbestos abatement work areas, evaluating the integrity of containment barriers, placement and operation of local exhaust systems, ACM-generated waste containment and disposal procedures, decontamination, site safety and health requirements, and notification of other employees onsite. Designated CP must be onsite at all times when asbestos abatement activities are underway. Submit training certification and a current New Mexico Construction Industries Division asbestos contractor's and supervisor's license. Submit evidence that designated CP has a minimum of 2 years of on-the-job asbestos abatement experience relevant to OSHA designated competent person requirements. Designated CP must be a first-tier subcontractor.

B. Worker's License: Submit documentation that workers meet the requirements of 29 CFR 1926.1101, 40 CFR 61-Subpart M and have a current State of New Mexico asbestos worker's license.

C. Contractor's License: Submit a copy of the asbestos contractor's license issued by New Mexico Construction Industries Division. Submit the following certification along with the license: "I certify that the personnel I am responsible for during the course of this Project fully understand the contents of 29 CFR 1926.1101, 40 CFR 61-Subpart MEM 385-1-1, and the federal, state, and local requirements for those asbestos abatement activities that they will be involved in." This certification statement must be signed by the Company's President or Chief Executive.

D. Federal, State, or Local Citations on Previous Projects: Submit a statement, signed by an officer of the company, containing a record of any citations issued by federal, state or local regulatory agencies relating to asbestos activities within the last 5 years (including projects, dates, and resolutions); a list of penalties incurred through non-compliance with asbestos project specifications, including liquidated damages, overruns in scheduled time limitations and resolutions; and situations in which an asbestos-related contract has been terminated (including projects, dates, and reasons for

terminations). If there are none, a negative declaration signed by an officer of the company must be provided.

E. Preconstruction Conference: Conduct a safety preconstruction conference to discuss the details of the asbestos hazard abatement plan, accident prevention plan (APP) including the AHAs required in specification Section 01 35 23, Safety Requirements. The safety preconstruction conference must include the Contractor and their designated CP, designated IH, and Project Supervisor and the Contracting Officer. Deficiencies in the APP will be discussed. Onsite work must not begin until the APP has been accepted.

1.07 SECURITY

A. A log book must be kept documenting entry into and out of the regulated area. Entry into regulated areas must only be by personnel authorized by the Contractor and the Contracting Officer. Personnel authorized to enter regulated areas must be trained, medically evaluated, and wear the required PPE.

PART 2 PRODUCTS

2.01 POLYETHYLENE SHEETING

A. Physical Characteristics: Minimum of 6 mils thickness.

B. Functional Characteristics: As specified in Section 02 61 00, Removal and Disposal of Contaminated Soil.

C. Performance Characteristics: None.

2.02 TAPE

A. As specified in Section 02 61 00, Removal and Disposal of Contaminated Soil.

2.03 WETTING AGENTS

A. Physical Characteristics: None.

B. Functional Characteristics: Removal encapsulant (a penetrating encapsulant) must be provided when conducting removal abatement activities that require a longer removal time or are subject to rapid evaporation of amended water. Removal encapsulant must be capable of wetting the ACM and retarding fiber release during disturbance of the ACM greater than or equal to that provided by amended water.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 EQUIPMENT

A. Provide the Contracting Officer or the Contracting Officer's Representative, with PPE as required for entry to and inspection of the asbestos control area. Provide equivalent training to the Contracting Officer or a designated representative as provided to Contractor employees in the use of the required PPE. Provide manufacturer's certificate of compliance for all equipment used to contain airborne asbestos fibers.

1. Air Monitoring Equipment:
   a. Equipment must include, but must not be limited to the following:
      1) High-volume sampling pumps that can be calibrated and operated at a constant airflow up to 16 liters per minute.
      2) Low-volume, battery powered, body-attachable, portable personal pumps that can be calibrated to a constant airflow up to approximately 3.5 liters per minute, and a self-contained rechargeable power pack capable of sustaining the calibrated flow rate for a minimum of 10 hours. The pumps must also be equipped with an automatic flow control unit which must maintain a constant flow, even as filter resistance increases due to accumulation of fiber and debris on the filter surface.
      3) Single-use standard 25 mm diameter cassette, open face, 0.8 micron pore size, mixed cellulose ester membrane filters and cassettes with 50 mm electrically conductive extension cowl, and shrink bands for personal air sampling.
      4) A flow calibrator capable of calibration to within plus or minus 2 percent of reading over a temperature range of minus 4 degrees F to 140 degrees F and traceable to a NIST primary standard.

B. Respirators: Select respirators from those approved by the National Institute for Occupational Safety and Health (NIOSH), Department of Health and Human Services.

1. Respirators for Handling Asbestos: Provide personnel engaged in cleanup, handling, removal of asbestos materials with respiratory protection as indicated in 29 CFR 1926.1101 and 29 CFR 1926.103. Breathing air must comply with CGA G-7.

C. Exterior Whole-body Protection:

1. Outer Protective Clothing: Provide personnel exposed to asbestos with disposable "non-breathable" whole-body outer protective clothing, head coverings, gloves, and foot coverings. Provide disposable plastic or

rubber gloves to protect hands. Cloth gloves may be worn inside the plastic or rubber gloves for comfort, but must not be used alone. Make sleeves secure at the wrists, make foot coverings secure at the ankles, and make clothing secure at the neck by the use of tape. Reusable whole-body outer protective clothing is not allowed.

2. Work Clothing: Provide cloth work clothes for wear under the outer protective clothing and foot coverings and dispose of them after use.
3. Eye Protection: Provide eye protection that complies with ANSI/ISEA Z87.1 when operations present a potential eye injury hazard. Provide goggles to personnel engaged in asbestos abatement operations when the use of a full-face respirator is not required.

D. Regulated Areas: All Class I, II, and III asbestos work must be conducted within regulated areas. The regulated area must be demarcated to minimize the number of persons within the area and to protect persons outside the area from exposure to airborne asbestos. Control access to regulated areas, ensure that only authorized personnel enter, and verify that Contractor required medical surveillance, training and respiratory protection program requirements are met prior to allowing entrance.

E. Warning Signs and Labels: Provide warning signs printed in English, Spanish, or other languages represented by the work force involved in abatement activities at all approaches to asbestos control areas. Locate signs at such a distance that personnel may read the sign and take the necessary protective steps required before entering the area. Provide labels and affix to all asbestos materials, scrap, waste, debris, and other products contaminated with asbestos. Containers with preprinted warning labels conforming to the requirements are acceptable.

1. Warning Sign:
   a. Provide vertical format conforming to 29 CFR 1926.200, and 29 CFR 1926.1101 minimum 20 inches by 14 inches displaying the following legend in the lower panel:

Legend	Notation
DANGER	1-inch sans serif Gothic or Block
ASBESTOS	1-inch sans serif Gothic or Block
MAY CAUSE CANCER	1-inch sans serif Gothic or Block
CAUSES DAMAGE TO LUNGS	1/4-inch sans serif Gothic or Block
AUTHORIZED PERSONNEL ONLY	1/4-inch sans serif Gothic or Block

2. Spacing between lines must be at least equal to the height of the upper of any two lines.

3. Warning Labels:
   a. Provide labels conforming to 29 CFR 1926.1101 of sufficient size to be clearly legible, displaying the following legend:

DANGER
CONTAINS ASBESTOS FIBERS
MAY CAUSE CANCER
CAUSES DAMAGE TO LUNGS
DO NOT BREATHE DUST AVOID CREATING DUST

F. Decontamination Area: A decontamination area (equipment room/area) must be provided for Class I work involving less than 25 feet or 10 square feet of TSI or surfacing ACM, and for Class II and Class III asbestos work operations where exposures exceed the PELs or where there is no negative exposure assessment. The equipment room or area must be adjacent to the regulated area for the decontamination of employees, material, and their equipment which could be contaminated with asbestos. The area must be covered by an impermeable drop cloth on the floor or horizontal working surface. The area must be of sufficient size to accommodate cleaning of equipment and removing PPE without spreading contamination beyond the area.

G. Decontamination Area Exit Procedures:

1. Ensure that the following procedures are followed:
   a. Before leaving the regulated area, remove all gross contamination and debris from work clothing using a HEPA vacuum.
   b. Employees must remove their protective clothing in the equipment room and deposit the clothing in labeled impermeable bags or containers for disposal or laundering.
   c. Employees must not remove their respirators until showering.
   d. Employees must shower prior to entering the clean room. If a shower has not been located between the equipment room and the clean room or the work is performed outdoors, ensure that employees engaged in Class I asbestos jobs: a) Remove asbestos contamination from their work suits in the equipment room or decontamination area using a HEPA vacuum before proceeding to a shower that is not adjacent to the work area; or b) Remove their contaminated work suits in the equipment room, without cleaning worksuits, and proceed to a shower that is not adjacent to the work area.

3.02 WORK PROCEDURE

A. Perform asbestos-related work in accordance with 29 CFR 1926.1101, 40 CFR 61-Subpart M and as specified herein. Use wet removal procedures as listed in the asbestos hazard abatement plan. Wear and use protective clothing and equipment as specified herein. No eating, smoking, drinking, chewing gum, tobacco, or applying cosmetics is permitted in the asbestos work or control areas. Personnel of other trades not engaged in the removal of asbestos-containing material must not be exposed at any time to airborne concentrations of asbestos unless all the personnel protection and training provisions of this specification are complied with by the trade personnel. Stop abatement work in the regulated area immediately when the airborne total fiber concentration: 1) equals or exceeds 0.01 f/cc, or the pre-abatement concentration, whichever is greater, outside the regulated area; or 2) equals or exceeds 1.0 f/cc inside the regulated area. Correct the condition to the satisfaction of the Contracting Officer, including visual inspection and air sampling. Work must resume only upon notification by the Contracting Officer. Corrective actions must be documented. If an asbestos fiber release or spill occurs outside of the asbestos control area, stop Work immediately, correct the condition to the satisfaction of the Contracting Officer including clearance sampling, prior to resumption of Work.

B. Protection of Existing Work to Remain: Perform Work without damage or contamination of adjacent work. Where such work is damaged or contaminated as verified by the Contracting Officer using visual inspection or sample analysis, it must be restored to its original condition or decontaminated by the Contractor at no expense to the Government as deemed appropriate by the Contracting Officer. This includes inadvertent spill of dirt, dust, or debris in which it is reasonable to conclude that asbestos may exist. When these spills occur, stop Work immediately. Then clean up the spill. When satisfactory visual inspection and air sampling results are obtained from the GC Work may proceed at the discretion of the Contracting Officer.

C. Asbestos Control Area Requirements:

1. Regulated Area for Class II Removal: Removal of asbestos cement pipe is Class II removal activity. Establish designated limits for the asbestos regulated work area with the use of red barrier tape; install critical barriers, splash guards and signs, and maintain all other requirements for asbestos control area except local exhaust. Place impermeable dropcloths on surfaces beneath removal activity extending out 3 feet in all directions. A detached decontamination system may be used. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If workers, the airborne fiber concentration of the workers, or designated limits at any time

exceed background or 0.01 fiber per cubic centimeter, whichever is greater, stop Work immediately and correct the situation.

D. Removal Procedures: Wet asbestos material with a fine spray of amended water during removal, cutting, or other handling so as to reduce the emission of airborne fibers. Remove material and immediately place in 6-mil plastic disposal bags. Remove asbestos containing material in a gradual manner, with continuous application of the amended water or wetting agent in such a manner that no asbestos material is disturbed prior to being adequately wetted. Where unusual circumstances prohibit the use of 6-mil plastic bags, submit an alternate proposal for containment of asbestos fibers to the Contracting Officer for approval. For example, in the case where both piping and insulation are to be removed, the Contractor may elect to wet the insulation, wrap the pipes and insulation in plastic and remove the pipe by sections. Containerize asbestos-containing material while wet. Do not allow asbestos material to accumulate or become dry. Handle asbestos-containing material as indicated in 40 CFR 61-Subpart M.

E. Methods of Compliance:

1. Mandated Practices:
   a. Specific abatement techniques and items identified must be detailed in the Contractor's AHAP. Use the following engineering controls and work practices in all operations, regardless of the levels of exposure:
      1) Vacuum cleaners equipped with HEPA filters.
      2) Wet methods or wetting agents except where it can be demonstrated that the use of wet methods is unfeasible due to the creation of electrical hazards, equipment malfunction, and in roofing.
      3) Prompt cleanup and disposal.
      4) Inspection and repair of polyethylene.
      5) Cleaning of equipment and surfaces of containers prior to removing them from the equipment room or area.
2. Control Methods:
   a. Local exhaust ventilation equipped with HEPA filter.
   b. Enclosure or isolation of processes producing asbestos dust.
   c. Where the feasible engineering and work practice controls are not sufficient to reduce employee exposure to or below the PELs, use them to reduce employee exposure to the lowest levels attainable and must supplement them by the use of respiratory protection.
3. Unacceptable Practices:
   a. The following work practices must not be used:
      1) High-speed abrasive disc saws that are not equipped with point of cut ventilator or enclosures with HEPA filtered exhaust air.

2) Compressed air used to remove asbestos containing materials, unless the compressed air is used in conjunction with an enclosed ventilation system designed to capture the dust cloud created by the compressed air.
3) Dry sweeping, shoveling, or other dry cleanup.
4) Employee rotation as a means of reducing employee exposure to asbestos.

F. Class I Work Procedures:

1. In addition to requirements of Paragraph Mandated Practices and Paragraph Control Methods, the following engineering controls and work practices must be used:
   a. A CP must supervise the installation and operation of the control methods.
   b. For jobs involving the removal of more than 25 feet or 10 square feet of TSI or surfacing material, place critical barriers over all openings to the regulated area.
   c. HVAC systems must be isolated in the regulated area by sealing with a double layer of plastic or air-tight rigid covers.
   d. Impermeable dropcloths (6 mil or greater thickness) must be placed on surfaces beneath all removal activity.
   e. Where a negative exposure assessment has not been provided or where exposure monitoring shows the PEL was exceeded, the regulated area must be ventilated with a HEPA unit and employees must use PPE.

G. Class II Work Procedures:

1. In addition to requirements of Paragraph Mandated Practices and Paragraph Control Methods, the following engineering controls and work practices must be used:
   a. A CP must supervise the Work.
   b. For indoor work, critical barriers must be placed over all openings to the regulated area.
   c. Impermeable dropcloths must be placed on surfaces beneath all removal activity.

H. Specific Control Methods for Class II Work:

1. Asbestos Cement Pipe: Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. When removing cementitious asbestos-containing pipe use the following work practices. Intentionally cutting, abrading or breaking is prohibited. Asbestos cement pipe must be sprayed with

amended water prior to removal. Place cut pipe in an impervious waste bag or wrapped in plastic sheeting no later than the end of the work shift. Place debris into a disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve “adequately wet” conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duct tape to seal the bag, wash to remove any visible contamination and place into a second 6-mil minimum thickness disposal bag. Containerize asbestos containing waste while wet. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fiber per cubic centimeter, whichever is greater, stop Work immediately and correct the situation.

2. Gaskets: Establish designated limits for the asbestos regulated work area with the use of red barrier tape, critical barriers, signs, and maintain all other requirements for asbestos control area except local exhaust. Gaskets must be thoroughly wetted with amended water prior to removal and immediately placed in a disposal container. If a gasket is visibly deteriorated and unlikely to be removed intact, removal must be undertaken within a glovebag. Any scraping to remove residue must be performed wet. Place debris into a disposal bag or other approved container. Once the material is in the disposal bag, apply additional water as needed to achieve “adequately wet” conditions for NESHAP compliance. Place bagged asbestos waste under negative pressure with the use of a HEPA vacuum, goose neck and duct tape to seal the bag, wash to remove any visible contamination and place into a second disposal bag. Containerize asbestos containing waste while wet. Conduct area monitoring of airborne fibers during the work shift at the designated limits of the asbestos work area and conduct personal samples of each worker engaged in the work. If the airborne fiber concentration of the workers or designated limits at any time exceeds background or 0.01 fiber per cubic centimeter, whichever is greater, stop Work immediately and correct the situation.

I. Air Sampling: Perform sampling of airborne concentrations of asbestos fibers in accordance with 29 CFR 1926.1101, the Contractor’s air monitoring plan and as specified herein. Unless otherwise specified, use NIOSH Method 7400 for sampling and analysis. Monitoring may be duplicated by the Government at the discretion of the Contracting Officer. If air sampling results obtained by the Government differ from those results obtained by the Contractor, the Government will determine which results predominate. Results of breathing zone samples must be posted at the Job Site and made available to the

Contracting Officer. Submit all documentation regarding initial exposure assessments, negative exposure assessments, and air-monitoring results.

1. Sampling During Asbestos Work: Provide personal and area sampling as indicated in 29 CFR 1926.1101 and governing environmental regulations. Breathing zone samples must be taken for at least 25 percent of the workers in each shift, or a minimum of two, whichever is greater. Air sample fiber counting must be completed and results provided within 24 hours (breathing zone samples after completion of a sampling period). In addition, provided the same type of work is being performed, provide area sampling at least once every work shift close to the work inside the enclosure, outside the clean room entrance to the enclosure, and at the exhaust opening of the local exhaust system. If sampling outside the enclosure shows airborne levels have exceeded background or 0.01 fiber per cubic centimeter, whichever is greater, stop all work, correct the condition(s) causing the increase, and notify the Contracting Officer immediately. Where alternate methods are used, perform personal and area air sampling at locations and frequencies that will accurately characterize the evolving airborne asbestos levels. The written results must be signed by testing laboratory analyst, and testing laboratory principal. The air sampling results must be documented on a Contractor's daily air-monitoring log.

J. Site Inspection: While performing asbestos engineering control work, the Contractor must be subject to onsite inspection by the Contracting Officer who may be assisted by or represented by safety or industrial hygiene personnel. If the Work is found to be in violation of this specification, the Contracting Officer or its representative will issue a stop work order to be in effect immediately and until the violation is resolved. All related costs including standby time required to resolve the violation must be at the Contractor's expense.

3.03 CLEANUP AND DISPOSAL

A. Housekeeping: Essential parts of asbestos dust control are housekeeping and cleanup procedures. Maintain surfaces of the asbestos control area free of accumulations of asbestos fibers. Give meticulous attention to restricting the spread of dust and debris; keep waste from being distributed over the general area. Use HEPA-filtered vacuum cleaners. DO NOT BLOW DOWN THE SPACE WITH COMPRESSED AIR. When asbestos removal is complete, all asbestos waste is removed from the Work Site, and final cleanup is completed, the Contracting Officer will attest that the area is safe before the signs can be removed. The Contracting Officer will visually inspect all surfaces within the enclosure for residual material or accumulated dust or debris. The Contractor must re-clean all areas showing dust or residual materials. If re-cleaning is required, air sample and establish an acceptable asbestos airborne

concentration after re-cleaning. The Contracting Officer must agree that the area is safe in writing before unrestricted entry will be permitted. The Government must have the option to perform monitoring to determine if the areas are safe before entry is permitted.

B. Title to Materials: All waste materials, except as specified otherwise, become the property of the Contractor and must be disposed of as specified in applicable local, state, and federal regulations and herein.

C. Disposal of Asbestos:

1. Procedure for Disposal: Coordinate all waste disposal manifests with the Contracting Officer. Collect asbestos waste, contaminated wastewater filters, asbestos-contaminated water, scrap, debris, bags, containers, equipment, and asbestos-contaminated clothing which may produce airborne concentrations of asbestos fibers and place in sealed fiber-proof, waterproof, non-returnable containers (e.g., double plastic bags 6 mils thick, cartons, drums or cans). Wastes within the containers must be adequately wet in accordance with 40 CFR 61-Subpart M. Affix a warning and Department of Transportation (DOT) label to each container including the bags or use at least 6-mil thick bags with the approved warnings and DOT labeling preprinted on the bag. Clearly indicate on the outside of each container the name of the waste generator and the location at which the waste was generated. Prevent contamination of the transport vehicle (especially if the transport vehicle is a rented truck likely to be used in the future for non-asbestos purposes). These precautions include lining the vehicle cargo area with plastic sheeting (similar to work area enclosure) and thorough cleaning of the cargo area after transport and unloading of asbestos debris is complete. Dispose of waste asbestos material at landfill off Government property that has been approved or permitted by New Mexico Environment Department to accept asbestos waste. For temporary storage, store sealed impermeable bags in asbestos waste drums or skids. An area for interim storage of asbestos waste-containing drums or skids will be assigned by the Contracting Officer or its authorized representative. Comply with 40 CFR 61-Subpart M, and COMAR 26.11.21 for storing, hauling and disposal. Sealed plastic bags may be dumped from drums into the burial site unless the bags have been broken or damaged. Damaged bags must remain in the drum and the entire contaminated drum must be buried. Workers unloading the sealed drums must wear appropriate respirators and PPE when handling asbestos materials at the disposal site.
2. Asbestos Disposal Quantity Report: Record and report, to the Contracting Officer, the amount of asbestos-containing material removed and released for disposal. Deliver the report for the previous day at the beginning of each day shift with amounts of material removed

during the previous day reported in linear feet or square feet as described initially in this specification and in cubic feet for the amount of asbestos-containing material released for disposal.

END OF SECTION

SECTION 03 01 32
REPAIR OF VERTICAL AND OVERHEAD CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 301, Specifications for Structural Concrete.
   b. 506.2, Specification for Shotcrete.
2. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C293/C293M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Center-Point Loading.
   j. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   l. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   m. C596, Standard Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   n. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   o. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.

p. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
q. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
r. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
s. D4259, Standard Practice for Abrading Concrete.
t. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

3. NSF International (NSF): 61, Standard for Drinking Water System Components – Health Effects.

1.02 DEFINITIONS

A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. High-Pressure Water Blasting: Sometimes referred to as hydro-demolition. Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

D. Low-Pressure Spray Mortar: Mortar suitable to be applied by low-pressure spraying, and in small areas may be applied by hand troweling.

E. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets for each material supplied.
2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar for each repair location in concrete.

3. Drawings indicating results of sounding for hollow areas including location, size, and estimated quantity of hollow-sounding areas for each repair location.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer's preparation and installation instructions.
2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates: Confirmation material is certified to meet requirements of NSF 61.
4. Statements of Qualification:
   a. Repair mortar system applicator.
   b. Independent Testing Laboratory.
5. Field and laboratory test reports.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: For Repair System B – Low-Pressure Spray Mortar, in lieu of recognition or certification, demonstrate application of repair mortar manufacturer's system and obtain Certification of Proper Installation.
2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.

C. Pre-repair Conference:

1. Required Meeting Attendees:
   a. Contractor.
   b. Repair Subcontractor.
   c. Contracting Officer.
2. Schedule and conduct prior to conducting mockups and incorporation of respective products into Project. Notify Contracting Officer of location and time.
3. Agenda shall include, but not limited to:
   a. Review of field conditions. Conduct field observations of Work to be performed.
   b. Based on above observations, confirm material selection and make Project-specific repair method recommendations.

c. Review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.

B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR

A. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 488CI.
2. Or equal.

B. Physical Characteristics:

1. One-component or two-component, cement based, fiber reinforced, shrinkage compensated, gray in color, with a minimum 30-minute working time.
2. Free of chlorides and other chemicals causing corrosion.

C. Functional Characteristics: Sprayable, extremely low permeability, sulfate resistant, easy to use and requiring only addition of water.

D. Performance Characteristics:

1. Cured materials mixed in accordance with manufacturer's instructions shall conform to the following criteria:
   a. Compressive Strength, ASTM C109/C109M at 28 Days: 6,000 psi minimum.
   b. Flexural Strength, ASTM C348 at 28 Days: 1,100 psi minimum.
   c. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent, at 28 Days: 3,000 psi minimum.
   d. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 600 psi minimum.
   e. Drying Shrinkage, ASTM C157/C157M Modified at 28 Days or ASTM C531: 0.1 percent maximum.

f. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 1,000 coulombs maximum.
g. System shall not produce a vapor barrier.
h. Certified to meet requirements of NSF 61 for contact with potable water.

2.02 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR

A. Manufacturers and Products:

1. Sika Corp., Lyndhurst, NJ; SikaTop 123 PLUS.
2. Or equal.

B. Physical Characteristics: Polymer-modified, one- or two-component, cementitious based, chloride resistant, flowable, gray in color, working time of 20 minutes minimum, surface renovation mortar.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Cured Mortar Properties:
a. Compressive Strength, ASTM C109/C109M at 28 Days: 7,000 psi minimum.
b. Flexural Strength, ASTM C348 at 28 Days: 1,200 psi minimum.
c. Slant Shear Bond Strength, ASTM C882/C882M Test Method Modified with No Bonding Agent at 28 Days: 2,000 psi minimum.
d. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 psi minimum.
e. Drying Shrinkage, ASTM C596 at 28 Days: 0.12 percent maximum. Not required for small repair areas approximately 1 square foot in area or less.
f. Freeze Thaw Resistance, ASTM C666/C666M, at 300 Cycles: 90 percent RDM.
g. Chloride Ion Permeability Based on Charge Passed, ASTM C1202: 800 coulombs maximum for liquid holding and belowgrade repairs.
h. Certified to meet requirements of NSF 61 for contact with potable water.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.04 REINFORCEMENT

A. Deformed Steel Reinforcement: Per Section 03 21 00, Steel Reinforcement.

B. Tie Wire: 16-gauge, galvanized.

2.05 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

A. Manufacturers and Products:

1. Sika Corp., Lyndhurst, NJ; Sika Armatec 110 EpoCem.
2. Or equal.

B. Physical Characteristics:

1. Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.
2. Compatible with and from same manufacturer as the repair system used.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Mixed Bonding Agent Properties:
   a. Pot Life: 75 minutes to 105 minutes.
   b. Contact Time: 24 hours.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength, ASTM C496/C496M at 28 Days: 500 psi minimum.
   b. Flexural Strength, ASTM C348: 1,000 psi minimum.
   c. Slant Shear Bond Strength, ASTM C882/C882M at 14 Days:
      1) 2-hour Open Time: 2,500 psi minimum.
      2) 24-hour Open Time: 2,000 psi minimum.
3. Bonding agent shall not produce a vapor barrier.

2.06 EVAPORATION RETARDANT

A. As specified in Section 03 39 00, Concrete Curing.

2.07 CURING COMPOUND

A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system. Refer to Section 03 30 00, Cast-in-Place Concrete.

B. Existing Concrete Work: Repair concrete as identified in Contract Documents.

3.02 APPLICATION

A. General:

1. Repair System B: Medium to large areas and number of repair areas.
2. Repair System C: Small and limited areas and number of repair areas.

3.03 PREPARATION

A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Contracting Officer, and review proposed extent of repair with Contracting Officer.

B. Remove unsound, honeycombed, deteriorated, or otherwise defective areas of concrete from work areas.

1. Use 8,000 psi minimum high-pressure water or abrasive blasting machine as required for Site conditions.
2. Remove concrete to abrade substrate concrete surfaces to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot long straightedge, in accordance with ASTM D4259.
3. For existing structures, extent of concrete removal as shown on the Drawings.
4. Where final surface is required to be flush with existing adjacent surface remove existing concrete depth as required for application of minimum thickness of repair mortar.

C. Do not use power-driven jackhammers, chipping hammers, or scabblers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.

D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.

E. Remove unsound concrete to satisfaction of Contracting Officer.

F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.

G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to circumference of exposed steel reinforcement if one or more of the following surface conditions exist:

1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Contracting Officer.

H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.

I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminates from prepared areas.

J. Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar as required by and in accordance with repair mortar manufacturer’s printed instructions.

K. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Contracting Officer.

3.04 REINFORCEMENT INSTALLATION

A. Coat exposed new and existing steel reinforcement and reinforcement mesh with cementitious reinforcement coating at same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers’ printed instructions.

3.05 PROTECTION

A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

B. Protect adjacent surfaces, and equipment, from being damaged by overshooting, rebound, and dust, as applicable for repair mortar system used, from low-pressure spray mortar.

3.06 REPAIR SYSTEM B – LOW-PRESSURE SPRAY MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer's printed instructions.

B. After priming prepared substrate concrete surface per manufacturer's recommendations, apply mortar by low-pressure spraying equipment, unless noted otherwise.

C. Bonding Agent:

1. Use bonding agent when manufacture required for hand applied areas, in accordance with repair mortar manufacturer's instructions.
2. Application of repair mortar over bonding agent shall be completed within time frame recommended by bonding agent manufacturer.
3. Consult with manufacturer for optimum and minimum acceptable degrees of surface tackiness of coat.

D. Work mortar firmly and quickly into repair area.

E. Finish repair mortar to match adjacent concrete surface.

F. Cure as specified in Article Curing.

3.07 REPAIR SYSTEM C – POLYMER-MODIFIED REPAIR MORTAR PLACEMENT

A. Mix mortar in accordance with manufacturer's printed instructions.

B. Bond Coat: Apply to prepared substrate concrete surface before application of mortar in accordance with repair mortar manufacturer's printed instructions. Do not apply more bond coat than can be covered with mortar before bond coat dries. Do not retemper bond coat.

C. Place mortar by hand or low-pressure spray and trowel to specified surface finish, in accordance with requirements of repair material's printed instructions.

D. Finish repair mortar to smooth even surface to match adjacent concrete surface.

E. Cure as specified in Article Curing, and in accordance with manufacturer's printed instructions.

3.08 CURING

A. Prior to curing, apply water fog to repair mortar system in accordance with repair mortar system manufacturer's printed instructions.

B. Cure in accordance with repair mortar manufacturer's printed instructions.

C. Where permitted by repair mortar manufacturer's printed instructions, commence water or continue water fog curing after repair mortar system application and when curing will not cause erosion of mortar.

D. Continuously water or fog cure repair mortar system for a period of 7 days.

E. Do not cure using curing compound or membrane, unless method is part of repair mortar system manufacturer's printed instructions and approval is obtained from Contracting Officer.

F. Cure intermediate layers of repair mortar in accordance with repair mortar manufacturer's printed instructions.

G. Where curing compound is permitted by repair mortar system manufacturer, apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.09 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed wet mortar materials from nozzle, or mixer, during construction for compliance with Specifications for testing at 7 days, and 28 days.

3. Provide a minimum of three samples for each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

C. Direct Tension Bond Test:

1. Only where required by Contracting Officer for specific repair location.
2. In Situ Bond Testing: Perform tension bond test in accordance with ASTM C1583/C1583M.
3. Record locations on in situ bond tests on each type of applied repair mortar.

D. Testing laboratory retained by Contractor must provide the following:

1. Compression Strength Test:
   a. Testing will follow a “modified” ASTM C109/C109M.
   b. A minimum of three production samples of mixed material will be obtained from each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days.
   c. Record location where repair mortar is being applied at time production samples are obtained.
2. Direct Tension Bond Test:
   a. Only where required by Contracting Officer for specific repair location.
   b. Two core samples will be obtained and tested for each 2,000 square feet of repair work.
   c. Cores will be 2-1/2-inch or 3-inch diameter to a total depth equal to at least 2.5 times repair mortar thickness.
   d. Bond Strength of Repair Mortar to Substrate Concrete: 300 psi minimum in direct tension without failure or movement.
   e. Record locations of Bond Tests on each type of applied repair mortar tested.

E. Retest mortar repairs that do not meet test requirements.

F. Repair and fill holes using same repair mortar where core samples have been removed.

3.10 MORTAR REPAIR FAILED TEST

A. Remove and replace unacceptable Work.

B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge. Remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.

C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.

D. Failed Bond Tests: Remove affected areas of repair mortar represented by failed bond test results. Prepare substrate surface and reapply repair mortar as specified herein above.

E. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.11 CLEANING

A. Remove overshot low-pressure spray, Repair System B repair mortar and rebound materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of or repair areas, finishing, and curing, and dispose offsite at an approved disposal site.

END OF SECTION

SECTION 03 01 33
REPAIR OF HORIZONTAL CONCRETE SURFACES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T277, Standard Method of Test for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
2. ASTM International (ASTM):
   a. A82/A82M, Standard Specification for Steel Wire, Plain, for Concrete Reinforcement.
   b. A185/A185M, Standard Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   c. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   d. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. C78/C78M, Standard Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).
   g. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C348, Standard Test Method for Flexural Strength of Hydraulic-Cement Mortars.
   j. C469, Standard Test Method for Static Modulus of Elasticity and Poisson's Ratio of Concrete in Compression.
   k. C496/C496M, Standard Test Method for Splitting Tensile Strength of Cylindrical Concrete Specimens.
   l. C666/C666M, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
   m. C779/C779M, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
   n. C882/C882M, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used with Concrete by Slant Shear.
   o. C928/C928M, Standard Specification for Packaged, Dry, Rapid-Hardening Cementitious Materials for Concrete Repairs.

p. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
q. C1202, Standard Test Method for Electrical Indication of Concrete's Ability to Resist Chloride Ion Penetration.
r. C1583/C1583M, Standard Test Method for Tensile Strength of Concrete Surfaces and the Bond Strength or Tensile Strength of Concrete Repair and Overlay Materials by Direct Tension (Pull-off Method).
s. D638, Standard Test Method for Tensile Properties of Plastics.
t. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
u. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
v. D4259, Standard Practice for Abrading Concrete.
w. E699, Standard Practice for Evaluation of Agencies Involved in Testing, Quality Assurance, and Evaluating of Building Components.

3. NSF, International (NSF): 61, Standard for Drinking Water System Components – Health Effects.

1.02 DEFINITIONS

A. Abrasive Blasting: Surface preparation method that uses compressed air intermixed with an abrasive medium to clean surface of substrate concrete, exposed steel, and steel reinforcement. Compressed air and abrasive medium is projected at high speed through a nozzle directly at the surface. Method is used to remove corrosion by-products, laitance, or other materials that may inhibit bond of repair concrete.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. High-Pressure Water Blasting (sometimes referred to as hydro-demolition): Uses water that may contain an abrasive medium, projected under high pressure and high velocity. Used for demolition, cutting, partial or full depth removal, cleaning, scarifying, or roughening of concrete surfaces, or removing existing coatings, for preparation of substrate concrete surfaces.

D. New Concrete: As defined in Section 03 30 00, Cast-in-Place Concrete.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets for each material supplied.
2. Drawings supplemented by photographs indicating location, size, estimated quantity, and proposed repair mortar system for each repair location in concrete.

3. Drawings indicating results of sounding for hollow areas including location, size, estimated quantity, of hollow-sounding areas for each repair location.

B. Informational Submittals:

1. Repair Mortar System: Manufacturer's preparation and installation instructions.
2. Written description of equipment proposed for concrete removal and surface preparation.
3. Certificates:
   a. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, that repair mortar systems are prepackaged, shrinkage compensated, specially designed for use on horizontal surfaces that are exposed to weather, potable water, or receive traffic.
   b. Mortar Manufacturer's Certificate of Proper Installation: As specified in Section 01 67 00, Product Requirements.
   c. Confirmation epoxy resin bonding agents conform to ASTM C882/C882M.
4. Statements of Qualification:
   a. Repair mortar system applicator.
   b. Independent Testing Laboratory.
5. Field and laboratory test results.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Repair Mortar System Applicator: Trained and experienced applicator endorsed by repair mortar system manufacturer.
2. Repair Mortar System Manufacturer's Representative: Knowledgeable and experienced on technical data and application requirements for specified products.

B. Independent Testing Laboratory: Meet criteria stated in ASTM E699.

C. Pre-repair Conference:

1. Required Meeting Attendees:
   a. Contractor.
   b. Repair Subcontractor.
   c. Contracting Officer.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Contracting Officer of location and time.

3. Agenda shall include, but not limited to:
    a. Review of field conditions. Conduct field observations of the Work to be performed.
    b. Based on above observations, confirm material selection and make Project specific repair method recommendations.
    c. Review proposed surface preparation, material application, consolidation, finishing, curing, and protection of repair material from weather conditions.
    d. Other specified requirements requiring coordination.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package repair mortar system products in moisture-resistant bags, pails, or moisture-resistant bulk bags.

B. Deliver, store, and handle repair materials in accordance with manufacturer's printed instructions.

PART 2 PRODUCTS

2.01 REPAIR MORTAR SYSTEM NO. 3—SHRINKAGE COMPENSATED REPAIR MORTAR

A. Not for use where in contact with potable water.

B. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco S 466 CI.
2. Or equal.

C. Physical Characteristics: One-component or two-component cement-based, flowable, shrinkage compensated repair mortar system.

D. Functional Characteristics: None.

E. Performance Characteristics:

1. Compressive Strength, ASTM C109/C109M:
    a. 1 Day: 2,500 psi minimum.
    b. 7 Days: 6,000 psi minimum.
    c. 28 Days: 8,000 psi minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 770 psi minimum.
3. Modulus of Elasticity, ASTM C469 at 28 Days: 5.9 by 106 psi minimum.

4. Slant Shear Bond Strength, ASTM C882/C882M Modified:
   a. 7 Days: 2,150 psi minimum.
   b. 28 Days: 3, 000 psi minimum.
5. Freeze-thaw Resistance: ASTM C666/C666M, Procedure A, at 300 Cycles: 97.0 percent RDM.
6. Chloride Ion Permeability Based on Charge Passed: ASTM C1202 at 28 Days: 650 coulombs maximum.
7. Sulfate Resistance: ASTM C1012/C1012M after 6 Months: 0.01 percent length change maximum.

2.02 REPAIR MORTAR SYSTEM NO. 5—POLYMER MODIFIED REPAIR MORTAR

A. Manufacturers and Products:

1. Not for use where in contact with potable water:
   a. Euclid Chemical Co., Cleveland, OH; Duraltop Flowable Mortar.
   b. Or equal.
2. For use where in contact with potable water:
   a. Sika Corp., Lyndhurst, NJ; SikaTop 122 PLUS.
   b. Or equal.

B. Physical Characteristics: One-component or two-component, fast-setting, polymer modified cementitious based repair mortar system.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Compressive Strength, ASTM C109/C109M:
   a. 1 Day: 2,500 psi minimum.
   b. 7 Days: 5,000 psi minimum.
   c. 28 Days: 7,000 psi minimum.
2. Flexural Strength, ASTM C348 at 28 Days: 1,500 psi minimum.
3. Slant Shear Bond Strength: ASTM C882/C882M Modified at 28 Days: 2,000 psi minimum.
4. Splitting Tensile Strength: ASTM C496/C496M at 28 Days: 600 psi minimum.
5. Abrasion Resistance Depth of Wear: ASTM C779/C779M, Procedure A, at 60 Minutes: 0.033 inch maximum.
6. Drying Shrinkage: ASTM C157/C157M Modified, at 28 Days: 0.09 percent maximum.
7. Rapid Chloride Ion Permeability Based on Charge Passed, ASTM C1202:
   a. 28 Days: Under 850 coulombs maximum.
8. Where in contact with potable water: Certified to meet requirements of NSF 61 for contact with potable water.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards, as specified in Section 03 30 00, Cast-in-Place Concrete.

2.04 REINFORCEMENT

A. Deformed Steel Reinforcement: Per Section 03 21 00, Steel Reinforcement.

2.05 CEMENTITIOUS BONDING AGENT AND REINFORCEMENT COATING

A. Manufacturers and Products:

1. Sika Corp., Lyndhurst, NJ; Sika Armatec 110 EpoCem.
2. Or equal.

B. Physical Characteristics: Cementitious adhesive, specifically formulated for bonding plastic portland cement concrete or mortar to hardened portland cement concrete.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Mixed Bonding Agent Properties:
   a. Pot Life: 75 minutes to 105 minutes.
   b. Contact Time: 24 hours.
2. Cured Cementitious Adhesive Properties:
   a. Splitting Tensile Strength: ASTM C496/C496M at 28 Days: 600 psi minimum.
   b. Flexural Strength: ASTM C348: 1,000 psi minimum.
   c. Slant Shear Bond Strength:
      1) ASTM C882/C882M:
         a) 2-hour Open Time: 2,500 psi minimum.
         b) 24-hour Open Time: 2,000 psi minimum.
3. Bonding agent shall not produce a vapor barrier.
4. Compatible with, and from same manufacturer as the, repair mortar system used.

2.06 EPOXY BONDING AGENT

A. Manufacturers and Products:

1. BASF Construction Chemicals, LLC - Building Systems, Shakopee, MN; MasterEmaco ADH 326 when ambient temperature is 73 degrees F or higher.
2. Or equal.

B. Physical Characteristics: Two-component, moisture insensitive, 100 percent solids epoxy resin.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Tensile Strength, ASTM D638, at 14 Days: 4,400 psi minimum.
2. Elongation at Break, ASTM D638: 1.49 percent minimum.
3. Compressive Strength, ASTM D695, at 28 Days for Application Temperature of 73 Degrees F to 77 Degrees F: 8,000 psi minimum.
4. Bond Strength, ASTM C882/C882M, at 14 Days: 1,800 psi minimum.
5. Pot Life, at 73 Degrees F to 77 Degrees F: 75 minutes minimum.

2.07 EVAPORATION RETARDANT

A. As specified in Section 03 39 00, Concrete Curing.

2.08 CURING COMPOUND

A. As specified in Section 03 39 00, Concrete Curing.

PART 3 EXECUTION

3.01 GENERAL

A. New Concrete Work: Repair deficiencies in new concrete structures constructed under this Contract with applicable repair system.

B. Existing Concrete Work: Repair concrete as identified in Contract Documents.

3.02 APPLICATION

A. General:

1. Repair Mortar System No. 3: Patches, joints, or overlays 1 inch thick or greater. Return to service in 7 days or more.

2. Repair Mortar System No. 5:
   a. Patches and Overlays: 1/4 inch to 3 inches thick.
   b. Return to service for foot traffic in 4 hours; wheel traffic in 7 days.
   c. Working Time: 30 minutes at 70 degrees F.
   d. Application Temperature Range: 45 degrees F to 90 degrees F.

3.03 PREPARATION

A. Identify unsound and deteriorated concrete by sounding techniques, or as directed by Contracting Officer. Review proposed extent of repair with Contracting Officer.

B. Remove unsound, deteriorated, or otherwise defective areas of concrete from Work areas.

   1. Use 8,000 psi minimum high-pressure water or abrasive blasting machine, as appropriate to suit Site conditions.
   2. Remove concrete to abrade substrate concrete surface to a minimum amplitude roughness of 3/16 inch measured between high and low points with a 3-foot long straightedge, in accordance with ASTM D4259.
   3. For existing structures, extent of concrete removal as shown on the Drawings.
   4. Where final surface is required to be flush with existing adjacent surface, remove existing concrete depth as required for application of minimum thickness of repair mortar.

C. Do not use power-driven jackhammers, chipping hammers, scabblers, or scarifiers unless water blasting is not permitted or practical because of Site conditions, or may cause other damage to equipment or facilities. In such cases where chipping hammers are required, limit size of chipping hammer to 16 pounds or lighter, or use small electric chipping hammer, to reduce formation of micro-fractures in substrate concrete surface.

D. Following removal of unsound or deteriorated concrete, check substrate concrete surface by sounding techniques to identify unsound concrete remaining or resulting from use of chipping hammer.

E. Remove unsound concrete to satisfaction of Contracting Officer.

F. Square edges of patch areas by sawing or chipping to avoid tapered shoulders or featheredges. Avoid cutting embedded steel reinforcement. Roughen polished saw-cut edge by high-pressure water blasting or abrasive blasting.

G. Remove concrete adjacent to steel reinforcement to a minimum of 1-inch clearance around steel reinforcement for application and bonding of new repair mortar to entire circumference of exposed steel reinforcement if one or more of the following surface conditions exist:

1. 50 percent or more of circumference around steel reinforcement is exposed during concrete removal.
2. 25 percent or more of circumference around steel reinforcement is exposed during concrete removal and corrosion is present to extent that more than 25 percent loss of section has occurred.
3. Otherwise evident that bond between existing concrete and steel reinforcement has been destroyed or has deteriorated as determined by Contracting Officer.

H. Clean exposed steel reinforcement of loose rust and concrete splatter per recommendations of repair material manufacturer and in accordance with ASTM D4258.

I. Keep areas from which concrete has been removed free of dirt, dust, and water blasting waste slurry. Remove laitance and other bond inhibiting contaminates from prepared areas.

J. Preparation of Substrate Concrete Surface in Areas to Receive Repair Mortar System No. 3 and No. 5: Dampen repair areas at least 6 inches beyond area to receive repair mortar for at least 24 hours to provide saturated surface dry (SSD) condition without standing water at time of application of mortar, as required by and in accordance with repair mortar manufacturer's printed instructions.

K. Spalled Joints:

1. Saw cut edge 1 inch deep and 6 inches back from old joint.
2. Remove unsound concrete and concrete between saw cut and joint.
3. Place wood or fiber spacer to thickness of joint at joint line.

L. Overlays:

1. Square cut edges to a minimum of 1/4 inch deep.
2. Do not feather edge area.
3. Perform special preparation recommended by mortar manufacturer.

M. Collect and dispose of spent water and concrete debris from removal operations offsite in manner and location acceptable to Contracting Officer.

3.04 REINFORCEMENT

A. Coat exposed new and existing steel reinforcement with cementitious reinforcement coating at the same time as substrate concrete is coated, as specified below, per repair mortar and cementitious reinforcement coating manufacturers' printed instructions.

3.05 PROTECTION

A. If cementitious coating or bonding agent is used, protect adjacent surfaces from over application. Promptly remove bonding agent applied beyond repair area.

B. Protect adjacent surfaces, and equipment from spillage of repair mortar and dust, as applicable for repair mortar system used.

3.06 PLACEMENT

A. Repair Mortar System No. 3 and No. 5:

1. Remove standing and free water from prepared area.
2. Apply bond scrub coat of mortar to prepared surface in accordance with manufacturer's instructions. Do not apply more scrub coat of mortar than can be covered with repair mortar before scrub coat begins drying.
3. Immediately place mixed repair mortar into prepared area from one side to the other side.
4. Work material firmly into bottom and sides of patch to ensure a good continuous bond.
5. Level repair mortar and screed to elevation of existing concrete.
6. Finish to same texture as existing concrete around patch.
7. Repair Mortar System No. 5 screed or use self-leveling mixture to obtain a uniform and plane surface.

B. Joint Repair:

1. Remove joint spacer when repair mortar is hard enough that a pointed trowel will penetrate surface less than 1/2 inch.
2. When repair mortar is cured and ready for use, fill joint in accordance with repair mortar system manufacturer's instructions.

3.07 CURING

A. Repair Mortar System No. 1:

1. No curing is required.
2. Protect from rain immediately after placing.

3. Liquid-membrane curing compounds or plastic sheeting may be used in accordance with repair mortar manufacturer's instructions to protect the surface from precipitation.
4. Never wet cure.

B. Repair Mortar System No. 3 or No. 5: Apply curing compound in accordance with Section 03 39 00, Concrete Curing.

3.08 FIELD QUALITY CONTROL

A. Sounding for Hollow Areas:

1. Chain drag or light hammer tap repaired areas listening for hollow sound to determine areas that have not properly bonded to substrate concrete.
2. Mark hollow areas for removal and replacement.

B. Compression Strength Test:

1. Test in accordance with ASTM C109/C109M, except modified by making samples using repair mortar.
2. Obtain production samples of mixed materials from mixer during construction for compliance with Specifications.
3. Provide minimum of three samples for each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater for testing.
4. Record location where repair mortar is being applied at time production samples are obtained.

C. Testing laboratory retained by Contractor must provide the following:

1. Compression Strength Test:
   a. Testing will follow a "modified" ASTM C109/C109M.
   b. A minimum of three production samples of mixed material will be obtained from each 200 square feet of mortar repair, and a minimum of three samples in total, whichever is greater, for testing at 7 days, and 28 days.
   c. Record location where repair mortar is being applied at time production samples are obtained.

D. Retest mortar repairs that do not meet test requirements.

3.09 MORTAR REPAIR FAILED TEST

A. Remove and replace unacceptable Work.

B. Hollow Sounding Areas: Saw cut hollow sounding areas to a new square edge, remove unsound mortar repair. Prepare substrate surface and reapply repair mortar as specified herein above.

C. Failed Compression Strength Test: Remove affected areas of repair mortar represented by failed compression strength test results. Prepare substrate surface and reapply repair mortar as specified herein above.

D. Retest areas where repair mortar was removed and replaced, in accordance with test requirements specified herein above.

3.10 MANUFACTURERS' SERVICES

A. Provide mortar manufacturer's representative at Site to advice on product selection, review acceptability of surface preparation, mixing and installation assistance, inspection, and Certification of Proper Installation.

3.11 CLEANING

A. Remove excess repair mortar materials as the Work proceeds. Remove waste materials, unsound material from concrete surfaces, material chipped from structure, and water used in preparation of repair areas, finishing, and curing, and dispose offsite at approved disposal site.

END OF SECTION

SECTION 03 10 00
CONCRETE FORMING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   a. 301, Specifications for Structural Concrete.
   b. 318, Building Code Requirements for Structural Concrete.
2. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

1.02 DEFINITIONS

A. Architectural Concrete: See definition in Section 03 30 00, Cast-in-Place Concrete.

B. Defective Areas: See definition in Section 03 30 00, Cast-in-Place Concrete.

C. Exposed Concrete: See definition in Section 03 30 00, Cast-in-Place Concrete.

1.03 DESIGN REQUIREMENTS

A. Design formwork in accordance with ACI 301 and ACI 318 to provide concrete finishes specified in Section 03 30 00, Cast-in-Place Concrete.

B. Unless otherwise specified, limit deflection of facing materials for concrete surfaces to comply with ACI 301. Limit deflection of facing materials to comply with tolerance limits established by Contract Documents and with tolerances required by equipment manufacturers. Coordinate tolerance requirements with equipment manufacturers.

1.04 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Formwork drawings signed and sealed by a licensed professional engineer in the state of the Project.
   b. Layout of panel joints and tie hole pattern.

2. Product Data:
    a. Form release agent.
    b. Form ties.
    c. Products to be used for sealing tie holes.

B. Informational Submittals: Statement of qualifications for formwork designer.

1.05 QUALITY ASSURANCE

A. Qualifications: Formwork Designer: Formwork, falsework, and shoring design shall be designed by an engineer licensed in the state of Project.

PART 2 PRODUCTS

2.01 FORM MATERIALS

A. Wall Forms and Underside of Slabs and Beams:

1. Materials: Plywood, hard plastic finished plywood, overlaid waterproof particle board, or steel in “new and undamaged” condition, of sufficient strength and surface smoothness to produce specified finish.
2. Where steel forms are used, treat steel surfaces to prevent rusting using products approved for use on steel forms.

B. Column Forms:

1. Rectangular Columns: As specified for walls.

C. Sandblasted Surface Forms: Medium-density overlay plywood for flat concrete surfaces to be sandblasted.

D. Painted Surface Forms: High-density overlay plywood for flat concrete surfaces to be painted.

E. All Other Forms: Materials as specified for wall forms.

F. Leave in place bulkhead forms are not allowed.

2.02 ACCESSORIES

A. Form Release Agent:

1. Manufacturers and Products: Not for surfaces exposed to potable water.
    a. BASF, Shakopee, MN; MBT MasterFinish RL 211.
    b. Or equal.
2. Manufacturers and Products: For use with potable water structures.
    a. Dayton Superior; Clean Strip J1EF.
    b. Or equal.

3. Physical Characteristics:
    a. Ready-to-use water based material formulated to reduce or eliminate surface imperfections.
    b. Contain no mineral oil or organic solvents.
4. Functional Characteristics: None.
5. Performance Characteristics:
    a. Shall not bond with, stain, or adversely affect concrete surfaces.
    b. Shall not impair subsequent treatments of concrete surfaces when applied to forms.
    c. Where used on surfaces exposed to potable water: Environmentally safe, meeting local, state, and federal regulations.

B. Rustication Grooves and Beveled Edge Corner Strips: Nonabsorbent material, compatible with form surface, fully sealed on all sides prohibiting loss of paste or water between the two surfaces.

C. Form Snap-Ties:

1. Material: Steel.
2. Spreader Inserts:
    a. Conical or spherical type.
    b. Design to maintain positive contact with forming material.
    c. Furnish units that will leave no metal closer than 1.5 inches to concrete surface when forms, inserts, and tie ends are removed.
3. Wire ties not permitted.
4. Flat bar ties for panel forms; furnish plastic or rubber inserts with minimum 1.5-inch depth and sufficient dimensions to permit patching of tie hole.

D. Form Snap-Ties with Water Stop:

1. For water-holding structures, basements, pipe galleries, and accessible spaces below finish grade, furnish one of the following:
    a. Integral steel water stop 0.103-inch thick and 0.625-inch diameter tightly and continuously welded to tie.
    b. Neoprene water stop 3/16-inch thick and 15/16-inch diameter whose center hole is one-half diameter of tie, or molded plastic water stop of comparable size.
    c. Orient water stop perpendicular to tie and symmetrical about center of tie.
    d. Design ties to prevent rotation or disturbance of center portion of tie during removal of ends and to prevent water leaking along tie.

E. Through-Bolts:

1. At Contractor's option, may be used as alternate to form snap-tie or form snap-tie with water stop.
2. Tapered minimum 1-inch diameter at smallest end.
3. Elastic Vinyl Plug for Through-Bolt Tie Holes:
   a. Manufacturers and Products:
      1) Dayton Superior, Miamisburg, OH; A58 Sure Plug.
      2) Or equal.
   b. Physical Characteristics: None.
   c. Functional Characteristics: None.
   d. Performance Characteristics: Design and size of plug to allow insertion with tool to enable plug to elongate and return to original length and diameter upon removal; forms watertight seal.

PART 3 EXECUTION

3.01 FORM SURFACE PREPARATION

A. Prior to coating surface, thoroughly clean form surfaces that will be in contact with concrete or that have been in contact with previously cast concrete, dirt, and other surface contaminants.

B. Exposed Wood Forms in Contact with Concrete: Apply form release agent as recommended by manufacturer.

C. Steel Forms: Apply form release agent as soon as they are cleaned to prevent discoloration of concrete from rust.

3.02 ERECTION

A. General: In accordance with ACI 301, unless otherwise specified.

B. Beveled Edges (Chamfer):

1. Form 3/4-inch bevels at concrete edges, unless otherwise shown.
2. Where beveled edges on existing adjacent structures are other than 3/4 inch, obtain Contracting Officer's approval of size prior to placement of beveled edge.

C. Wall Forms:

1. Do not reuse forms with damaged surfaces.
2. Locate form ties and joints in uninterrupted uniform pattern.
3. Inspect form surfaces prior to installation to ensure conformance with specified tolerances.

D. Form Tolerances:

1. Provide forms in accordance with ACI 117 and ACI 318, and the following tolerances for finishes specified:
   a. See the Schedule of Concrete Finishes in Section 03 30 00, Cast-in-Place Concrete, for beam, column, and wall types related to required form tolerances.
   b. Wall Tolerances:
      1) Straight Vertical or Horizontal Wall Surface: Flat planes within tolerance specified.
      2) Wall Type W-A:
         a) Plumb within 1/4 inch in 10 feet or within 1 inch from top to bottom for walls over 40 feet high.
         b) Depressions in Wall Surface: Maximum 5/16 inch when 10-foot straightedge is placed on high points in all directions.
      3) Wall Type W-B:
         a) Plumb within 1/8 inch in 10 feet or within 1/2 inch from top to bottom for walls over 40 feet high.
         b) Depressions in Wall Surface: Maximum 1/8 inch when 10-foot straightedge is placed on high points in all directions.
      4) Thickness: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
      5) Form Offset: Between adjacent pieces of formwork, facing material shall not exceed 1/8 inch.
   c. Beams and Columns Tolerances:
      1) Exposed Straight Horizontal and Vertical Surfaces: Flat planes within tolerances specified.
      2) Lateral Alignment:
         a) Centerlines shall be within plus or minus 1/2 inch from dimensions shown.
         b) At intersections, centerlines shall intersect within plus or minus 1/2 inch of dimensions shown.
      3) Beam Type B-A:
         a) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
         b) Elevations: Within plus or minus 1/2 inch, except where tops of beams become part of finished slab. In this case refer to slab tolerances.
      4) Column Type C-A:
         a) Physical Dimensions: Maximum 1/4 inch minus or 1/2 inch plus from dimension shown.
         b) Plumb within 1/4 inch in 10 feet in all directions with maximum 1/2 inch out-of-plumb at top with respect to bottom.

3.03 FORM REMOVAL

A. Nonsupporting forms, sides of beams, walls, columns, and similar parts of Work, may be removed after cumulatively curing at not less than 50 degrees F for 24 hours from time of concrete placement if:

1. Concrete is sufficiently hard so as not to sustain damage by form removal operations.
2. Curing and protection operations are maintained.

B. Elevated Structural Slabs or Beams: In accordance with ACI 318, Chapter 6, and at such time as concrete has reached compressive strength equal to 80 percent of specified 28-day compressive strength as determined by test cylinders.

C. Form Ties: Remove conical inserts or through bolts and plug holes as specified in Section 03 30 00, Cast-in-Place Concrete.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in Statement of Special Inspections Plan as shown on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

END OF SECTION

SECTION 03 15 00
CONCRETE JOINTS AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   d. A767/A767M, Specification for Zinc-Coated (Galvanized) Steel Bars for Concrete Reinforcement.
   e. C920, Specification for Elastomeric Joint Sealants.
   f. D226, Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
   g. D227, Specification for Coal-Tar Saturated Organic Felt Used in Roofing and Waterproofing.
   h. D994, Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
   i. D1056, Specification for Flexible Cellular Materials—Sponge or Expanded Rubber.
   j. D1171, Standard Guide for Evaluating Nonwoven Fabrics.
   k. D1751, Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   l. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   m. D2240, Standard Test Method for Rubber Property – Durometer Hardness.
2. Corps of Engineers (COE): CRD-C-572, Corps of Engineers Specifications for Polyvinylchloride Waterstop.
3. NSF International (NSF): 61, Drinking Water System Components - Health Effects.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Waterstop: Details of splices, method of securing and supporting waterstop in forms to maintain proper orientation and location during concrete placement.
   b. Construction Joints and Control Joints: Layout and location for each type. Include joint locations shown on the Drawings, additional required joint locations and any proposed alternate locations.
2. Product Data:
   a. Waterstops.
   b. Premolded joint fillers.
   c. Roofing felt.
   d. Accessories not specified in other sections.
3. Samples: PVC waterstop splice, joint, and fabricated cross of each size, shape, and fitting of waterstop.

B. Informational Submittals:

1. Certification:
   a. Letter stating compatibility between liquids being contained and materials used for waterstops.
   b. Manufacturer’s application instructions for bonding agent.
2. Manufacturer’s written instructions for product shipment, storage, handling, installation/application, and repair for:
   a. Waterstops.
   b. Bonding agent.
   c. Premolded joint fillers.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Acceptance at Site: Verify delivered materials are in accordance with Specifications, regulatory agencies, and Manufacturer’s product data sheets prior to unloading and storing onsite.

B. Storage: Store materials under tarps to protect from oil, dirt, and sunlight or as required by Manufacturer.

PART 2 PRODUCTS

2.01 PLASTIC (PVC) WATERSTOP

A. Manufacturers and Products:

1. Sika-Greenstreak, St. Louis, MO; Style 732 (6 inches by 3/8 inch) and Style 735 (9 inches by 3/8 inch).
2. Or equal.

B. Physical Characteristics:

1. Extruded from elastomeric plastic compound of which basic resin shall be prime virgin polyvinyl chloride (PVC). Compound shall not contain scrapped material, reclaimed material, or pigment.
2. Specific Gravity: Approximately 1.37.
3. Shore Durometer Type A Hardness: Approximately 80.
4. Type Required in All Expansion, Contraction, and Control Joints: 6 inches wide or 9 inches wide with center bulb and parallel longitudinal ribs or protrusions on each side of strip center, as indicated on the Drawings.
5. Type Required in Construction Joints: Flat ribbed, 6 inches wide or 9 inches wide with parallel longitudinal ribs or protrusions on each side of strip center. Center bulb is optional.
6. Corrugated or tapered type waterstops are not acceptable.
7. Thickness: Constant from bulb edge (or center of waterstop) to outside stop edge.
8. Minimum Weight per Foot of Waterstop:
   a. 1.60 pounds for 3/8 inch by 6 inches.
   b. 2.30 pounds for 3/8 inch by 9 inches.
9. Factory Fabrications: Use only factory fabrications for intersections, transitions, and changes of direction.

C. Functional Characteristics: None.

D. Performance Characteristics: Performance Requirements: COE Specification CRD-C-572.

2.02 HYDROPHILIC WATERSTOP

A. Manufacturers and Products:

1. Sika-Greenstreak Plastic Products, St. Louis, MO; Hydrotite CJ-1020-2K with Leakmaster LV-1 adhesive and sealant.
2. Or equal.

B. Physical Characteristics:

1. For use at construction joints only, where new concrete is placed against existing concrete and as shown on the Drawings.
2. Material shall be a nonbentonite hydrophilic rubber compound.
3. Cross-section: 0.39 inches by 0.79 inch.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.03 BOND BREAKER

A. Tape for Joints: Adhesive-backed glazed butyl or polyethylene tape. Same width as joint that will adhere to premolded joint material or concrete surface.

B. Use bond prevention material as specified in Section 03 30 00, Cast-in-Place Concrete, except where bond breaker tape is specifically called for on the Drawings.

2.04 PREMOLDED JOINT FILLER

A. Bituminous Type: ASTM D994 or ASTM D1751.

B. Sponge Rubber: Neoprene, closed-cell, expanded; ASTM D1056, Type 2C5, with compression deflection, 25 percent deflection (limits), 119 kPa to 168 kPa (17 psi to 24 psi) minimum. Use in joints for potable and nonpotable water containment structures.

2.05 ACCESSORIES

A. Roofing Felt: ASTM D226, Type II, 30-pound asphalt-saturated or equal weight of ASTM D227 coal-tar saturated felt.

B. Steel Reinforcement: As specified in Section 03 21 00, Steel Reinforcement.

C. Nails: Galvanized, as required for securing premolded joint filler.

D. Ties for PVC Waterstop: “Hog Rings” or grommets for each edge at 12-inch maximum spacing.

E. Joint Sealant: Polyurethane.

F. Galvanized Rebar at Control Joints: ASTM A767/A767M and ASTM A615/A615M Grade 60 prior to galvanizing.

2.06 PREFORMED CONTROL JOINT

A. One-piece, flexible, polyvinyl chloride joint former.

B. One-piece galvanized steel strip with preformed groove.

C. Furnish in full-length, unspliced pieces.

2.07 POURABLE JOINT FILLERS

A. General: Although product is a sealant, it is being specified as a filler to prevent debris accumulation and allow expansion and contraction under shrinkage and thermal loads. It does not need to meet proportional sealant geometry requirements.

2.08 EPOXY-COATED DOWELS

A. Dowels: ASTM A36/A36M round smooth steel bars.

B. Bar Coating: Painting and coating, with factory-applied epoxy coating and factory or field applied lubrication coating conforming to ASTM A775/A775M-19.

PART 3 EXECUTION

3.01 GENERAL

A. Commence concrete placement after joint preparation is complete.

B. Time Between Concrete Pours: As specified in Section 03 30 00, Cast-in-Place Concrete.

C. Joints, backer material, joint filler and joint sealants shall extend to pavement edges or to each other, as the case may be, and shall be constructed perpendicular to surface of pavement.

D. Joints shall not vary from specified or indicated line by more than 1/4 inch.

E. Contractor shall submit jointing plan and details to the Contracting Officer for approval. Take into consideration placement of joints in curb and gutter, at catch basins, at bollard posts, and position of manholes and other large structures, as well as other limitations herein mentioned.

F. Place manhole or similar large structure in line of joint, or if impractical, isolate structure from pavement with premolded joint filler, 1/2 inch wide, conforming to AASHTO M213 and ASTM D1751.

3.02 SURFACE PREPARATION

A. Construction Joints: Prior to placement of abutting concrete, clean contact surface.

1. Remove laitance and spillage from steel reinforcement and dowels.
2. Roughen surface to minimum of 1/4-inch amplitude:
   a. Sandblast after concrete has fully cured.
   b. Water blast after concrete has partially cured.
   c. Green cut fresh concrete with high-pressure water and hand tools.
3. Perform cleaning so as not to damage waterstop, if one is present.

B. Construction Joint with Hydrophilic Waterstop:

1. Follow hydrophilic waterstop manufacturer's written instructions.
2. Clean debris, dirt, dust, and foreign material from concrete surface. Concrete surface must be smooth, clean, and dry. Grind concrete as required.

C. Expansion Joint:

1. Use wire brush or motorized device to mechanically roughen and thoroughly clean concrete surfaces on each side of joint.
2. Use dry, high-pressure air to remove dust and foreign material, and dry joint.
3. Prime surfaces as required before placing joint filler.

3.03 INSTALLATION OF WATERSTOPS

A. General:

1. Continuous waterstop shall be installed in all construction joints in walls and slabs of water holding basins and channels and in walls of belowgrade structures, unless specifically noted otherwise.
2. Join waterstop at intersections to provide continuous seal.
3. Center waterstop on joint.
4. Secure waterstop in correct position. Tie waterstop to steel reinforcement using grommets, "Hog Rings," or tiewire at maximum spacing of 12 inches. Do not displace waterstop during concrete placement.
5. Repair or replace damaged waterstop.
6. Place concrete and vibrate to obtain impervious concrete in vicinity of joints.
7. Joints in Footings and Slabs:
   a. Ensure that space beneath horizontal waterstop is completely filled with concrete.

b. During concrete placement, make visual inspection of waterstop area.
c. Limit concrete placement to elevation of waterstop in first pass, vibrate concrete under waterstop, lift ribbed waterstop to confirm full consolidation without voids, then place remaining concrete to full height of slab.

B. Plastic Waterstops:

1. Install in accordance with manufacturer's written instructions.
2. Splice in accordance with waterstop manufacturer's written instructions using polytetrafluoroethylene (PTFE)-coated thermostatically controlled heating iron at approximately 380 degrees F.
   a. Allow at least 10 minutes before new splice is pulled or strained in any way.
   b. Finished splices shall provide cross-section that is dense and free of porosity with tensile strength of not less than 80 percent of unspliced materials.
   c. Use only factory made waterstop fabrications for all intersections, changes of directions and transitions.
   d. Field splice permitted only for straight butt welds.
3. Wire looped plastic waterstop may be substituted for plastic waterstop.

C. Hydrophilic Waterstop:

1. Install in accordance with manufacturer's written instructions.
2. Provide minimum of 2-1/2 inches of concrete cover over waterstop. When structure has two layers of steel reinforcement, locate centered between layers of steel or as shown.
3. Apply adhesive to concrete surface and allow to dry for specified time before applying waterstop strip.
4. Lap ends of waterstop strip together at splices and corners and join with sealant.
5. Verify that waterstop is anchored firmly in place before placing concrete. Do not allow vibrator to come into contact with waterstop.
6. Lap hydrophilic waterstop 2 feet minimum with intersecting plastic waterstops.

D. Bituminous Type Premolded Joint Filler:

1. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.
2. Secure premolded joint filler in forms before concrete is placed.

E. Sponge Rubber Joint Filler: Install per manufacturer's written instructions.

3.04 EXPANSION JOINTS

A. Premolded Joint Filler:

1. Sufficient in width to completely fill joint space where shown.
2. Install per manufacturer's written instructions.
3. Precut premolded joint filler to required depth at locations where joint filler or sealant is to be applied.
4. Form cavities for joint filler with either precut, premolded joint filler, or smooth removable accurately shaped material.
5. Vibrate concrete thoroughly along joint form to produce dense, smooth surface.

B. Bituminous Type Premolded Joint Filler:

1. Drive nails approximately 1 foot 6 inches on center through filler, prior to installing, to provide anchorage embedment into concrete during concrete placement.
2. Secure premolded joint filler in forms before concrete is placed.
3. Install in walkways, at changes in direction, at intersections, and at 45-foot intervals, maximum.

C. Pourable Joint Filler:

1. General:
   a. Install in accordance with the manufacturer's written instructions, except as specified below:
      1) Apply primer prior to pouring joint filler.
      2) Use masking tape on top of slabs at sides of joints. Clean spillage. Remove masking tape afterwards.
      3) Sealant products used as fillers need not meet sealant geometry parameters. Do not use backing rods.

D. Steel Expansion Joint Dowels:

1. Install coated and lubricated bars parallel to wall or slab surface and in true horizontal position perpendicular to joint in both plan and section view, to permit joint to expand or contract without bending dowels.
2. Secure dowels tightly in forms with rigid ties.
3. Install steel reinforcement in concrete as shown.

3.05 CONTRACTION JOINTS

A. Sawed Type with Poured Filler:

1. Sawing shall be to a depth as shown on the Drawings with a maximum width of 1/4 inch and a minimum width of 1/8 inch, in straight lines as shown or as approved by the Contracting Officer.
2. Perform saw cuts as soon as Portland cement concrete has set enough to permit sawing without tearing or raveling, before uncontrolled cracking results, and within 24 hours of placing Portland cement concrete.
3. Saws may be single or tandem, as Contractor may elect, and shall be controlled by guides to true line.
4. Clean joints thoroughly of foreign matter before pouring approved rubber asphalt filler.
5. Tops of joint filler shall be true to pavement cross section within 1/8 inch and shall be protected from damage by Portland cement concrete operations.
6. Areas containing uncontrolled cracks shall be removed and replaced.
7. Restore curing agents broken or damaged by sawing operations.

B. Space longitudinal joints as shown on the Drawings or as approved by the Contracting Officer at the interface between lanes, normally at intervals between 12 feet to 16 feet.

C. Transverse joints shall be as shown on the Drawings or as approved by the Contracting Officer, with intervals of 12 feet to 16 feet.

D. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

3.06 CONSTRUCTION JOINTS

A. Construct when there is an interruption of longer 45 minutes in Portland cement concrete placing operations or where specified.

B. Place parallel with intended contraction joint.

C. Tool both free edges of joints with 1/8-inch radius rounder to remove laitance and mortar resulting from finishing operations and to provide clean rounded edge. Tooling shall not form ridges on surface of concrete.

D. New Portland cement concrete placed contiguous to joint shall conform to proportions and consistency of previously placed concrete.

E. Transverse Construction Joint:

1. Doweled type using No. 8 by 36-inch long dowels at 12-inch centers coated with plastic, grease, heavy oil, or other approved material that will neither bond with nor be harmful to operation at a depth of 1/2 the pavement thickness parallel to centerline.
2. If sufficient Portland cement concrete has not been mixed at the time of interruption to place a construction joint at least 3 feet from a planned contraction joint, remove excess Portland cement concrete back to a position to satisfactorily meet these criteria and to satisfaction of the Contracting Officer.
3. Fill joint which has opened to a width of 1/8 inch or greater during construction or maintenance periods with poured filler.
4. Do not construct within 3 feet of a transverse contraction joint.

F. Longitudinal Construction Joint:

1. Tied type using No. 5 by 36-inch deformed tie bars at 12-inch centers.
2. Tie Bars:
   a. Not required at construction joint between Portland cement concrete pavement and curb, except where shown on the Drawings and mentioned above.
   b. Placement:
      1) Plastic Portland Cement Concrete: Insert before vibrating and finishing Portland cement concrete; or
      2) Hardened Concrete:
         a) Drill hole, insert, and grout tie bars into place.
         b) Drill holes large and deep enough to allow tie bars to be inserted with grout.
         c) Perform any time after Portland cement concrete has attained enough strength to resist any damage caused by drilling.
         d) Tie bars shall be grouted a maximum of 3 hours prior to placement of adjacent Portland cement concrete.
      3) Replace loose tie bars by drilling and grouting as described.

3.07 SCORED JOINTS

A. Configuration: 1/4-inch wide by 1/4-inch deep at locations indicated on the Drawings formed by tooling of concrete while it is still fresh.

B. Do not fill or seal.

C. Layout of joints shall be straight and true and shall not vary from indicated line by more than 1/4 inch.

3.08 CONTROL JOINTS

A. Locate epoxy-coated steel reinforcement as shown.

B. Vibrate concrete thoroughly along the joint form to produce a dense, smooth surface. Do not roughen surface.

3.09 PREFORMED CONTROL JOINTS

A. Use only where specifically shown or as approved by the Contracting Officer.

B. Locate slightly below top of slab.

C. Install in accordance with manufacturer's written instructions in straight, full-length pieces.

D. Steel Strip Type with Preformed Groove: Brace to withstand pressure of concrete during and after placement using only approved stakes and other secondary installation materials.

3.10 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

3.11 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan as shown on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 40 00, Quality Requirements.

END OF SECTION

SECTION 03 21 00
STEEL REINFORCEMENT

PART 1 GENERAL

1.01 GENERAL

A. Steel reinforcement shall comply with ACI 301 and as modified in the following.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. SP-66, Detailing Manual.
2. American Welding Society (AWS): D1.4/D1.4M, Structural Welding Code - Reinforcing Steel.
3. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. A706/A706M, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   c. A767/767M, Standard Specification for Zinc-Coated (Galvanized) Steel bars for Concrete Reinforcement
   d. A775/A775M, Standard Specification for Epoxy-Coated Steel Reinforcing Bars.
4. Concrete Reinforcing Steel Institute (CRSI):
   a. Placing Reinforcing Bars.
   b. Manual of Standard Practice.
5. International Code Council (ICC): Evaluation Services Report.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings prepared in accordance with ACI 301 and ACI SP-66:
   a. Bending lists.
   b. Placing drawings.
2. Welded, metallic sleeve splice, and mechanical threaded connection.

B. Informational Submittals:

1. Lab test reports for steel reinforcement showing stress-strain curves and ultimate strengths.
2. Mechanical Threaded Connections:
   a. Current ICC Evaluation Services Report or equivalent code agency report listing findings to include acceptance, special inspection requirements, and restrictions.
   b. Verification device threads have been tested and meet requirements for thread quality, in accordance with manufacturer's published methods.
   c. Manufacturer's instructions.
3. Test results of field testing.
4. Sustainable Design: In accordance with Section 01 81 13, Sustainable Design Requirements, document sustainability performance for items listed below:
   a. Product Data for Recycled Materials:
      1) A complete list of materials and quantities.
      2) Percentages of post-consumer and preconsumer recycled content of all materials.

1.04 QUALITY ASSURANCE

A. Welder Qualifications: Certified in accordance with AWS D1.4/D1.4M.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with ACI 301 and recommendations of CRSI Placing Reinforcing Bars.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sustainable Material Requirements:

1. Recycled Content of Steel Products: Provide products with a minimum combined recycled content of 85 percent and a minimum postconsumer recycled content of 80 percent.

B. Reinforcing Bars:

1. Includes stirrups, ties, and spirals.
2. ASTM A615/A615M, Grade 60, where welding is not required.
3. ASTM A706/A706M, Grade 60, for reinforcing to be welded.
4. ASTM A767/767M, Grade 60, for galvanized bars.
5. ASTM A775/A775M, for epoxy-coated bars.

C. Mechanical Threaded Connections:

1. Manufacturers and Products:
   a. Erico Products, Inc., Cleveland, OH; Lenton Reinforcing Steel Couplers.
   b. Or equal.
2. Physical Characteristics: Metal coupling sleeve with internal threads engaging threaded ends of bars.
3. Functional Characteristics: None.
4. Performance Characteristics: Capable of developing in tension or compression 125 percent of yield strength of bar.

D. Welded Wire Fabric:

1. ASTM A1064, using wire of 75 ksi minimum tensile strength.
2. Furnish flat sheets only, rolled sheets not permitted.

2.02 ACCESSORIES

A. Tie Wire:

1. Black, soft-annealed 16-gauge wire.
2. Nylon-coated, epoxy-coated, or plastic-coated wire.

B. Bar Supports and Spacers:

1. Use precast concrete bar supports or all-plastic bar supports and side form spacers, unless noted otherwise. Do not use other types of supports or spacers.
2. Bar supports shall have sufficient strength and stiffness to carry loads without failure, displacement, or significant deformation. Space bar supports so minimum concrete cover is maintained for reinforcing between supports.
3. Use only precast concrete bar supports where concrete surfaces are exposed to weather, earth, water, chloride intrusion, or corrosive chemicals. Bar supports shall be nonconductive and have geometry and bond characteristics that deter movement of moisture from the surface to the reinforcement.
4. Precast concrete supports shall have same minimum strength and shall be made from same materials as that of the concrete in which they are to be embedded. Precast concrete supports shall be cast and properly cured for at least 7 days before use and shall have a wire or other device cast into each block for the purpose of attaching them securely to steel reinforcement.
5. In Beams, Columns, Walls, and Slabs Exposed to View after Form Removal: Use small precast concrete blocks made of same color as concrete in which they are embedded. All-plastic bar supports, and side

form spacers may be used, except where surface is exposed as described above.

6. Design and fabricate special bar supports for top reinforcing bars in slabs where standard bar supports do not possess necessary geometry, strength, or stiffness.

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Contracting Officer when reinforcing is ready for inspection and allow sufficient time for inspection prior to placing concrete.

B. Clean reinforcing bars of loose mill scale, oil, earth, and other contaminants.

C. Repair epoxy coating damaged as a result of handling, shipment, and placing. Repair with patching material in accordance with ASTM A775/A775M and manufacturer's recommendations.

D. Coat wire projecting from precast concrete bar supports with dielectric material, epoxy, or plastic.

3.02 INSTALLATION

A. Bundle or space bars, instead of field bending where construction access through reinforcing is necessary.

B. Splicing:

1. Minimum length of lap splices shall comply with table in Contract Documents.
2. Use lap splices, unless otherwise shown or permitted in writing by Contracting Officer.
3. Welded Splices: Accomplish by full penetration groove welds and develop a minimum of 125 percent of yield strength of bar.
4. Stagger splices in adjacent bars where indicated.

C. Mechanical Splices and Connections:

1. Use only in areas specifically approved in writing by Contracting Officer.
2. Install threaded rods as recommended by manufacturer with threads totally engaged into coupling sleeve and in accordance with ICC Evaluation Services Report or equivalent code agency report.
3. For metal sleeve splice, follow manufacturer's installation recommendations.
4. Maintain minimum edge distance and concrete cover.

D. Tying Reinforcing Bars:

1. Tie every other intersection on mats made up of Nos. 3, 4, 5, and 6 bars to hold them firmly at required spacing.
2. Bend tie wire away from concrete surface to provide clearance of 1 inch from surface of concrete to tie wire.

E. Reinforcement Around Openings: On each side and above and below pipe or opening, place an equivalent area of steel bars to replace steel bars cut for opening. Extend steel reinforcing a standard lap length beyond opening at each end.

F. Welding Reinforcement:

1. Only ASTM A706/A706M bars may be welded.
2. Do not perform welding until welder qualifications are approved.

G. Straightening and Rebending: Field bending of steel reinforcement bars is not permitted.

H. Unless permitted by Contracting Officer, do not cut reinforcing bars in field.

3.03 WELDED WIRE FABRIC INSTALLATION

A. Use only where specifically shown.

B. Extend fabric to within 2 inches of edges of slab and lap splices at least 1-1/2 courses of fabric or minimum 8 inches.

C. Tie laps and splices securely at ends and at least every 24 inches with tie wire.

D. Place welded wire fabric on concrete blocks and rigidly support equal to that provided for reinforced bars. Do not use broken concrete, brick, or stone.

E. Do not use fabric that has been rolled. Install flat sheets only.

3.04 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan as shown on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 40 00, Quality Requirements.

END OF SECTION

SECTION 03 30 00
CAST-IN-PLACE CONCRETE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 117, Specification for Tolerances for Concrete Construction and Materials.
   b. 301, Specifications for Structural Concrete.
   c. 305.1, Specification for Hot Weather Concreting.
   d. 306.1, Standard Specification for Cold Weather Concreting.
   e. 350.1, Specification for Tightness Testing of Environmental Engineering Concrete Containment Structures.
   f. CP-1, Technical Workbook for ACI Certification of Concrete Field Testing Technician – Grade 1.
2. ASTM International (ASTM):
   a. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   b. C33/C33M, Standard Specification for Concrete Aggregates.
   c. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   d. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   e. C109/C109M, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or [50-mm] Cube Specimens).
   f. C143/C143M, Standard Test Method for Slump of Hydraulic-Cement Concrete.
   g. C150/C150M, Standard Specification for Portland Cement.
   h. C157/C157M, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
   i. C227, Standard Test Method for Potential Alkali Reactivity of Cement-Aggregate Combinations (Mortar-Bar Method).
   j. C231/C231M, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   k. C260/C260M, Standard Specification for Air-Entraining Admixtures for Concrete.
   l. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
   m. C595/C595M, Standard Specification for Blended Hydraulic Cements.

n. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
o. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
p. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
q. C989, Standard Specification for Slag Cement for Use in Concrete and Mortars.
r. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
s. C1017/C1017M, Standard Specification for Chemical Admixtures for Use in Producing Flowing Concrete.
t. C1074, Standard Practice for Estimating Concrete Strength by the Maturity Method.
u. C1077, Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation.
v. C1218/C1218M, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
w. C1240, Standard Specification for Silica Fume Used in Cementitious Mixtures.
x. C1260, Standard Test Method for Potential Alkali Reactivity of Aggregates (Mortar-Bar Method).
y. C1293, Standard Test Method for Determination of Length Change of Concrete Due to Alkali-Silica Reaction.
z. C1567, Standard Test Method for Determining the Potential Alkali-Silica Reactivity of Combinations of Cementitious Materials and Aggregate (Accelerated Mortar-Bar Method).
aa. C1582/C1582M, Standard Specification for Admixtures to Inhibit Chloride-Induced Corrosion of Reinforcing Steel in Concrete.
bb. C1602/C1602M, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
cc. D4580, Standard Practice for Measuring Delaminations in Concrete Bridge Decks by Sounding.
dd. E329, Standard Specification for Agencies Engaged in Construction Inspection, Special Inspection, or Testing Materials Used in Construction.

3. National Ready Mixed Concrete Association (NRMCA).
4. NSF International (NSF/ANSI) 61, Standard for Drinking Water System Components – Health Effects.

1.02 DEFINITIONS

A. Basin Train: Series of interconnected basins that operate as a unit with same water level.

B. Cold Weather: When ambient temperature is below 40 degrees F or is approaching 40 degrees F and falling.

C. Contractor's Licensed Design Engineer: Individual representing Contractor who is licensed to practice engineering as defined by statutory requirements of professional licensing laws in state or jurisdiction in which Project is to be constructed.

D. Defective Area: Surface defects that include honeycomb, rock pockets, indentations, and surface voids greater than 3/16-inch deep, surface voids greater than 3/4 inch in diameter, cracks in liquid containment structures and below grade habitable spaces with visible leakage or that are 0.005-inch wide and wider, and cracks in other structures that are 0.010-inch wide and wider, spalls, chips, embedded debris, sand streaks, mortar leakage from form joints, deviations in formed surface that exceed specified tolerances and include but are not limited to fins, form pop-outs, and other projections. At exposed concrete, defective areas also include texture irregularities, stains, and other color variations that cannot be removed by cleaning.

E. Exposed Concrete: Concrete surface that can be seen inside or outside of structure regardless of whether concrete is above water, dry at all times, or can be seen when structure is drained. Surfaces must be considered exposed concrete, even if covered by paint, sealers, or similar applications.

F. Hot Weather: As defined in ACI 305.1.

G. Hydraulic Structure: Liquid containment structure.

H. Mass Concrete:

1. Concrete sections with a minimum specified dimension that is equal to or greater than 3 feet 0 inch.
2. Concrete sections with a minimum specified dimension that is equal to or greater than 2 feet 0 inch, and concrete mixture includes an accelerating admixture.

I. New Concrete: Less than 60 days old.

1.03 SUBMITTALS

A. Action Submittals:

1. Mix Designs:
   a. Contain proportions of materials and admixtures to be used on Project, signed by mix designer.
   b. Documentation of average strength for each proposed mix design in accordance with ACI 301.
   c. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following:
      1) Portland cement.
      2) Fly ash.
      3) Slag cement.
      4) Aggregates, including specified class designation for coarse aggregate.
      5) Admixtures.
      6) Concrete producer has verified compatibility of constituent materials in design mix.
   d. Concrete mix of Entrance Road Water Tank shall be certified to comply with NSF/ANSI 61 for contact with potable water.
   e. Test Reports:
      1) Water-soluble Chloride-ion Content in Hardened Concrete:
         a) One of the following:
            (1) Test report in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.
            (2) Calculation of water-soluble chloride content based on certified chloride content of each constituent material and proportion of constituent material in concrete mixture.
            (3) All of the following:
               (a) Manufacturer's certificate of compliance that each admixture does not intentionally add chlorides and/or that the chloride content of each admixture does not exceed trace amounts.
               (b) Verification that potable water is used in the concrete mix or test data documenting the chloride content of the water.
               (c) Letter from the concrete supplier stating that fine and coarse aggregates are from sources that are not known to be susceptible to chlorides in the aggregates.

(4) Shrinkage Test Results: In accordance with ASTM C157/C157M as modified herein.

(5) Alkali Aggregate Reactivity: Aggregate shall be classified as nonpotentially reactive in accordance with Article Concrete Mix Design. Include documentation of test results per applicable standards.

f. Aggregates:

1) Percent of fine aggregate weight to total aggregate weight.

2) Deleterious substances in fine aggregate per ASTM C33/C33M, Table 2.

3) Deleterious substances in coarse aggregate per ASTM C33/C33M, Table 4.

g. Admixtures: Manufacturer's catalog cut sheets and product data sheets for each admixture used in proposed mix designs.

2. Product Data: Specified ancillary materials.

3. Detailed plan for curing and protection of concrete placed and cured in cold weather. Details shall include, but not be limited to, the following:

a. Procedures for protecting subgrade from frost and accumulation of ice or snow on reinforcement, other metallic embeds, and forms prior to placement.

b. Procedures for measuring and recording temperatures of reinforcement and other embedded items prior to concrete placement.

c. Methods for temperature protection during placement.

d. Types of covering, insulation, housing, or heating to be provided.

e. Curing methods to be used during and following protection period.

f. Use of strength accelerating admixtures.

g. Methods for verification of in-place strength.

h. Procedures for measuring and recording concrete temperatures.

i. Procedures for preventing drying during dry, windy conditions.

4. Detailed plan for hot weather placements, including curing and protection for concrete placed in ambient temperatures over 80 degrees F. Plan shall include, but not be limited to, the following:

a. Procedures for measuring, and recording temperatures of reinforcement and other embedded items prior to concrete placement.

b. Use of retarding admixture.

c. Methods for controlling temperature of reinforcement and other embedded items and concrete materials before and during placement.

d. Types of shading and wind protection to be provided.

e. Curing methods, including use of evaporation retardant.

f. Procedures for measuring and recording concrete temperatures.

g. Procedures for preventing drying during dry, windy conditions.

B. Informational Submittals:

1. Preinstallation Conference minutes.
2. Manufacturer's application instructions for bonding agent and bond breaker.
3. Statement of Qualification:
   a. Batch Plant: Certification as specified herein.
   b. Mix designer.
   c. Installer.
   d. Testing agency.
4. Field test reports.
5. Thermal Control Plan: For mass concrete sections in accordance with ACI 301.
6. Recorded temperature data from concrete placement where specified.
7. Liquid tightness test results.
8. Concrete Delivery Tickets:
   a. For each batch of concrete before unloading at Site.
   b. In accordance with ASTM C94/C94M, including requirements 14.2.1. through 14.2.10.
   c. Indicate amount of mixing water withheld and maximum amount that may be permitted to be added at Site.
9. Sustainable Design: In accordance with Section 01 81 13, Sustainable Design Requirements, document sustainability performance for the items listed below.
   a. Product Data for Recycled Materials:
      1) A complete list of materials and quantities.
      2) Percentages of post-consumer and preconsumer recycled content of all materials.

1.04 QUALITY ASSURANCE

A. Concrete construction shall conform to requirements of ACI 117 and ACI 301, except as modified herein.

B. Refer to Article Field Quality Control.

C. Qualifications:

1. Batch Plant: NRMCA Program for Certification of Ready-Mixed Concrete Production Facilities or approved equivalent program.
2. Mix Designer: Person responsible for developing concrete mixture proportions certified as NRMCA Concrete Technologist Level 2 or DOT certified mix designer in jurisdiction of the Work. Requirement may be waived if individual is Contractor's Licensed Design Engineer.

3. Testing Agency: Unless otherwise permitted, an independent agency, qualified according to ASTM C1077 and ASTM E329 for testing indicated.
   a. Where field testing is required of Contractor, 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.
   b. 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. Thermal Control Plan:

1. Include the following minimum requirements:
   a. Calculated or measured adiabatic temperature rise of concrete.
   b. Upper limit for concrete temperature at time of placement.
   c. Description of specific measures and equipment that will be used to ensure maximum temperature in placement will not exceed specified maximum temperature limit.
   d. Calculated maximum temperature in placement based on expected conditions at time of placement and use of proposed measures to control temperatures.
   e. Description of specific measures and equipment that will be used to ensure temperature difference will not exceed specified temperature difference limit.
   f. Calculated maximum temperature difference in placement based on expected conditions at time of placement and use of proposed measures to control temperature differences.
   g. Description of equipment and procedures that will be used to monitor and log temperatures and temperature differences.
   h. Drawing showing locations for temperature sensors in placement.
   i. Description of format and frequency of providing temperature data to Contracting Officer.
   j. Description of measures to address and reduce excessive temperatures and temperature differences if they occur.
   k. Description of curing procedures, including materials and methods, and curing duration.
   l. Description of formwork removal procedures to ensure temperature difference at temporarily exposed surface will not exceed temperature difference limit, and how curing will be maintained.

m. Alternate temperature limits when permitted by Contracting Officer.
    1) Determination of alternate temperature limits shall be based on detailed thermal and crack analyses.
    2) Analyses shall be stamped by Contractor's Licensed Design Engineer.
n. If concrete design mixture is changed, thermal control plan must be updated.

E. Mockup Panels:

1. Construct in accordance with requirements of Contract Documents to demonstrate wall finish Type W-9.
    a. Dimensions: 10 feet by 8 feet, minimum.
2. Before concrete work starts, construct panels with specified materials, forming systems, reinforcing details, and leakage prevention techniques.
3. Show architectural details, joints, form ties, reveals, and rebar spacers to produce finished surface required.
4. Test form release agent on one mockup panel to ensure no adverse effects are caused on form or form liner materials.
5. Surface finish and color shall be uniform in appearance to Samples.
6. Approved panels shall establish standards of quality by which Work will be judged.
7. Replace panels if not representative of Work as specified.
8. Panels may be incorporated into Work if approved by Contracting Officer.

F. Preinstallation Conference:

1. Required Meeting Attendees:
    a. Contractor, including pumping, placing, and finishing, and curing subcontractors.
    b. Ready-mix producer.
    c. Admixture representative.
    d. Testing and sampling personnel.
    e. Contracting Officer who authored Statement of Special Inspection Plan or Contracting Officer's designee.
2. Schedule and conduct prior to incorporation of respective products into Project. Notify Contracting Officer of location and time.
3. Agenda shall include:
    a. Admixture types, dosage, performance, and redosing at Site.
    b. Mix designs, test of mixes, and Submittals.
    c. Placement methods, techniques, equipment, consolidation, and form pressures.
    d. Slump and placement time to maintain slump.
    e. Finish, curing, and water retention.

f. Thermal control plan.
g. Protection procedures for weather conditions.
h. Other specified requirements requiring coordination.

4. Conference minutes.

PART 2 PRODUCTS

2.01 MATERIALS

A. Sustainable Material Requirements:

1. Recycled Content of Concrete Products: Provide products with a preconsumer recycled content not less than 20 percent.

B. Cementitious Materials:

1. Cement:
   a. Portland Cement: Unless otherwise specified, conform to requirements of ASTM C150/C150M.
   b. Blended Hydraulic Cement:
      1) Unless otherwise specified, conform to requirements of ASTM C595/C595M.
      2) Portland cement used in blended hydraulic cement, conform to requirements of ASTM C150/C150M.
   c. Furnish from one source.
2. Supplementary Cementitious Materials (SCM):
   a. Fly Ash (Pozzolan):
      1) Class F fly ash in accordance with ASTM C618, except as modified herein:
         a) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.
         b) ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
   b. Slag Cement: In accordance with ASTM C989, Grade 100 or Grade 120.
      1) Shall not be produced from process that has utilized hazardous or potentially hazardous materials.

C. Aggregates:

1. Unless otherwise permitted, furnish from one source for each aggregate type used in a mix design.
2. In accordance with ACI 301, except as modified herein.
3. Free of materials and aggregate types causing popouts, discoloration, staining, or other defects on surface of concrete.
4. Resistant to Alkali Silica Reactivity: See Article Concrete Mix Design.

5. Coarse Aggregate:
   a. Combination of gravels and crushed gravels, crushed stone, or combination of these materials containing no more than 15 percent flat or elongated particles (long dimension more than five times the short dimension).
   b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 4 for specified class designation.
   c. Class designation in accordance with ASTM C33, Table 3: 4S unless otherwise specified.
6. Fine Aggregates:
   a. Clean, sharp, natural sand.
   b. Limit deleterious substances in accordance with ASTM C33/C33M, Table 2 and as follows:
      1) Limit material finer than 75-µm (No. 200) sieve to 5 percent mass of total sample.
      2) Limit coal and lignite to 1 percent.

D. Admixtures:

1. Characteristics:
   a. Compatible with other constituents in mix.
   b. Contain at most, only trace amount chlorides in solution.
   c. Do not use admixtures known to be toxic after concrete is 30 days.
   d. Furnish type of admixture as recommended by manufacturer for anticipated temperature ranges.
2. Air-Entraining Admixture: ASTM C260/C260M.
3. Water-Reducing Admixture: ASTM C494/C494M, Type A or Type D.
4. Retarding Admixture: ASTM C 494/C 494M, Type B.
5. Accelerating Admixture: ASTM C 494/C 494M, Type C.
6. High-Range, Water-Reducing Admixture: ASTM C494/C494M, Type F or Type G.
7. Shrinkage Reducing Admixture: ASTM C494, Type S. Reduces drying shrinkage of cementitious mixtures.
8. Do not use calcium chloride as an admixture.
9. Admixtures with no standard, ASTM or other, designation may be used where permitted.

E. Water and Ice: Mixing water for concrete and water used to make ice shall be potable water unless alternative sources of water are permitted.

1. Water from alternative sources shall comply with requirements of ASTM C1602/C1602M, and concentration of chemicals in combined mixing water shall be less than:
   a. Chloride Content: 1,000 ppm.
   b. Sulfate Content as SO4: 3,000 ppm.

c. Alkalis as (Na_2O + 0.658 K_2O): 600 ppm.
d. Total Solids by Mass: Less than 50,000 ppm.

2.02 ANCILLARY MATERIALS

A. Bonding Agent:

1. Manufacturers and Products:
   a. Sika Chemical Corp., Lyndhurst, NJ; Sikadur 32 Hi-Mod.
   b. Or equal.
2. Physical Characteristics: Two-component, moisture insensitive, 100 percent solids epoxy.
3. Functional Characteristics: None.
4. Performance Characteristics: Meets ASTM C881/C881M, Type V.

B. Bond Breaker:

1. Manufacturers and Products:
   a. Dayton Superior Corporation, Miamisburg, OH; Sure Lift J6WB.
   b. Or equal.
2. Physical Characteristics:
   a. Water-based reactive and membrane-forming low VOC bond breaker.
   b. VOC Content: Less than 100 g/L.
3. Functional Characteristics: None.
4. Performance Characteristics: Nonstaining type, providing positive bond prevention.

C. Repair Material:

1. In accordance with requirements of Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
2. In accordance with requirements of Section 03 01 33, Repair of Horizontal Concrete Surfaces.

D. Crack Repair: In accordance with requirements of Section 03 64 23, Epoxy Resin Injection Grouting, and Section 03 64 24, Polyurethane Injection Grouting.

2.03 CONCRETE MIX DESIGN

A. General:

1. Concrete mix of Entrance Road Water Tank shall be certified to comply with NSF/ANSI 61 for contact with potable water.
2. See Supplement at the end of this section for mix design requirements for each class of concrete used on Project.

3. Prepare design mixtures for each type and strength of concrete, selecting and proportioning ingredients in accordance with requirements of ACI 301, unless otherwise specified.
4. Selection of constituent materials and products in mix design are optional, unless specified otherwise.
5. Unless otherwise permitted, use water-reducing admixture or water-reducing admixture and high-range, water-reducing admixture in pumped concrete, in concrete with a water-cementitious materials ratio below 0.50, and in concrete that is part of a liquid-containment structure.
6. Unless otherwise permitted, use water-reducing admixture and high-range, water-reducing admixture in columns, piers, pilasters, and walls.
7. Use water-reducing admixture or high-range, water-reducing admixture to achieve fresh properties that facilitate handling, placing, and consolidating of concrete, and specified hardened properties.
8. Use water-reducing and retarding admixture when anticipated high temperatures, low humidity, or other adverse placement conditions can adversely affect fresh properties of concrete.
9. Unless otherwise specified, desired fresh properties of concrete shall be determined by Contractor, and coordinated with concrete producer. Fresh properties of concrete shall remain stable to satisfaction of Contractor, for duration of placement and consolidation, and shall remain in conformance with requirements of Contract Documents.
10. Contractor is encouraged to consider using environmentally sustainable concrete mix design technologies such as use of supplementary cementitious materials and aggregate packing.

B. Potential Alkali-aggregate Reactivity of Concrete:

1. Do not use aggregates known to be susceptible to alkali-carbonate reaction (ACR).
2. Aggregates shall have been tested to determine potential alkali-aggregate reactivity in concrete in accordance with ASTM C1260 or ASTM C1567.
    a. Aggregates that indicate expansion greater than 0.10 percent at 16 days after casting shall not be used unless they have been shown to be nondeleteriously reactive in accordance with ASTM C227 or ASTM C1293, with less than 0.04 percent expansion at 1 year for cement-aggregate combinations or less than 0.04 percent expansion at 2 years for combinations with pozzolan or slag.

b. Alkali content of cement used in proposed concrete mixture shall not be greater than alkali content of cement used in test for potential alkali-aggregate reactivity.
c. Use low-alkali cement or incorporate pozzolans into concrete mixture as necessary to satisfy testing for potential alkali reactivity.

C. Proportions:

1. Design mix to meet aesthetic, durability, and strength requirements.
2. Where fly ash is included in mix, minimum fly ash content shall be a minimum of 15 percent of weight of total cementitious materials.

D. Concrete Shrinkage Limits:

1. Where shrinkage limits are specified, design mix for following shrinkage limits and test in accordance with ASTM C157/C157M, with the following modifications:
   a. Prisms shall be moist cured for 7 days prior to 28-day drying period.
   b. Comparator reading at end of 7-day moist cure shall be used as initial length in length change calculation.
   c. Reported results shall be average of three prisms.
   d. If shrinkage of a specimen departs from average of that test age by more than 0.004 percent, disregard results obtained from that specimen.
   e. Unless otherwise specified, results at end of 28-day drying period shall not exceed 0.042 percent if 3-inch prisms are used, or exceed 0.040 percent if 4-inch prisms are used. Aggregate will be rejected if test values exceed these limits.

E. Slump Range at Site:

1. Prior to submitting mix design, consult with concrete producer and select a target slump value at point of delivery, for each application of each design mix. Unless otherwise permitted, target slump value will then be enforced for duration of Project.
2. Design mixes that include a high-range, water-reducing admixture shall have a minimum slump of 2 inches prior to addition of admixture. Unless otherwise permitted, slump shall be 8 inches maximum at point of delivery, for concrete with a high-range, water-reducing admixture.
3. Slump tolerance shall meet requirements of ACI 117.

F. Combined Aggregate Gradation:

1. Combined Gradation Limits: Fine aggregate shall be in range of 36 percent to 40 percent of total aggregate weight.

2.04 CONCRETE MIXING

A. General: Unless otherwise specified, in accordance with ACI 301.

2.05 TEMPERATURE LIMITS

A. For mass concrete, and unless otherwise permitted, provide documentation that maximum concrete temperature in structure will not exceed 160 degrees F, and maximum temperature differential between center of section and external surfaces of concrete will not exceed 35 degrees F.

2.06 SOURCE QUALITY CONTROL

A. Source Quality Control Inspection: Contracting Officer shall have access to and have right to inspect batch plants, cement mills, and supply facilities of suppliers, manufacturers, and Subcontractors, providing products included in this section.

PART 3 EXECUTION

3.01 GENERAL

A. Unless otherwise specified, in accordance with ACI 301.

3.02 PLACING CONCRETE

A. Preparation: In accordance with ACI 301, except as modified herein.

B. Inspection: Notify Contracting Officer and Special Inspector at least 1 full working day in advance before starting to place concrete.

C. Placement into Formwork:

1. Where vapor retarder or barrier is required, coordinate subgrade preparation with requirements in Division 07 of Specifications.
2. Reinforcement: Secure in position before placing concrete.
3. Placement frequency shall be such that lift lines will not be visible in exposed concrete finishes.
4. Use placement devices as required to prevent segregation.
5. Trowel and round off top exposed edges of walls with 1/4-inch radius steel edging tool.
6. Cure concrete as specified in Section 03 39 00, Concrete Curing.

D. Retempering: Not permitted for concrete where cement has partially hydrated.

E. Pumping of Concrete: Provide standby pump, conveyor system, crane and concrete bucket, or other system onsite during pumping, for adequate

redundancy to ensure completion of concrete placement without cold joints in case of primary placing equipment breakdown.

F. Mass Concrete:

1. Cure and protect concrete in accordance with accepted thermal control plan and as follows:
   a. Minimum curing period shall be 14 days.
   b. Unless otherwise permitted, preserve moisture by maintaining forms in place.
2. Strength measurement shall be representative of in-place concrete within 2 inches of concrete surface.
3. Concrete strength shall be verified through correlation of concrete temperature and compressive strengths established by cylinder compressive tests and in accordance with ASTM C1074.
4. Unless otherwise specified, control concrete temperatures to within specified limits from time concrete is placed until time internal temperature has cooled from its maximum, such that difference between average daily ambient and maximum internal concrete temperature at time of protection removal, is less than specified temperature difference limit.
5. Unless otherwise specified, place one temperature sensor at center of mass of placement and one temperature sensor at a depth 2 inches from center of nearest exterior surface. Place additional sensor at each location to serve as a backup in event that other temperature sensor fails. In addition, provide temperature sensor in shaded location for monitoring ambient onsite temperature.
   a. Unless otherwise specified, monitor temperatures hourly using electronic sensors capable of measuring temperature from 32 degrees F to 212 degrees F to an accuracy of 2 degrees F.
   b. Ensure temperature sensors are operational before placing concrete.
   c. Unless otherwise specified, provide daily data from sensors to Contracting Officer to show requirements are met.
   d. Compare temperatures and temperature differences with maximum limits specified in Article Temperature Limits, every 12 hours, unless otherwise permitted. If either exceeds specified limits, take immediate action as described in accepted thermal control plan to remedy situation. Do not place additional mass concrete until cause of excessive temperature or temperature difference has been identified and corrections are accepted.

G. Maximum Size of Concrete Placements:

1. Locate expansion, control, and contraction joints where shown on the Drawings.

2. Construction Joints:
   a. Locate construction joints as follows:
      1) Where approved in joint location submittal required in Section 03 15 00, Concrete Joints and Accessories.
3. Consider beams, girders, brackets, column capitals, and haunches as part of floor or roof system and place monolithically with floor or roof system.
4. Should placement sequence result in cold joint located below finished water surface, install waterstop in joint.

H. Consolidation and Visual Observation:

1. Consolidation Equipment and Methods: ACI 301.
2. Provide at least one standby vibrator in operable condition at Site prior to placing concrete.

I. Hot Weather:

1. Prepare ingredients, mix, place, cure, and protect in accordance with ACI 301, ACI 305.1, and as follows:
   a. Maintain concrete temperature below 85 degrees F at time of placement, or furnish test data or other proof that admixtures and mix ingredients do not produce flash set plastic shrinkage, or cracking as a result of heat of hydration. Cool ingredients before mixing to maintain fresh concrete temperatures as specified or less.
   b. Provide for windbreaks, shading, fog spraying, sprinkling, ice, wet cover, or other means as necessary to maintain concrete at or below specified temperature.
2. Concrete Curing: As specified in Section 03 39 00, Concrete Curing.

J. Cold Weather Placement:

1. Unless otherwise permitted, shall be in accordance with requirements of ACI 306.1 and as follows:
   a. Cold weather requirements shall apply when ambient temperature is below 40 degrees F or approaching 40 degrees F and falling.
   b. Do not place concrete over frozen earth or against surfaces with frost or ice present. Frozen earth shall be thawed to acceptance of Contracting Officer.
   c. Unless otherwise permitted, do not place concrete in contact with surfaces less than 35 degrees F; requirement is applicable to all surfaces including reinforcement and other embedded items.
   d. Provide supplemental external heat as needed when other means of thermal protection are unable to maintain minimum surface temperature of concrete as specified in ACI 306.1.

e. Maintain minimum surface temperature of concrete as specified in ACI 306.1 for no less than 3 days during cold weather conditions.

f. Cure concrete as specified in Section 03 39 00, Concrete Curing.

1) Protect concrete from freezing until end of curing period and until concrete has attained a compressive strength of 3,500 psi or design compressive strength if less than 3,500 psi.

2. Provide maximum and minimum temperature sensors placed on concrete surfaces spaced throughout Work to allow monitoring of concrete surface temperatures representative of Work. Unless otherwise permitted, record surface temperature of concrete at least once every 12 hours during specified curing period.

3. External Heating Units: Do not exhaust heater flue gases directly into enclosed area as it causes concrete carbonation as a result of concentrated carbon dioxide.

4. Maintain curing conditions as specified in Section 03 39 00, Concrete Curing.

K. Concrete Floor for Precast Concrete Building:

1. As specified in Section 13 34 20, Precast Concrete Building:

a. There shall be a 1/2-inch deep recess, the width of the wall panels, cast into the floor. The 1/2-inch recess makes the interior floor surface 1/2-inch higher than the joint between the wall panel and floor slab preventing intrusion of water.

b. Provide floor penetrations to accommodate the following current and future underground connections by others:

1) Electrical: Location and quantities as shown on the Drawings.

2) Plumbing: Location and quantities as shown on the Drawings.

c. Install all embeds, provided by required for the attachment of precast concrete wall panels.

3.03 CONCRETE BONDING

A. Construction Joints in New Concrete Members: Prepare surface of construction joint as specified in Section 03 15 00, Concrete Joints and Accessories.

B. Construction Joints at Existing Concrete:

1. Thoroughly clean and mechanically roughen existing concrete surfaces to roughness profile of 1/4 inch.

2. Saturate surface with water for 24 hours prior to placing new concrete.

3.04 REPAIRING CONCRETE

A. General:

1. Inject cracks that leak with crack repair epoxy as specified in Section 03 64 23, Epoxy Resin Injection Grouting, and Section 03 64 24, Polyurethane Injection Grouting.
2. Repair defective areas of concrete.
3. Repair horizontal concrete surfaces in accordance with Section 03 01 33, Repair of Horizontal Concrete Surfaces.
4. Repair vertical and overhead concrete surfaces in accordance with Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces.
5. Develop repair techniques with material manufacturer on surface that will not be visible in final construction prior to starting actual repair work and show how finish color will blend with adjacent surfaces. Obtain approval from Contracting Officer.
6. Obtain quantities of repair material and manufacturer's detailed instructions for use to provide repair with finish to match adjacent surface or apply sufficient repair material adjacent to repair to blend finish appearance.
7. Repair of concrete shall provide structurally sound surface finish, uniform in appearance or upgrade finish by other means until acceptable to Contracting Officer.

B. Tie Holes: Unless otherwise specified, fill with specified repair material.

1. Prepare substrate and mix, place, and cure repair material per manufacturer's written recommendations.

C. Alternate Form Ties, Through-Bolts:

1. Mechanically roughen entire interior surface of through hole.
2. Apply bonding agent to roughened surface and drive elastic vinyl plug to half depth.
3. Dry pack entire hole from both sides of plug with nonshrink grout, as specified in Section 03 62 00, Grouting.
4. Use only enough water to dry pack grout.
5. Dry pack while bonding agent is still tacky.
6. If bonding agent has dried, remove bonding agent by mechanical means and reapply new coat of bonding agent.
7. Compact grout using steel hammer and steel tool to drive grout to high density.
8. Cure grout with water.

D. Exposed Metal Objects:

1. Remove metal objects not intended to be exposed in as-built condition of structure including wire, nails, and bolts, by chipping back concrete to depth of 1 inch and then cutting or removing metal object.
2. Repair area of chipped-out concrete as specified for defective areas.

E. Blockouts at Pipes or Other Penetrations: Where shown install in accordance with requirements of the Drawings.

3.05 CONCRETE WALL FINISHES

A. Type W-1 (Ordinary Wall Finish):

1. Patch tie holes.
2. Remove projections.
3. Repair defective areas.
4. Inject cracks.

B. Type W-2 (Smooth Wall Finish):

1. Patch tie holes.
2. Grind off fins and other projections.
3. Repair defective areas to provide smooth uniform appearance.
4. Inject cracks.

C. Type W-5 (Finish for Painting):

1. In accordance with requirements for Type W-2 except as follows:
   a. Leave surface ready for painting.

D. Type W-9 (Grout Cleaned Wall Finish):

1. Begin cleaning operations after contiguous surfaces are completed and accessible. Do not clean surfaces as adjacent work progresses.
2. Grout: Mixed with one-part portland cement and one and one half parts fine sand and bonding agent to produce grout with consistency of thick paint. White portland cement shall be substituted for part of gray portland cement in order to produce color matching color of surrounding concrete, as determined by trial patch.
3. Wet surface of concrete sufficiently to prevent absorption of water from grout and apply grout uniformly with brushes or spray gun.
4. Immediately after applying grout, scrub surface vigorously with cork float or stone to coat surface and fill air bubbles and holes.
5. While grout is still plastic, remove excess grout by working surface with rubber float, burlap, or other means. After surface whitens from drying,

about 30 minutes at 70 degrees F, rub vigorously with clean burlap. Continue to water cure wall until curing period of 7 days is complete.

6. Latex bonding admixture may be used.

E. Type W-11 (Abrasive Blast Wall Finish):

1. Repair cracks before abrasive blasting.
2. Perform abrasive blasting on concrete surfaces in same area of view, at same time, to obtain uniformity of appearance.
3. Same person shall accomplish sandblasting on one structure and on concrete in same area.
4. Perform abrasive blasting to match approved mockup panel.
5. Abrasive: Use clean silica sand, free of foreign materials, and supplied in sealed sacks.
6. When specified, begin abrasive blasting to expose aggregate when concrete has a compressive strength of at least 2,000 psi and after safe removal of forms and supports. Blast to match mockup. Achieve degree of abrasive blasting as specified in the Contract Documents:
   a. Brush: Dull surface sheen.
   b. Light: Exposure of fine aggregate.
   c. Medium: Coarse aggregate exposure.
   d. Heavy: Coarse aggregate revealed.
7. When abrasive grits contain free water for dust abatement, wash abrasive blasting debris off finished wall surface before drying occurs.

3.06 CONCRETE SLAB FINISHES

A. General:

1. Use manual screeds, vibrating screeds, or roller compacting screeds to place concrete level and smooth.
2. Do not use “jitterbugs” or other special tools designed for purpose of forcing coarse aggregate away from surface and allowing layer of mortar, which will be weak and cause surface cracks or delamination, to accumulate.
3. Finish slab in accordance with specified slab finish.
4. Do not dust surfaces with dry materials nor add water to surfaces.
5. Cure concrete as specified in Section 03 39 00, Concrete Curing.

B. Type S-1 (Steel Troweled Finish):

1. Finish by screeding and floating with straightedges to bring surfaces to required finish elevation.
2. Wood float to true, even plane with no coarse aggregate visible.
3. Use sufficient pressure on wood floats to bring moisture to surface.
4. After surface moisture has disappeared, hand steel trowel concrete to produce smooth, smooth dense surface, free from trowel marks.

5. Provide light steel-troweled finish (two trowelings) at air-entrained slabs. Provide hard steel-troweled finish (ringing sound from the trowel) for nonair-entrained slabs.
6. Do not use dry cement or additional water during troweling, nor will excessive troweling be permitted.
7. Power Finishing:
    a. Approved power machine may be used in lieu of or in addition to hand finishing in accordance with directions of machine manufacturer.
    b. Do not use power machine when concrete has not attained necessary set to allow finishing without introducing high and low spots in slab.
    c. Do first steel troweling for Slab S-1 finish by hand.

C. Type S-2 (Wood Float Finish):

1. Finish slab to receive fill and mortar setting bed by screeding with straightedges to bring surface to required finish plane.
2. Wood float finish to compact and seal surface.
3. Remove laitance and leave surface clean.
4. Coordinate with other finish procedures.

D. Type S-3 (Underside Elevated Slab Finish):

1. When forming is removed, grind off projections on underside of slab and repair defective areas, including small shallow air pockets where schedule of concrete finishes requires:
    a. Prepare surfaces to match Wall Type of adjacent walls.

E. Type S-5 (Broomed Finish):

1. Finish as specified for Type S-1 floor finish, except use only a light-steel troweled finish, and then finish surface by drawing fine-hair broom lightly across surface.
2. Broom in same direction and parallel to expansion joints, or, in case of inclined slabs, perpendicular to slope, except for round roof slab, broom surface in radial direction.

F. Type S-6 (Sidewalk Finish):

1. Slope walks down 1/4 inch per foot away from structures, unless otherwise shown.
2. Strike off surface by means of strike board and float with wood or cork float to true plane, then flat steel trowel before brooming.
3. Broom surface at right angles to direction of traffic or as shown.
4. Lay out sidewalk surfaces in blocks, as shown or as directed by Contracting Officer, with grooving tool.

3.07 CONCRETE SLAB TOLERANCES

A. Slab Tolerances:

1. Exposed Slab Surfaces: Comprise of flat planes as required within tolerances specified.
2. Slab Finish Tolerances and Slope Tolerances: Crowns on floor surface not too high as to prevent 10-foot straightedge from resting on end blocks, nor low spots that allow block of twice the tolerance in thickness to pass under supported 10-foot straightedge.
3. Slab Type S-A: Steel gauge block 5/16 inch thick.
4. Slab Type S-B: Steel gauge block 1/8 inch thick.
5. Slab Type S-A and S-B:
   a. Finish Slab Elevation: Slope slabs to floor drain and gutter, and shall adequately drain regardless of tolerances.
6. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

B. Slab Elevation and Thickness:

1. Finish Slab Elevation: Slope slabs to floor drains and gutter. Slabs shall adequately drain regardless of tolerances.
2. Thickness: Maximum 1/4 inch minus or 1/2 inch plus from thickness shown. Where thickness tolerance will not affect slope, drainage, or slab elevation, thickness tolerance may exceed 1/2 inch plus.

3.08 BEAM AND COLUMN FINISHES

A. Match surface finish for adjacent walls.

3.09 BACKFILL AGAINST STRUCTURES

A. Do not backfill against walls until concrete has obtained specified 28-day compressive strength.

B. Refer to General Structural Notes as shown on the Drawings for additional requirements, including elevated slab and diaphragm completion prior to backfill.

C. Unless otherwise permitted, place backfill simultaneously on both sides of structure, where such fill is required, to prevent differential pressures.

3.10 CLEANING AND STERILIZING OF POTABLE WATER BASINS

A. Clean and sterilize structures for potable water as specified in Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

3.11 FIELD QUALITY CONTROL

A. General:

1. Unless otherwise noted, concrete field testing services will be provided by Contractor.
2. The following is an overview of types and frequency of concrete field testing.
3. Provide adequate facilities for safe storage and proper curing of concrete test specimens onsite for first 24 hours, and for additional time as may be required before transporting to test lab.
4. Unless otherwise specified, concrete will be sampled for making test specimens, from point of delivery.
5. Unless otherwise specified, sampled concrete used to mold strength test specimens (ASTM C31/C31M) will be tested for slump (ASTM C143/C143M), temperature (ASTM C1064/C1064M), and density (ASTM C138/C138M).
6. Air Content:
   a. When concrete is pumped, concrete will be sampled for testing air content at point of delivery and at point of placement.
      1) For Each Concrete Mixture: Provided results of air content tests for first load of the day are within specified limits, testing need only be performed at point of delivery for subsequent loads of that concrete mixture except that testing should be performed at point of placement every 4 hours.
   b. When measured air content at point of delivery is greater than specified limit, a check test of air content will be performed immediately on a new sample from delivery unit. If check test fails, concrete has failed to meet requirements of Contract Documents.
   c. If measured air content is less than lower specified limit, adjustments will be permitted in accordance with ASTM C94/C94M, unless otherwise specified. If check test of adjusted mixture fails, concrete has failed to meet requirements of Contract Documents.
   d. Concrete that has failed to meet requirements of Contract Documents must be rejected.
7. Test specimens will be stored and cured in accordance with ASTM C31/C31M and tested in accordance ASTM C39/C39M.
8. Frequency of testing may be changed at discretion of Contracting Officer.
9. Evaluation and acceptance will be in accordance with ACI 301 and the Contract Documents.

B. Concrete Strength Test:

1. Unless otherwise specified, specimens will be made and tested as follows:
   a. One specimen at age of 7 days for information.
   b. Two 6-inch diameter or three 4-inch diameter test specimens at age of 28 days for acceptance.
   c. A minimum of one spare test specimen per sample.
2. If result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, moist cure in-situ concrete in accordance with Section 03 39 00, Concrete Curing, for an additional 7 days.

C. Tolerances:

1. Concrete tolerances must comply with the more stringent of equipment manufacturers' tolerances, and specified tolerances.
2. Formed Surfaces: Measure and inspect for compliance with tolerances specified in Section 03 10 00, Concrete Forming and Accessories.
3. Slab Finish Tolerances and Slope Tolerances:
   a. Make floor flatness measurements day after floor is finished and before shoring is removed to eliminate effects of shrinkage, curing, and deflection.
   b. Support 10-foot long straightedge at each end with steel gauge blocks of thicknesses equal to specified tolerance.
   c. Compliance with designated limits in four of five consecutive measurements is satisfactory unless defective conditions are observed.

D. Liquid Tightness Tests:

1. Purpose: To determine integrity and liquid-tightness of finished exterior and interior concrete surfaces of liquid containment structures.
2. Test all water-holding structures for liquid-tightness.
3. Water for initial tightness test will be provided by Contracting Officer.
4. Provide means to transport water to structure to be tested.
5. If additional tightness tests are required because of failure to meet criteria, provide water for subsequent tests.
6. After testing has been completed, dispose of test water in a manner approved by Contracting Officer.
7. Liquid-Tightness Test Requirement:
   a. Perform tightness tests in accordance with ACI 350.1 and as specified herein.
   b. Do not place backfill coatings or other work that will cover concrete surfaces until tightness testing has been completed and approved.
   c. Measure evaporation, precipitation, and temperature as specified.

8. Measure water surface at two points 180 degrees apart when possible where attachments, such as ladders exist, at 24-hour intervals.
9. Acceptance Criteria:
   a. Acceptance of the containment structure shall be based on criteria for both Part 1 and Part 2. Containment structures shall be retested until compliance is achieved.
   b. Part 1, Qualitative: If moisture is observed on the containment structure surfaces, exterior to the contained liquid, where moisture can be picked up on a dry hand, the containment structure is non-compliant.
   c. Part 2, Quantitative:
      1) Volume loss shall not exceed 0.050 percent of contained liquid volume per 24-hour period, adjusted for evaporation, precipitation, and temperature.
      2) Acceptance that structure has passed Part 2 of the tightness test shall be based on total volume loss at end of specified test period.
10. Repairs When Test Fails:
   a. Dewater structure; fill leaking cracks with crack repair epoxy as specified in Section 03 64 23, Epoxy Resin Injection Grouting, and Section 03 64 24, Polyurethane Injection Grouting.
   b. Patch areas of damp spots previously recorded, and repeat water leakage test in its entirety until structure successfully passes test.

3.12 MANUFACTURERS SERVICES

A. Provide representative at Site, for installation assistance, inspection, and certification of proper installation for concrete ingredients, mix design, mixing, and placement.

1. Concrete Producer Representative:
   a. Observe how concrete mixes are performing.
   b. Assist with concrete mix design, performance, placement, weather problems, and problems as may occur with concrete mix throughout Project, including instructions for redosing.
   c. Establish control limits on concrete mix designs.
   d. Provide equipment for control of concrete redosing for air entrainment or high-range, water-reducing admixture, superplasticizers, at Site to maintain proper slump and air content if needed.
2. Admixture Manufacturer’s Representative: Available for consultations as required to ensure proper installation and performance of specified products.
3. Bonding Agent Manufacturer’s Representative: Available for consultations as required to ensure proper installation and performance of specified products.

3.13 PROTECTION OF INSTALLED WORK

A. After curing as specified in Section 03 39 00, Concrete Curing, and after applying final floor finish, cover slabs with plywood or particle board or plastic sheeting or other material to keep floor clean and protect it from material and damage as a result of other construction work.

B. Repair areas damaged by construction, using specified repair materials and approved repair methods.

3.14 SCHEDULE OF CONCRETE FINISHES

A. Form Tolerances: As specified in Section 03 10 00, Concrete Forming and Accessories.

B. Provide concrete finishes as scheduled:

Area	Type of Finish	Required Form Tolerances
Exterior Wall Surfaces		
Abovegrade/exposed (above point 6" below finish grade)	W-9	W-B
Abovegrade/covered with brick veneer or other finish material	W-1	W-A
Backfilled/waterproofed (below point 6" below finish grade)	W-1	W-A
Backfilled/not waterproofed (below point 6" below final grade)	W-1	W-A
Interior Wall Surfaces		
Open top water-holding tanks and basins/not painted or coated	W-2	W-A
Covered water-holding tanks and basins/not painted or coated	W-1	W-A
Water-holding tanks, channels, and basins/painted or coated	W-5	W-A
Buildings, pipe galleries, and other dry areas/not painted or coated	W-9	W-A
Buildings, pipe galleries, and other dry areas/painted or coated	W-5	W-A

Exterior Slabs		
Roof slab/exposed	S-5	S-B
Roof slab/covered with roofing material	S-1	S-A
Water-holding tanks and basins/top of wall	S-5	S-B
Top of footing	S-2	S-A
Other water-holding tanks and basins	S-1	S-A
Stairs and landings	S-5	S-B
Sidewalks	S-6	S-B
Other exterior slabs	S-5	S-A
Interior Slabs		
Buildings and other dry areas not otherwise listed	S-1	S-B
Slabs to receive mortar setting bed for tile	S-2	S-A
Slabs to receive resilient flooring or carpet	S-1	S-A
Hydraulic channels	S-1	S-A
Underside of elevated slabs	S-3	S-A
Beams and Columns		
Beams/coated		B-A
Beams/not coated		B-A
Columns/coated		C-A
Columns/not coated		C-A

3.15 SUPPLEMENTS

A. Requirements of concrete mix designs following “End of Section,” are a part of this specification and supplement requirements of Part 1 through Part 3 of this section:

1. Concrete Mix Design, Class 4500F2S1W1C1.
2. Concrete Mix Design, Class 3500F1S1W1C1.

END OF SECTION

CONCRETE MIX DESIGN, CLASS 4500F2S1W1C1

A. Mix Locations: Typical, unless otherwise specified.

B. Exposure Categories and Classifications: F2S1W1C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.42.
2. Minimum concrete compressive strength (f'c) shall be 4,500 psi at 28 days.
3. Concrete mix of Entrance Road Water Tank shall be certified to comply with NSF/ANSI 61 for contact with potable water.
4. Designed to conform to shrinkage limits.
5. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in.	**Air Content (%)***
3/4	6.0
1	6.0
1-1/2	5.5
*Tolerance of air content is +/- 1-1/2 percent.	

6. Limit supplementary cementitious materials measured as a percent of weight of total cementitious materials in mix design, as follows:
   a. Fly Ash and Other Pozzolans: 25 percent.
   b. Slag Cement: 50 percent.
   c. Combined Fly Ash and Other Pozzolans and Slag Cement: 50 percent, with fly ash and other pozzolans not exceeding 25 percent.
   d. Total cementitious materials include ASTM C150/C150M and ASTM C595/C595M cement.
      1) Fly ash and other pozzolans in Type IP, blended cement, ASTM C595/C595M.
      2) Slag used in the manufacture of an IS blended cement, ASTM C595/C595M.
7. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.

2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

c. ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).

1) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

8. Unless otherwise permitted, minimum cementitious materials content in mix design shall be as follows:

a. 515 pounds per cubic yard for concrete with 1-1/2-inch nominal maximum size aggregate.

b. 535 pounds per cubic yard for 1-inch nominal maximum size aggregate.

c. 560 pounds per cubic yard for 3/4-inch nominal maximum size aggregate.

d. Unless otherwise permitted, limit cementitious materials content to 100 pounds per cubic yard greater than specified minimum cementitious materials content in mix design.

9. Limit water-soluble, chloride-ion content in hardened concrete to 0.10 percent, unless otherwise specified.

a. Limits are stated in terms of chloride ions in percent by weight of cement.

b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to Part 1 through Part 3 of this section for additional requirements.

CONCRETE MIX DESIGN, CLASS 3500F1S1W1C1

A. Mix Locations:

1. Electrical duct banks.
2. Pipe encasements that are not cast monolithically with concrete base mats or slabs.
3. Concrete fill.

B. Exposure Categories and Classifications: F1S1W1C1.

C. Mix Properties:

1. Limit water to cementitious materials ratio (W/Cm) in mix design to maximum value of 0.50.
2. Minimum concrete compressive strength (f'c) shall be 3,500 psi at 28 days.
3. Air-entraining admixtures are prohibited in concrete mixtures and total air content shall not be greater than 3 percent, for the following:
   a. Slabs to receive hard-troweled finish.
   b. Slabs to receive dry shake floor hardener.
   c. Slabs to receive topping placed monolithically as two-course floor on top of plastic concrete.
4. Unless otherwise specified, provide air content based on nominal maximum size of aggregate as follows:

Nominal Maximum Aggregate Size in.	**Air Content (%)***
3/4	5.0
1	4.5
1-1/2	4.5
*Tolerance of air content is +/- 1-1/2 percent.	

5. Provide cementitious materials in accordance with one of the following:
   a. ASTM C150/C150M Type II; inclusion of supplementary cementitious materials in design mix is optional.
   b. ASTM C150/C150M types other than Type II, plus supplementary cementitious materials in accordance with one of the following:
      1) Tricalcium Aluminate Content of Total Cementitious Materials: Maximum 8 percent by weight.
      2) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

3) ASTM C595/C595M Type IP or Type IS (less than 70), tested to comply with moderate sulfate resistance option (MS).

a) Provide documentation of test results in accordance with ASTM C1012/C1012M, for combinations of cementitious materials providing sulfate resistance with expansion less than 0.10 percent at 6 months.

6. Limit water-soluble, chloride-ion content in hardened concrete to 0.30 percent, unless otherwise specified.

a. Limits are stated in terms of chloride ions in percent by weight of cement.

b. Unless otherwise permitted, provide documentation from concrete tested in accordance with ASTM C1218/C1218M at an age between 28 days and 42 days.

D. Refer to Part 1 through Part 3 of this section for additional requirements.

SECTION 03 39 00
CONCRETE CURING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 308.1, Specification for Curing Concrete.
2. ASTM International (ASTM): C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
3. NSF International: 61, Drinking Water System Components – Health Effects.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' data indicating compliance with the requirements specified herein for the following products:
   a. Exposed aggregate finish retardant on formed surface.
   b. Evaporation retardant.
   c. Curing compound.
   d. Penetrating water repellent sealer.
   e. Clear liquid densifier.
2. Curing methods proposed for each type of element such as slab, walls, beams, and columns in each facility.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following:
   a. Curing compound showing moisture retention requirements.
2. Sustainable Design: In accordance with Section 01 81 13, Sustainable Design Requirements, document sustainability performance for items listed below.
   a. Product Data for Low Emitting Materials-Paints and Coatings:
      1) A complete list of paints and coatings used inside the building envelope during construction.
   b. Manufacturer's literature documenting VOC content of each product and compliance with requirements of Green Seal Standard GS-11, Green Seal Standard GC-03, and South Coast Air Quality Management District (SCAQMD) Rule No. 1113.

PART 2 PRODUCTS

2.01 MATERIALS

A. Volatile Organic Compound (VOC) Content of Sealer:

1. Provide sealers that comply with the following limits for VOC content when calculated according to California Air Resources Board, Architectural Coatings Suggested Control Measure:
   a. Concrete Curing Compounds: 350 g/L.
   b. Concrete Sealer: 100 g/L.
   c. Reactive Penetrating Sealer: 350 g/L.

B. Curing Compound: Water-based, high-solids content, nonyellowing, curing compound meeting requirements of ASTM C309, Type I, Class A.

C. Wet Curing Blankets:

1. Manufacturers and Products:
   a. Sika Chemical Corp., Lyndurst, NJ; Sika UltraCure DOT.
   b. Or equal.
2. Physical Characteristics: Single-use wet curing blankets consisting of white reflective polyethylene vapor barrier and cellulose fabric.
3. Functional Characteristics: None.
4. Performance Characteristics: Capable of maintaining a 100 percent relative humidity condition on the concrete surface for a curing period of 14 days.

D. Evaporation Retardant:

1. Manufacturers and Products:
   a. BASF Construction Chemicals, Shakopee, MN; MasterKure ER 50.
   b. Or equal.
2. Physical Characteristics: None.
3. Functional Characteristics: None.
4. Performance Characteristics: Reduces surface moisture evaporation from freshly placed concrete.

E. Clear Sealer (One-Component Penetrating Silane Sealer):

1. Manufacturers and Products:
   a. Euclid Chemical Co.; Baracade WB 244.
   b. Or equal.
2. Physical Characteristics:
   a. Water-based siloxane/silane penetrating water repellent sealer.
   b. VOC Content: Less than 50 g/L.

3. Functional Characteristics: None.
4. Performance Characteristics:
   a. Reduction in Chloride Ion Content: 89 percent in 21 days.
   b. Reduction in Water Absorption: 85 percent in 21 days.

F. Clear Hardener:

1. Manufacturers and Products:
   a. Euclid Chemical Co., Cleveland, OH; Euco Diamond Hard.
   b. Or equal.
2. Physical Characteristics:
   a. Aqueous solution containing a blend of silicate and siliconate polymers.
   b. VOC Content: Equal to or less than 5 g/L.
3. Functional Characteristics: None.
4. Performance Characteristics: Increases concrete surface hardness.

G. Water: Clean and potable, containing less than 500 ppm of chlorides.

PART 3 EXECUTION

3.01 CONCRETE CURING

A. General:

1. Cure all concrete in accordance with project specifications and ACI 308.1.
2. Where surfaces are to receive coatings, painting, cementitious material, or other similar finishes, use only water curing procedures.
3. Use only water curing on potable water structures.
4. Where curing compound cannot be used, water curing as described below or special methods using moisture shall be agreed upon by Contracting Officer prior to placing concrete.
5. As required in Section 03 30 00, Cast-in-Place Concrete, if result of 7-day concrete strength test is less than 50 percent of specified 28-day strength, extend period of moist curing specified below, by 7 additional days.

B. Use one of the following methods as approved by Contracting Officer:

1. Vertical Surfaces:
   a. Method 1: Leave concrete forms in place and keep surfaces of forms and concrete wet for 7 days.
   b. Method 2: Continuously sprinkle with water 100 percent of exposed surfaces for 7 days starting immediately after removal of forms.

c. Method 3: Apply curing compound, where allowed, immediately after removal of forms.

2. Horizontal Surfaces:
   a. Method 1: Protect surface by water ponding for 7 days.
   b. Method 2:
      1) Cover with burlap or cotton mats and keep continuously wet for 7 days.
      2) Cover with wet curing blankets in accordance with manufacturer's directions for minimum of 7 days.
   c. Method 3: Cover with 1-inch layer of wet sand, earth, or sawdust, and keep continuously wet for 7 days.
   d. Method 4: Continuously sprinkle exposed surface for 7 days.
   e. Method 5: Apply curing compound, where allowed, immediately after final finishing when surface will no longer be damaged by traffic.

3.02 EVAPORATION RETARDANT APPLICATION

A. Use on flatwork when environmental conditions are anticipated to cause rapid drying of the concrete surface. Do not use evaporation retardant on potable water structures, unless product is NSF 61 approved.

B. Spray onto surface of fresh flatwork concrete immediately after screeding to react with surface moisture.

C. Reapply as needed to ensure a continuous moist surface until final finishing is completed.

3.03 CLEAR SEALER APPLICATION

A. Before application and with Work above completed, water cure concrete walls and floors for a minimum of 28 days to receive sealer, keep clean, unpainted, and free from membrane curing compounds.

B. Concrete to receive penetrating sealer shall be dry for a minimum 24 hours immediately prior to application.

C. Apply per manufacturer's recommendations utilizing low pressure airless spray equipment.

   1. Actual coverage and number of coats to be determined by field test sample application and water absorption testing. Final approval by Contracting Officer is required.

D. Apply at a coverage rate of 125 square feet per gallon to 200 square feet per gallon. Cure penetrating sealer on slabs for the minimum time recommended by manufacturer prior to allowing foot or vehicular traffic.

3.04 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site for installation assistance, inspection, and certification of proper installation for products specified.

B. Provide clear sealer manufacturer's representative to demonstrate proper application of product.

C. Provide clear hardener manufacturer's representative to demonstrate proper mixing and application of product.

D. Provide curing compound manufacturer's representative to demonstrate proper application of curing compound to show coverage in one coat.

END OF SECTION

SECTION 03 40 00
PRECAST CONCRETE STRUCTURES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C150, Standard Specification for Portland Cement.
   b. C387, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. C858, Standard Specification for Underground Precast Concrete Utility Structures.

1.02 SUBMITTALS

A. Action Submittals:

1. Experience record on production of precast structures, indicating the capability to satisfactorily perform the work.
2. Drawings showing precast structure including layouts of top slab hatch and all pipe penetrations.
3. Manufacturer’s catalog data on precast concrete items. Show dimensions of structures and locations of openings including thicknesses of walls, floor, and top slab with their reinforcing steel. Show materials of construction by ASTM reference and grade.
4. Manufacturer’s design structural calculations and certification signed and sealed by a licensed civil or structural engineer currently registered in the state work is being performed that structure design complies with the specified design load conditions in accordance with the Drawing General Structural Notes and the referenced ASTM specifications (e.g., ASTM C857 and ASTM C858).
5. Manufacturer’s catalog data, descriptive literature, and installation instructions for the water proofing material.

PART 2 PRODUCTS

2.01 PRECAST CONCRETE STRUCTURES

A. Comply with ASTM C858 and ASTM C478 except as modified herein.

B. Design Live and Dead Loads: In accordance with ASTM C857. Design precast concrete structures to withstand site gravity and lateral soil design criteria as noted on the Drawing General Structural Notes.

C. Minimum Wall and Slab Thickness: 6 inches.

D. Design and construct structures to be watertight.

E. Provide openings in precast structures for piping and access in accordance with the Drawings.

2.02 SEALANTS AND MORTAR

A. Fill joints between precast sections with a double layer of plastic sealing compound to make watertight. Fill with mortar all recesses, lifting inserts, or other cavities not filled with plastic sealing compound. Mortar shall comply with ASTM C387, Type S.

2.03 CONCRETE AND STEEL REINFORCEMENT

A. As specified in Section 03 21 00, Steel Reinforcement and Section 03 30 00, Cast-in-Place Concrete.

2.04 EXTERIOR WATERPROOFING

A. Exterior Waterproofing Material: Black bituminous compound of brush or spray consistency for application on below grade concrete surfaces.

2.05 APPURTENANCES

A. Provide ladders, sidewalk doors, vents, supports, inserts, and other miscellaneous metalwork as shown on the Drawings.

2.06 FABRICATION

A. Reinforcing Steel:

1. Place in position before concrete is cast.
2. Keep clean and free from form oil or other substances harmful to bond.

B. Forms: Produce smooth surfaces.

C. Concrete: Deposit, vibrate, finish, and cure in accordance with recommended practices of ACI 304R. Steam curing is permitted.

D. Coordinate dimensions, determine type, quantity, size, and location of, and furnish necessary embedded items in precast concrete. Coordinate location of embedded items in cast-in-place concrete necessary to connect precast items.

2.07 SOURCE QUALITY CONTROL

A. Prepare minimum three standard concrete test cylinders for each 50 cubic yards or fraction thereof of concrete placed in the precast work in accordance with ASTM C31.

B. Test and record concrete strengths.

PART 3 EXECUTION

3.01 EXCAVATING AND BACKFILLING

A. Provide 6-inch minimum thickness 3/4-inch crushed rock over the full width of the vault base and extend horizontally 12 inches beyond the outside faces of the vault and foundation.

3.02 ERECTION

A. Verify that anchorage inserts are in correct locations.

B. Handle and erect concrete with care as recommended by manufacturer.

C. Erect precast units plumb, straight, level, square, and in proper alignment.

D. Fasten units securely in place and brace to maintain position, stability, and alignment until permanently connected and structure is complete and stable.

E. Field Cutting: Not allowed without prior approval of Contracting Officer.

3.03 INSTALLING STRUCTURE SECTIONS

A. Set each precast concrete structure section plumb on a double layer bed of sealant to make a watertight joint with the preceding unit. Point the inside joint and wipe off the excess sealant.

3.04 WATERPROOFING

A. Waterproofing shall be factory applied to all exterior surfaces of structure sections and risers per manufacturer's recommendations. Prior to backfilling, field-apply waterproofing material on joints and damaged surfaces. Protect coating from damage during backfilling and compacting.

3.05 FIELD QUALITY CONTROL

A. Inspection:

1. With Contracting Officer, inspect precast members for chips, cracks, discoloration, and other damage.
2. Record location and condition of damaged.

B. Resolution:

1. Repair damage to satisfaction of Contracting Officer.
2. Remove members with damage or repairs not acceptable to Contracting Officer.
3. Install new acceptable members in place of those removed.
4. Perform reinsertion and obtain acceptance by Contracting Officer.

3.06 PROTECTION

A. Protect precast units from chipping, spalling, cracking, or other damage to the units after delivery to the Site.

B. After erection, protect units from damage.

END OF SECTION

SECTION 03 62 00
GROUTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C230, Standard Specification for Flow Table for Use in Tests of Hydraulic Cement.
   b. C307, Standard Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   c. C531, Standard Test Method for Linear Shrinkage and Coefficient of Thermal Expansion of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   d. C579, Standard Test Methods for Compressive Grout Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   e. C882, Standard Test Method for Bond Strength of Epoxy-Resin Systems Used With Concrete By Slant Shear.
   f. C939, Standard Test Method for Flow of Grout for Preplaced-Aggregate Concrete (Flow Cone Method).
   g. C940, Standard Test Method for Expansion and Bleeding of Freshly Mixed Grouts for Preplaced-Aggregate Concrete in the Laboratory.
   h. C1107/C1107M, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).
   i. C1181, Standard Test Methods for Compressive Creep of Chemical-Resistant Polymer Machinery Grouts.
   j. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data of grouts.
2. Proposed method for keeping existing concrete surfaces wet prior to placing nonshrink grout.
3. Forming method for fluid grout placements.
4. Curing method for grout.

B. Informational Submittals:

1. Manufacturer's Written Instructions:
   a. Adding fiber reinforcing to batching.
   b. Mixing of grout.
2. Manufacturer's proposed training schedule for grout work.
3. Manufacturer's Certificate of Compliance in accordance with Section 01 67 00, Product Requirements.
   a. Grout free from chlorides and other corrosion-causing chemicals.
   b. Nonshrink grout properties of Category II and Category III, verifying expansion at 3 days or 14 days will not exceed the 28-day expansion and nonshrink properties are not based on gas or gypsum expansion.
4. Statements of Qualification: Grout manufacturer's representative.
5. Test Reports:
   a. Test report for 24-hour evaluation of nonshrink grout.
   b. Test results and service report from demonstration and training session.
   c. Field test reports and laboratory test results for field-drawn Samples.
6. List of Contractor's equipment installation staff trained by grout manufacturer's representative in:
   a. Nonshrink grout installation and curing.
   b. Epoxy grout installation and curing.

1.03 QUALIFICATIONS

A. Grout Manufacturer's Representative: Authorized and trained representative of grout manufacturer. Minimum of 1-year experience that has resulted in successful installation of grouts similar to those for this Project.

B. For grout suppliers not listed herein, provide completed 24-hour Evaluation of Nonshrink Grout Test Form, attached at the end of this section. Provide independent testing laboratory test results for testing conducted within last 18 months.

PART 2 PRODUCTS

2.01 NONSHRINK GROUT AND EPOXY GROUT SCHEDULE

A. Furnish nonshrink grout (Category I, II, and III) and epoxy grout for applications as indicated in the following schedule:

Application	Temperature Range	Max. Placing Time	
	40 deg F to 100 deg F	**20 Min.**	**Greater Than 20 Min.**
Blockouts at existing bridge abutments for new pipe penetrations	I or II		II
Column baseplates single-story	I or II		II
Beam bearing plates at CMU and concrete	I or II		II
Machine bases 25 hp or less	II	II	II
Form Tie-Through bolt openings	II	II	II
Machine bases 26 hp and up	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout
Baseplates and/or soleplates with vibration, thermal movement, etc.	III or Epoxy Grout	III or Epoxy Grout	III or Epoxy Grout

2.02 NONSHRINK GROUT

A. Category I:

1. Manufacturers and Products:
   a. BASF Building System, Inc., Shakopee, MN; MasterFlow 100.
   b. Or equal.
2. Physical Characteristics:
   a. Nonmetallic and nongas-liberating.
   b. Prepackaged natural aggregate grout requiring only the addition of water.
3. Functional Characteristics: None.

4. Performance Characteristics:
    a. Test in accordance with ASTM C1107/C1107M:
        1) Grout shall have flowable consistency.
        2) Flowable for 15 minutes.
    b. Grout shall not bleed at maximum allowed water.
    c. Minimum strength of flowable grout, 3,000 psi at 3 days, 5,000 psi at 7 days, and 7,000 psi at 28 days.

B. Category II:

1. Manufacturers and Products:
    a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 928.
    b. Or equal.
2. Physical Characteristics:
    a. Nonmetallic, nongas-liberating.
    b. Prepackaged natural aggregate grout requiring only the addition of water.
3. Functional Characteristics: None.
4. Performance Characteristics:
    a. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.
    b. Test in accordance with ASTM C1107/C1107M:
        1) Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
        2) Temperatures of 40 degrees F, 80 degrees F, and 90 degrees F.
    c. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
    d. Minimum strength of fluid grout, 3,500 psi at 1 day, 4,500 psi at 3 days, and 7,500 psi at 28 days.
    e. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.

C. Category III:

1. Manufacturers and Products:
    a. BASF Building Systems, Inc., Shakopee, MN; MasterFlow 885.
    b. Or equal.
2. Physical Characteristics:
    a. Metallic and nongas-liberating.
    b. Prepackaged aggregate grout requiring only the addition of water.
3. Functional Characteristics: None.
4. Performance Characteristics:
    a. Aggregate shall show no segregation or settlement at fluid consistency at specified times or temperatures.

b. Test in accordance with ASTM C1107/C1107M:
   1) Fluid consistency 20 seconds to 30 seconds in accordance with ASTM C939.
   2) Temperatures of 40 degrees F and 100 degrees F.
c. 1 hour after mixing, pass fluid grout through flow cone with continuous flow.
d. Minimum strength of fluid grout, 4,000 psi at 1 day, 5,000 psi at 3 days, and 9,000 psi at 28 days.
e. Maintain fluid consistency when mixed in 1-yard to 9-yard loads in ready-mix truck.

2.03 EPOXY GROUT

A. Manufacturers and Products:

1. BASF Building System, Inc., Shakopee MN; MasterFlow 648.
2. Or equal.

B. Physical Characteristics:

1. High-strength, nonshrink, high-temperature epoxy grouting material developed for the support of heavy equipment with vibratory loads.
2. Three-component mixture of a two-component epoxy resin system (100 percent solids) with a graded, precision aggregate blend.
3. Premeasured, prepackaged system.
4. Flowable.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Minimum compressive strength in accordance with ASTM C579 Method B, 9,500 psi at 75 degrees F at 7 days, 11,000 psi at post cure.
2. Maximum creep resistance in accordance with ASTM C1181 at 600 psi, 140 degrees F; 6.0 by 10^{-3} in/in.
3. Minimum bond strength in accordance with ASTM C882, 2,000 psi.
4. Minimum tensile strength in accordance with ASTM C307, 2,000 psi.
5. Maximum coefficient of thermal expansion in accordance with ASTM C531 at 73 degrees F to 210 degrees F, 23.0 by10^{-6} in/in/degrees F.
6. Working Time: Minimum 2 hours at 50 degrees F; 1.5 hours at 70 degrees F; 50 minutes at 90 degrees F.
7. Good chemical resistance.
8. Good effective bearing area.
9. Noncorrosive.

10. Moisture insensitive.
11. Modify resin and aggregate content where recommended by epoxy grout manufacturer to provide desired epoxy grout flow properties.

PART 3 EXECUTION

3.01 GROUT

A. General: Mix, place, and cure grout in accordance with grout manufacturer's representative's training instructions.

B. Epoxy Grout: Concrete slab shall be fully cured for 28 days to ensure excess water has evaporated. Test concrete surface for moisture in accordance with ASTM D4263 before epoxy grout is placed.

C. Form Tie-Through Bolt Holes: Provide nonshrink grout, Category II, fill space with dry pack dense grout hammered in with steel tool and hammer. Through-bolt holes; coordinate dry pack dense grout application with vinyl plug in Section 03 10 00, Concrete Forming and Accessories, and bonding agent in Section 03 30 00, Cast-in-Place Concrete.

D. Form Snap-Tie Hole: Fill tie hole in accordance with requirements of Section 03 30 00, Cast-in-Place Concrete.

3.02 GROUTING MACHINERY FOUNDATIONS

A. Block out original concrete or finish off at distance shown below bottom of machinery base with grout. Prepare concrete surface by sandblasting, chipping, or by mechanical means to remove any soft material. Surface roughness in accordance with manufacturer's written instructions.

B. Clean metal surfaces of all paint, oil, grease, loose rust, and other foreign material that will be in contact with grout.

C. Sandblast to bright metal all metal surfaces in contact with epoxy grout in accordance with manufacturer's written instructions.

D. Set machinery in position and wedge to elevation with steel wedges, or use cast-in leveling bolts. Remove wedges after grout is set and pack void with grout.

E. Form with watertight forms at least 2 inches higher than bottom of plate.

F. Fill space between bottom of machinery base and original concrete in accordance with manufacturer's representative's training instructions.

G. If grout cannot be placed from one edge and flowed to the opposite edge, air vents shall be provided through the plate to prevent air entrapment.

H. Radius all corners of grout pad.

I. Install expansion joints for epoxy grout placement in accordance with manufacturer's written instructions.

3.03 FIELD QUALITY CONTROL

A. General:

1. Performed by Contractor's inspection staff.
2. Perform the following quality control inspections. The grout manufacturer's representative shall accompany the Project representative's inspection staff on the first installation of each size and type of equipment.

B. Evaluation and Acceptance of Nonshrink Grout:

1. Inspect the surface preparation of concrete substrates onto which nonshrink grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
2. Inspect preparation and application of nonshrink grout form work for conformance to the manufacturer's recommendations.
3. Conduct a final review of completed nonshrink grout installation for conformance to these Specifications.
4. Provide a flow cone and cube molds with restraining plates onsite. Continue tests during Project as demonstrated by grout manufacturer's representative.
5. Perform flow cone and bleed tests, and make three 2-inch by 2-inch cubes for each 25 cubic feet of each type of nonshrink grout used. Use restraining caps for cube molds in accordance with ASTM C1107/C1107M.
6. For large grout applications, make three additional cubes and one more flow cone test. Include bleed test for each additional 25 cubic feet of nonshrink grout placed.
7. Consistency: As specified in Article Nonshrink Grout. Flow cone test in accordance with ASTM C939. Grout with consistencies outside range requirements shall be rejected.
8. Segregation: As specified in Article Nonshrink Grout. Grout when aggregate separates shall be rejected.
9. Nonshrink grout cubes shall test equal to or greater than minimum strength specified.
10. Strength Test Failures: Nonshrink grout work failing strength tests shall be removed and replaced.
11. Perform bleeding test in accordance with ASTM C940 to demonstrate grout will not bleed.

12. Store cubes at 70 degrees F.
13. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C1107/C1107M.
14. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Contracting Officer.

C. Evaluation and Acceptance of Epoxy Grout:

1. Inspect ambient conditions during various phases of epoxy grouting installation for conformance with the epoxy grout manufacturer's requirements.
2. Inspect the surface preparation of concrete substrates onto which epoxy grout materials are to be applied, for conformance to the specified application criteria including, but not limited to, substrate profile, degree of cleanliness, and moisture.
3. Inspect the surface preparation of the metallic substrates onto which the epoxy primer is to be applied.
4. Inspect the epoxy-primed metallic substrate for coverage and adhesion.
5. Inspect preparation and application of epoxy grout form work for conformance to the manufacturer's recommendation.
6. Verify consistency obtained is sufficient for the proper field placement at the installed temperatures.
7. Inspect and record that the "pot life" of epoxy grout materials is not exceeded during the installation.
8. Inspect epoxy grout for cure.
9. Inspect and record that localized repairs made to grout voids are in conformance with the specification requirements.
10. Conduct a final review of completed epoxy grout installation for conformance to these Specifications.
11. Compression tests and fabrication of specimens for epoxy grout shall be made in accordance to ASTM C579, Method B, at intervals during construction as selected by the Project representative. A set of three specimens shall be made for testing at 7 days, and each earlier time period as appropriate.
12. Independent testing laboratory shall prepare, store, cure, and test cubes in accordance with ASTM C579.
13. All grout, already placed, which fails to meet the requirements of these Specifications, is subject to removal and replacement at no additional cost to the Contracting Officer.

3.04 MANUFACTURER'S SERVICES

A. General:

1. Coordinate demonstrations, training sessions, and applicable Site visits with grout manufacturer's representative. Allow 2-week notice to grout manufacturer's representative for scheduling purposes.
2. Provide and conduct onsite, demonstration and training sessions for bleed tests, mixing, flow cone measurement, cube testing, application, and curing for each category and type of grout.
3. Necessary equipment and materials shall be available for demonstration.
4. Conduct training prior to equipment mount installation work on equipment pads.
5. Training for each type of grout shall be not less than 4 hours' duration.

B. Nonshrink Grout Training:

1. Training is required for all Type III grout installations.
2. Provide nonshrink grout installation training by the qualified grout manufacturer's representative for Contractor's workers that will be installing nonshrink grout for baseplates and equipment mounts. Schedule training to allow Contracting Officer's attendance.
3. Mix nonshrink grouts to required consistency, test, place, and cure on actual Project, such as, baseplates and form tie-through bolt holes to provide actual on-the-job training.
4. Use minimum of two bags for each grout Category III. Mix grout to fluid consistency and conduct flow cone and two bleed tests, make a minimum of six cubes for testing of two cubes at 1 day, 3 days, and 28 days. Use remaining grout for final Work.
5. Include recommended grout curing methods in the training.
6. Transport test cubes to independent test laboratory and obtain test reports.
7. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.
8. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

C. Epoxy Grout Training:

1. Provide epoxy grout installation training by the qualified epoxy grout manufacturer's representative for Contractor's workers that will be installing epoxy grout for equipment mounts. Schedule training to allow Contracting Officer's attendance.

2. Include training in:
   a. Performance testing such as compressive strength testing of the epoxy grout.
   b. All aspects of using the products, from mixing to application.
3. Transport test cubes to independent test laboratory and obtain test reports.
4. Training by manufacturer's representative does not relieve Contractor of overall responsibility for this portion of the work.
5. Submit a list of attendees that have been satisfactorily trained to perform epoxy grout installation for equipment mounting.

3.05 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. 24-hour Evaluation of Nonshrink Grout Test Form and Grout Testing Procedures.

END OF SECTION

SUPPLEMENT 1

_____
(Test Lab Name)

_____
(Address)

_____
(Phone No.)

24-HOUR EVALUATION OF NONSHRINK GROUT TEST FORM

OBJECTIVE: Define standard set of test procedures for an independent testing laboratory to perform and complete within a 24-hour period.

SCOPE: Utilize test procedures providing 24-hour results to duplicate field grouting demands. Intent of evaluation is to establish grout manufacturer's qualifications.

PRIOR TO TEST: Obtain three bags of each type of grout.

1. From intended grout supplier for Project.
2. Three bags of grout shall be of same lot number.

ANSWER THE FOLLOWING QUESTIONS FOR GROUT BEING TESTED FROM LITERATURE, DATA, AND PRINTING ON BAG:

A.	Product data and warranty information contained in company literature and data?	Yes_____	No_____
B.	Literature and bag information meet specified requirements?	Yes_____	No_____
C.	Manufacturer guarantees grout?	Yes_____	No_____
D.	Guarantee extends beyond grout replacement value and allows participation with Contractor in replacing and repairing defective areas?	Yes_____	No_____
E.	Water demands and limits printed on bag?	Yes_____	No_____
F.	Mixing information printed on the bag?	Yes_____	No_____
G.	Temperature restrictions printed on bag?	Yes_____	No_____

*Rejection of a grout will occur if one or more answers are noted NO.

GROUT TESTING PROCEDURES

A. Bagged Material:

1. List lot numbers. _____
2. List expiration date. _____
3. Weigh bags and record weight. _____

Contracting Officer will disqualify grout if bag weights have misstated measure plus or minus 2 pounds by more than one out of three bags. (Accuracy of weights is required to regulate amount of water used in mixing since this will affect properties.)

B. Mixing and Consistency Determination:

1. Mix full bag of grout in 10-gallon pail.
2. Use electric drill with a paddle device to mix grout (jiffy or jiffler type paddle).
3. Use maximum water allowed per water requirements listed in bag instructions.
4. Mix grout to maximum time listed on bag instructions.
5. In accordance with ASTM C939 (flow cone) determine time of mixed grout through the flow cone. _____ seconds
6. Add water to attain 20-second to 30-second flow in accordance with ASTM C939.
7. Record time of grout through cone at new water demand. _____ seconds
8. Record total water needed to attain 20-second to 30-second flow. _____ pounds
9. Record percent of water. _____ percent

C. When fluid grout is specified and additional water is required beyond grout manufacturer's listed maximum water, ASTM C1107/C1107M will be run at new water per grout ratio to determine whether grout passes using actual water requirements to be fluid. Use new water per grout ratio on remaining tests.

D. Bleed Test:

1. Fill 2-gallon cans half full of freshly mixed grout at ambient temperatures for each category and at required consistency for each.
2. Place one can of grout in tub of ice water and leave one can at ambient temperature.
3. Cover top of both cans with glass or plastic plate preventing evaporation.
4. Maintain 38 degrees F to 42 degrees F temperature with grout placed in ice and maintain ambient temperature for second container for 1 hour.

5. Visually check for bleeding of water at 15-minute intervals for 2 hours.

6. Perform final observation at 24 hours.

If grout bleeds a small amount at temperatures specified, grout will be rejected.

E. Extended Flow Time and Segregation Test (for Category II and Category III):

1. Divide the remaining grout into two 3-gallon cans. Place the cans into the 40-degree F and 90-degree F containers and leave for 20, 40, and 60 minutes. Every 20 minutes remove and check for segregation or settlement of aggregate. Use a gloved hand to reach to the bottom of the can, if more than 1/4 inch of aggregate has settled to the bottom or aggregate has segregated into clumps reject the grout.

2. Right after the settlement test mix the grout with the drill mixer for 10 seconds. Take a ASTM C939 flow cone test of grout and record flow time. Maintain this process for 1 hour at ambient temperatures of 40 degrees F and 90 degrees F.

   a. 20 min _____, sec. @ 40 degrees F.

   b. 40 min _____, sec. @ 40 degrees F.

   c. 60 min _____, sec. @ 40 degrees F.

   d. 20 min _____, sec. @ 90 degrees F.

   e. 40 min _____, sec. @ 90 degrees F.

   f. 60 min _____, sec. @ 90 degrees F.

All Category II and Category III grout that will not go through the flow cone with continuous flow after 60 minutes will be disqualified.

_____	_____
Qualified	Disqualified

F. 24-hour Strength Test:

1. Using grout left in mixing cans in accordance with ASTM C1107/C1107M for mixing and consistency determination test and for extended time flow test, make minimum of nine cube samples.

2. Store cubes at 70 degrees F for 24 hours.

3. Record average compressive strength of nine cubes at 24 hours.

Grout will be disqualified if 24-hour compressive strengths are less than 2,500 psi for grouts claiming fluid placement capabilities.

Grouts that have not been disqualified after these tests are qualified for use on the Project for the application indicated in Nonshrink Grout Schedule.

_____	_____
Signature of Independent Testing Laboratory	Date Test Conducted

SECTION 03 63 00
CONCRETE DOWELING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. International Code Council (ICC):
   a. International Building Code (IBC).
   b. Evaluation Services Reports.

1.02 DEFINITIONS

A. ICC Evaluation Services Report: Published by ICC for products provided by concrete adhesive anchor manufacturers.

B. Special Inspection: As defined in the ICC IBC and indicated on the Statement of Special Inspection Plan as shown on the Drawings.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Manufacturer’s catalog information.

B. Informational Submittals:

1. Manufacturer’s instructions for preparation, placement, drilling of holes, installation of anchors and adhesive, and handling of cartridges, nozzles, and equipment.
2. Manufacturer’s written letter of certification identifying installer’s qualifications to install products.
3. ICC Evaluation Services Report: Specific to proposed doweling system manufacturer.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installer: Trained and certified by manufacturer.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Container Markings: Include manufacturer's name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

B. Store adhesive components in accordance with manufacturer's written instructions.

C. Dispose of when:

1. Shelf life has expired.
2. Stored other than per manufacturer's instructions.

PART 2 PRODUCTS

2.01 MATERIALS

A. Adhesive:

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT-RE 500 V3 (ESR-3814) or HIT-HY 200-R V3 (ESR-4868) Adhesive Anchors.
   b. Or equal.
2. Physical Characteristics:
   a. Disposable, Self-Contained Cartridge System:
      1) Capable of dispensing both components in proper mixing ratio.
      2) Fit into manually or pneumatically operated caulking gun.
3. Functional Characteristics: None.
4. Performance Characteristics:
   a. Approved by an ICC Evaluation Services Report for conformance to 2021 IBC requirements for doweling of steel reinforcing bars in cracked concrete.
   b. Suitable for long-term loads as well as for wind and seismic loads.
   c. Meet requirements of ASTM C881/C881M.
   d. Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.

B. Mixing Nozzles: Disposable, manufactured in several sizes to accommodate size of reinforcing dowels.

C. Reinforcing Dowels: As specified in Section 03 21 00, Steel Reinforcement.

PART 3 EXECUTION

3.01 INSTALLATION

A. Drilling Equipment:

1. Drilling Hammers for Dowel Holes:
   a. Electric or pneumatic rotary type with medium or light impact.
   b. Hollow drills with flushing air systems are preferred.
2. Where edge distances are less than 2 inches, use lighter impact equipment to prevent microcracking and concrete spalling during drilling process.

B. Hole Diameter: Use drill bit diameter meeting ICC Evaluation Services Report requirements and as recommended by manufacturer.

C. Obstructions in Drill Path: When existing steel reinforcement is encountered during drilling, obtain Contracting Officer approval for proposed fix.

D. Doweling:

1. Install per details shown on the Drawings and in accordance with adhesive manufacturer’s instructions.
2. When using epoxy anchors, dowels may be prebent prior to installation to 15 degrees to align with other bars. Do not heat dowels to bend.
3. Bent Bar Dowels: Where edge distances are critical, and intersection with steel reinforcement is likely, drill hole at 10-degree angle or less and use prebent reinforcing bars.

E. Adhesive:

1. Install in accordance with written manufacturer’s instructions.
2. Dispense components through specially designed static mixing nozzle that thoroughly mixes components and places mixed adhesive at base of predrilled hole.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspection Plan as shown on the Drawings. Contractor responsibilities and related information on

special inspection and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

1. Special inspection will be performed by the Special Inspector in accordance with ICC ESR requirements and as specified in Section 01 45 33, Special Inspection, Observation, and Testing.
2. Continuous inspection required where noted herein and where concrete dowels are installed in overhead applications.
3. Periodic inspection required where continuous inspection is not specified.
4. Special Inspector will observe installation in accordance with requirements of the ICC Evaluation Services Report and will submit report including the following:
    a. Product Description: Product name, rod diameter, and length.
    b. Drill bit compliance.
    c. Hole diameter, diameter, and depth and cleanliness.
    d. Adhesive expiration date.
5. Verification of dowel installation in accordance with manufacturer's published instructions.

END OF SECTION

SECTION 03 64 23
EPOXY RESIN INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C882, Standard Specification for Test Method for Bond Strength of Epoxy Resin System Used with Concrete by Slant Shear.
   b. D570, Standard Test Method for Water Absorption of Plastics.
   c. D638, Standard Test Method for Tensile Properties of Plastics.
   d. D648, Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edgewise Position.
   e. D695, Standard Test Method for Compressive Properties of Rigid Plastics.
   f. D790, Standard Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
2. National Sanitation Foundation (NSF):
   a. Standard 60, Standard for Drinking Water Treatment and Chemicals – Health Effects.
   b. Standard 61, Standard for Drinking Water System Components – Health Effects.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Defective Area: As defined in Section 03 30 00, Cast-in-Place Concrete.

C. Hydraulic Structure: Liquid containment structure and/or structure designed to mitigate liquid infiltration.

D. Injection: Method of bonding together, addressing or eliminating leakage through cracks or joints by installing resin under pressure to fill the void in crack or joint.

E. Joint: A planned and formed discontinuity in concrete structure at junction of adjacent and sequential concrete placements and may contain embedded waterstops.

F. Leak or Leakage: Crack or joint exhibiting presence of moisture, sign of efflorescence, intermittently wet to touch, or continuous flow of liquid.

G. Narrow Cracks: Width equal to or less than 0.015 inch.

H. Wide Cracks: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for epoxy resin.
2. Technical data for metering, mixing, and injection equipment.
3. Depth of penetration, length, material used, and procedures where epoxy is approved for use.
4. Marked up drawings of proposed epoxy injection repair crack locations, widths, and lengths and direction on structure.
5. Health and safety plan for acid flushing.
6. Sample bottle.
7. Pot Life Test.
8. Slant Shear Test (Bond Strength).

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for epoxy resins.
2. Certificate for NSF 61 conformance.
3. Statements of Qualification for Epoxy Resin:
   a. Manufacturer's Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
4. Sample of epoxy resin two component ratio and injection pressure test records for concrete crack repair work.
5. Installation instructions for repairing core holes with repair mortar.
6. Test results of epoxy resin bond tests.
7. Epoxy resin two component ratio and injection pressure test records for concrete crack repair work.

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staffs:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of epoxy injection process for concrete structure.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.

c. Experienced in operation, maintenance, and troubleshooting of application equipment.

2. Injection Crew and Job Foreman:

a. Provide written and verifiable evidence showing compliance with the following requirements:

1) Licensed or certified by epoxy resin material manufacturer.

2) Minimum 3 years' experience in successful epoxy injection for at least 10,000 linear feet of successful crack injection, including 2,000 linear feet of wet crack injection to stop water leakage.

B. Injected Epoxy Resin:

1. Fill cracks and joints with minimum resin depth penetration no less than 90 percent of:

a. Full thickness of concrete section for cracks or joints.

b. Depth between waterstop and inside face of structure for joints with an embedded waterstop.

C. Injected cracks and joints which leak shall be considered deficient work irrespective of depth of penetration. Reinjection of deficient work or, with approval of Contracting Officer, provide other repairs to eliminate leakage.

D. Bond Strength Test for Epoxy Resin:

1. Concrete failure before resin failure.

2. 1,500 psi minimum bond strength per ASTM C882 test requirements with no failure of either concrete or epoxy resin.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Package resin material in new sealed containers and label with following information:

a. Manufacturer's name.

b. Product name and lot number.

c. Mix ratio by volume for components.

B. Storage and Protection: Store epoxy resin material containers in accordance with manufacturer's printed instructions and at ambient temperatures below 110 degrees F and above 45 degrees F.

PART 2 PRODUCTS

2.01 EPOXY INJECTION RESIN

A. Physical Characteristics: None.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. Two-component A and B structural epoxy resin for injection into cracks, joints or other voids in concrete structures for bonding or grouting.
2. Uncured Resin Properties:
   a. When mixed in ratio specified on resin container label:

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Pot Life (60-gram mass) @ 77, plus or minus 4 deg F	As specified in Article Source Quality Control	13 to 25 minutes	15 to 30 minutes
Pot Life (60-gram mass) @ 100, plus or minus 4 deg F	As specified in Article Source Quality Control	3 to 10 minutes	10 to 20 minutes
Viscosity @ 40, plus or minus 3 deg F	Brookfield RVT Spindle No. 4 @ 20 rpm	4,400 cps	600 cps
Viscosity @ 75 to 77 deg F	Brookfield RVT Spindle No. 2 @ 20 rpm	375 to 350 cps	175 to 140 cps

3. Epoxy Resin Properties: When cured for 7 days at 77 degree F, plus or minus 3 degrees F and conditioned at test temperature 12 hours prior to test, unless otherwise specified.

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Ultimate Tensile Strength, psi	ASTM D368	8,000 min.	5,000 min.
Tensile Elongation @ Break, percent	ASTM D638	4.2 max.	3.0 max.
Flexural Strength, psi	ASTM D790	10,000 min.	10,000 min.
Flexural Modulus, psi	ASTM D790	5.5×10^5 min.	4.5×10^5 min.
Compressive Yield Strength, psi	ASTM D695*	15,000 min.	12,000 min.
Compressive Modulus, psi	ASTM D695*	4.0×10^5 min.	4.0×10^5 min.

	Test Method	Wide Cracks or Joints	Narrow Cracks or Joints
Heat Deflection Temperature	ASTM D648*	130 deg F min.	140 deg F min.
Cured 3 days @ 40 deg F – Wet Concrete		3,500 psi min.	3,500 psi min.
Cured 1 day @ 77 deg F – Dry Concrete		5,000 psi min.	5,000 psi min.
Cured 3 days @ 77 deg F plus or minus 3 deg F		5,000 psi min.	5,000 psi min.

*Cure test specimens so that peak exothermic temperature of resin does not exceed 100 degrees F.

Note: See referenced specifications for preparation method of test specimens.

2.02 SURFACE SEAL

A. Sufficient strength and adhesion for holding injection fittings firmly in place and to resist pressures preventing leakage during injection.

B. Capable of removal after injection resin has cured.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal ANSI/NSF Standard 60 drinking water standards.

2.04 SAMPLE BOTTLE

A. Five-inch natural wide mouth HDPE bottle or 4-ounce clear PVC cylinder bottle; supplied with caps.

2.05 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of epoxy resin.

B. Pot Life Test:

1. Condition Component A and Component B to required temperature.
2. Measure components in ratio of Component B as stated on manufacturer's label into an 8-fluid ounce paper cup.
3. Mix components for 60 seconds using non-metallic stirring instrument. Scrape sides and bottom of cup periodically.
4. Probe mixture once with non-metallic stirring instrument every 30 seconds, starting 2 minutes prior to minimum specified pot life.
5. Pot Life Definition: Time at which a soft stringy mass forms in center of cup.

C. Slant Shear Test: Prepare specimens and perform tests in accordance with ASTM C882.

PART 3 EXECUTION

3.01 GENERAL

A. Unless permitted otherwise, structurally repair cracks or joints listed below:

1. Cracks considered to be defective as defined in Section 03 30 00, Cast-in-Place Concrete.

B. Do not proceed with injection work until submittals have been reviewed and approved by Contracting Officer.

C. Perform cracks or joints injection work after removing defective surface materials and after performing surface preparation, but prior to applying surface repair material unless otherwise noted. See Section 03 01 32, Repair of Vertical and Overhead Concrete Surfaces, Section 03 01 33, Repair of Horizontal Concrete Surfaces, for concrete surface repair system.

D. Width of cracks may vary along length and through thickness of concrete section.

E. Remove all excess, unused epoxy resin materials on concrete surfaces exposed to view prior to end of Work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter and mix two epoxy resin components and inject mixture into cracks or joints.

B. Pumps:

1. Electric or air powered with interlocks providing positive ratio control of proportions for the two components at nozzle.
2. Primary injection pumps for each material of different mix ratio, including a standby backup pump of similar ratio.
3. Capable of immediate compensation for changes in resins.
4. Do not use batch mix pumps.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed epoxy resin at pressures in accordance with epoxy resin manufacturer’s printed instruction and able to maintain pressure.

D. Automatic Shutoff Control: Provide sensors on both Component A and Component B reservoirs for stopping machine automatically when only one component is being pumped to mixing head.

E. Proportioning Ratio Tolerance: Maintain epoxy resin manufacturer's prescribed mix ratio within a tolerance of plus or minus 5 percent by volume at discharge pressure up to 160 psi.

F. Ratio/Pressure Check Device:

1. Two independent valve nozzles capable of controlling flow rate and pressure by opening or closing valve to restrict material flow.
2. Pressure gauge capable of sensing pressure behind each valve.

3.03 PREPARATION

A. Free cracks or joints from loose matter, dirt, laitance, oil, grease, efflorescence, salt, and other contaminants.

B. Clean cracks or joints in accordance with epoxy resin manufacturer's instructions.

C. Clean surfaces adjacent to cracks or joints from dirt, dust, grease, oil, efflorescence, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instruction by low pressure water cleaning using a pressure of 1,000 psi to 3,000 psi.

D. Do not use acids and corrosives for cleaning, other than those specified herein unless neutralized prior to injecting epoxy resin.

E. During installation and curing of materials, if ambient temperature is expected to drop below manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

G. Dry out cracks or joints if required by manufacturer's instructions.

3.04 APPLICATION

A. All liquid is to be removed from hydraulic structure prior to commencing with epoxy injection, unless approved otherwise.

B. Entry Ports:

1. Establish openings for epoxy resin entry in surface seal along crack.
2. Determine space between entry ports equal to thickness of concrete member to allow epoxy resin to penetrate to the full thickness of the member.
3. Drill injection holes at an angle between 45 degrees and 60 degrees from surface of concrete and perpendicular to alignment of cracks or

joints, to intersect crack or joint at midpoint of concrete section, and intersect joints at midpoint between waterstop and interior concrete surface, except as noted otherwise.

4. Locate drill holes on alternate sides of crack or joint where possible, unless orientation of crack or joint is known or has been verified by non-destructive testing techniques or core drilling.
5. Drill Hole Spacing: Do not to exceed concrete thicknesses or 12 inches maximum, except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack or joint and at commencement of drilling holes for injection and at beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow or too deep.
8. Remove dust and debris in drill holes and on surface of structure resulting from drilling operation, by flushing with water prior to installing the injection packers or ports.
9. Space entry ports closer together to allow adjustment of injection pressure to obtain minimum loss of epoxy to soil at locations where:
   a. Cracks or joints extend entirely through concrete element.
   b. Backfill of walls on one side.
   c. Slab-on-grade.
   d. Difficult to excavate behind wall to seal both surfaces of crack.
10. Install injection packers or ports in drill holes in accordance with manufacturer’s printed instructions with zerk coupling or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

C. Acid Flushing of Cracks and Joints:

1. Flush cracks and joints with acid flushing solution in accordance with manufacturer’s printed instructions. at high pressure or resin injection pressure. Apply acid flushing solution for a sufficient duration to permit solution to penetrate full depth and length of cracks and joints or to waterstop in joints.
2. Following acid flushing, flush cracks and joints with copious quantities of potable water in accordance with manufacturer’s printed instructions. at a pressure of 1,000 psi, or resin injection pressure, whichever is greater. until no evidence of acid flushing solution is visible in flush water.
3. Submit in-field health and safety plan for acid flushing operation. As a minimum, identify worker conducting acid flushing by wearing a reflective safety vest and signs indicating “Acid Flushing”. Also, clearly identify Work area where acid flushing is underway by signs and isolate by placing orange pylons or other temporary barrier, and signs indicating “Acid Flushing”. As work progresses, move pylons or barriers and signs to maintain a safe zone.

D. Application of Surface Seal along Cracks and Joints:

1. Apply surface seal in accordance with manufacturer's instructions to designated cracks and joints face prior to injection. Seal surface of cracks or joints to contain and prevent escape of injection epoxy.
2. Cure surface seal in accordance with manufacturer's printed instructions before commencing inject work.

E. Epoxy Injection:

1. Ensure zerk coupling is not installed in ports or packers next to the one being injected.
2. Start injection into each crack or joint at lowest elevation entry port or packer along vertical or diagonal crack or joint, and at one end of horizontal crack or joint.
3. Where injection entry ports or packers are used, continue injection at first port or packer until resin begins to flow out of port or packer at next highest elevation. Plug first port or packer and start injection at second port or packer until resin flows from next port or packer.
4. Inject entire crack or joint with same sequence.
5. At no time inject more than 6 feet length of first vertical crack or joint before verifying resin in sample bottle has start to set and cure.
6. Prior to commencing injection work along a horizontal crack or joint in structure when processed using ports or packers with zerk couplings are used, remove zerk couplings from injection ports or packers except for two ports or packers located where injection work will commence. Commence injection work in first two ports or packers. Once clean resin is vented from third injection port or packer, cease injection at first port or packer, and install zerk coupling and commence injection at third port or packer. Repeat process for fourth and subsequent ports or packers until full length of crack or joint has been injected.

F. Finishing:

1. Allow epoxy resin to cure in accordance with manufacturer's instruction after cracks or joints have been completely injected to allow surface seal removal without draining or runback of uncured epoxy resin material from cracks or joints.
2. Remove surface seal and injection packers or ports from cured injection resin along crack.
3. Finish crack or joint faces flush with adjacent concrete.
4. Indentations or protrusions caused by placement of entry ports, packers, drill holes, or damage from removal of surface seal is not acceptable.
5. Grind off protrusions and patch indentations and holes from injection packers and entry ports with a suitable patch material to satisfaction of Contracting Officer.

6. Remove surplus surface seal material splatters and injection resin material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Epoxy Resin Two Component Ratio Tests:

1. Disconnect mixing head and pump two resin components simultaneously through ratio check device.
2. Adjust discharge pressure to 160 psi for both resin components.
3. Simultaneously discharge both resin components into separate calibrated containers.
4. Compare amounts simultaneously discharged into calibrated containers during same time period to determine mix ratio.
5. Complete test at 160 psi discharge pressure and repeat procedure for 0 psi discharge pressure.
6. Run ratio test for each injection unit at beginning and end of each injection work day, and when injection work has stopped for more than 1 hour.
7. Document and maintain complete accurate records of ratios and pressure checks.

B. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect two resin component delivery lines to pressure check device.
2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure test for each injection equipment unit:
   a. Beginning and end of each injection work day.
   b. When injection work stop for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

C. Bottled Sample Tests:

1. During injection operation, provide at least one sample of mixed epoxy resin for each injection pump per shift per injection work day in a sample bottle.

2. Provide sufficient sample to demonstrate sample material epoxy resin will set and cure correctly.
3. Label each bottled sample with Contractor's name, date, and time sample was taken, and location in structure where sample was taken. Record details of bottle sample tests.
4. Place filled sample bottle upright in a container and allow sample to cure.
5. After sample has been allowed to cure, cut bottled sample open and visually inspect contents to verify that epoxy resin material has completely reacted and cured.
6. Evaluation and Assessment of Test:
    a. Should bottled sample(s) indicate a problem; such as epoxy resin not cured or foreign liquid in sample bottle, take verifying core sample immediately from cracks or joints, where material was used.
    b. Should above-referenced bottle sample(s) and core sample(s) indicate a problem with epoxy resin, arrange to have a Technical Representative of the epoxy resin manufacturer come to Site to review bottled sample(s) and core drilled sample(s) with Contracting Officer and provide technical advice on corrective measures.
    c. Carry out further investigation work or corrective measures recommended by Technical Representative of epoxy resin manufacturer.

END OF SECTION

SECTION 03 64 24
POLYURETHANE INJECTION GROUTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
   a. D638, Standard Test Method for Tensile Properties of Plastics.
   b. D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics.
   c. D1623, Standard Test Method for Tensile and Tensile Adhesion Properties of Rigid Cellular Plastics.
   d. D3574, Standard Test Method for Flexible Cellular Material Slab, Bonded, and Molded Urethane Foams.
2. National Sanitation Foundation (NSF):
   a. Standard 60, Standard for Drinking Water Treatment and Chemicals—Health Effects.
   b. Standard 61, Standard for Drinking Water System Components—Health Effects.

1.02 DEFINITIONS

A. Crack: Complete or incomplete separation of concrete into two or more parts produced by breaking or fracturing.

B. Injection: Method of bonding together; method of addressing or eliminating leakage through cracks or joints by installing polymer under pressure to fill the void in the crack or joint.

C. Joint: A planned and formed discontinuity in the concrete structure at the junction of adjacent and sequential concrete placements, and may contain embedded waterstops.

D. Leak or Leakage: Crack or joint exhibiting moisture, sign of efflorescence, intermittent wet to the touch, or continuous flow of liquid.

E. Narrow Cracks: Width equal to or less than 0.015 inch.

F. Wide Crack: Wider than 0.015 inch.

1.03 SUBMITTALS

A. Action Submittals:

1. Physical and chemical properties for polyurethane injection resin.
2. Technical data for metering, mixing, and injection equipment.
3. Submit marked up drawings of proposed polyurethane injection work including locations, depth of penetration, length, materials used, and procedures.
4. Sample bottle.

B. Informational Submittals:

1. Manufacturer's recommended surface preparation procedures and application instructions for polyurethane resin injection.
2. Certificate for NSF 61 conformance.
3. Statements of Qualification for Polyurethane Resin Injection:
   a. Manufacturer's Site representative.
   b. Injection applicator.
   c. Injection pump operating technician.
4. Sample of polyurethane resin mix ratio and injection pressure test records for concrete crack and joint injection work.
5. Installation instructions for repairing core holes with repair mortar.
6. Polyurethane resins injection pressure test records for concrete crack and joint injection work

1.04 QUALITY ASSURANCE

A. Qualifications for Injection Staff:

1. Manufacturer's Site Representative:
   a. Capable of instructing successful methods of polyurethane injection process for concrete structures.
   b. Understands and is capable of explaining technical aspects of correct material selection and use.
   c. Experienced in the operation, maintenance, and troubleshooting of application equipment.
2. Injection crew and job foreman shall provide written and verifiable evidence showing compliance with the following requirements:
   a. Licensed or certified by polyurethane resin manufacturer.
   b. Minimum 3 years' experience in successful polyurethane injection for at least 10,000 linear feet of successful crack and joint injection, including 2,000 linear feet of wet crack and joint injection to stop water leakage.

1.05 PERFORMANCE REQUIREMENTS

A. The injected polyurethane resin shall fill the cracks and joints, and in no case shall the depth of penetration of the injection material be less than 90 percent of:

1. The full thickness of the concrete section for cracks.
2. The depth between the waterstop and the face of the structure for joints.

B. In cured state, injected polyurethane resin forms a dense rubber-like closed cell flexible foam compression gasket-type seal material.

C. Notwithstanding the foregoing, injected cracks or joints which exhibit leakage are considered deficient work irrespective of the depth of penetration observed in quality control core drilled samples. Reinject deficient work as required to meet the performance requirements.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Packing and Shipping:

1. Package adhesive material in new sealed containers and label with following information:
   a. Manufacturer's name.
   b. Product name and lot number.

B. Storage and Protection: Store polyurethane resin material containers in accordance with manufacturer's printed instructions or in the absence of such information at ambient temperatures below 110 degrees F and above 68 degrees F.

PART 2 PRODUCTS

2.01 POLYURETHANE RESIN

A. Physical Characteristics: None.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. Single-component, water-activated, hydrophilic polyurethane injection resin.
2. Accelerator: Compatible with polyurethane resin from same manufacturer.
3. Elongation: Minimum 350 percent, in accordance with ASTM D3574 or ASTM D638 test method.

4. Tensile Strength: Minimum 150 psi, in accordance with ASTM D3574 or ASTM D638 test method.
5. Meets NSF 61 requirements.

2.02 SURFACE SEAL

A. Provide seal with sufficient strength and adhesion for holding injection fittings firmly in place, and to resist pressures preventing leakage during injection.

B. Capable of removal after injection resin has cured.

C. Meets NSF 61 requirements.

2.03 WATER

A. Clean and free from oil, acid, alkali, organic matter, or other deleterious substances, meeting federal drinking water standards.

2.04 SAMPLE BOTTLE

A. 5 inches natural wide mouth HDPE bottle or 4 ounces clear PVC cylinder bottle, supplied with caps.

2.05 SOURCE QUALITY CONTROL

A. Test Requirements: Perform tests for each batch of polyurethane resins.

PART 3 EXECUTION

3.01 GENERAL

A. Use of polyurethane injection shall be limited to nonstructural locations as determined by Structural Engineer.

B. Do not proceed with injection work until action submittals have been reviewed and approved by the Contracting Officer.

C. Perform injection work after performing surface preparation.

D. The width of the cracks shown may vary along the length and through the thickness of the concrete section.

E. Remove all excess unused polyurethane resins materials inside the structure prior to the end of the work.

3.02 EQUIPMENT

A. Portable, positive displacement type pumps with in-line metering to meter mixed components, and inject mixture into crack or joint.

B. Pumps: Positive displacement type pump.

C. Discharge Pressure: Automatic pressure controls capable of discharging mixed polyurethane resin at pressures in accordance with polyurethane resin manufacturer's printed instructions, and able to maintain such pressure.

D. Proportioning Ratio Tolerance: Maintain polyurethane manufacturer's prescribed mix ratio within a tolerance in accordance with polyurethane resin manufacturer's printed instructions.

E. Pressure gauge capable of sensing pressure behind valve.

3.03 PREPARATION

A. Free cracks and joints from loose matter, dirt, laitance, oil, grease, salt, and other contaminants.

B. Clean cracks and joints in accordance with polyurethane resins manufacturer's printed instructions.

C. Clean surfaces adjacent to cracks and joints from dirt, dust, grease, oil, efflorescence, encrustation, and other foreign matter detrimental to bond of surface seal system and to expose the full extent of cracks and joints in accordance with manufacturer's printed instructions.

D. Do not use acids and corrosives for cleaning, other than those specified herein, unless neutralized prior to injecting polyurethane resin.

E. During installation and curing of materials, if the ambient temperature is expected to drop below the manufacturer's recommended minimum temperature, provide enclosures and heat as required.

F. Provide work platforms as required.

3.04 APPLICATION

A. Injection Ports:

1. Drill holes shall be installed along cracks and joints designated for injection as required to meet the performance requirements for injection.
2. The requirements for installing drill holes for injection provided below represent acceptable minimum standards of practice.

3. Drill holes for injection at an angle between 45 degrees and 60 degrees from the surface of the concrete and perpendicular to the cracks or joints alignment as indicated on the Drawings, to intersect the cracks at the midpoint of the concrete section, and intersect the joints at the midpoint between the waterstop and interior concrete surface, except as noted otherwise.
4. Locate drill holes on alternate sides of the crack or joint where possible, unless orientation of the crack or joint is known or has been verified by nondestructive testing techniques or core drilling.
5. The spacing of drill holes not to exceed the concrete thickness or 12 inches (maximum), except as noted otherwise.
6. Adjust location and angle of drill holes to suit orientation of crack or joint and at required angle, such as using a template, during the Work especially at the commencement of drilling holes for injection and at the beginning of each subsequent shift.
7. Take measures to prevent drilling holes for injection too shallow, or too deep, and/or damaging the existing waterstop in the joints. Shallow hole injections lead to concrete spalls. Repair spalls at Contractor's expense.
8. Remove dust and debris in drill holes and on interior surface of the structure resulting from drilling operation, by flushing with water prior to installing injection packers or ports.
9. Install injection packers or ports in drill holes in accordance with manufacturer's printed instructions with zerk coupling, or other one-way ball or check valve, to permit testing for watertightness and acid flushing of cracks and joints.

B. Application of Surface Seal Along Cracks and Joints:

1. Apply surface seal along the length of the cracks and joints designated for injection on the top side and underside of slabs, or both sides of walls, where possible in order to contain, confine, and prevent escape of the injected polyurethane resin, in accordance with manufacturer's printed instructions.
2. Cure the surface seal in accordance with the material's manufacturer's printed instructions.

C. Mixing Polyurethane Injection Resin: Add accelerator to polyurethane injection resin at the required dosage to produce cured polyurethane material meeting performance requirements, and mix thoroughly in accordance with manufacturer's printed instructions until a homogeneous mixture is obtained outside of the structure.

D. Polyurethane Injection of Cracks and Joints:

1. Inject polyurethane resins, mixed with accelerator or in a neat form, into cracks and joints in a sequential manner, and reinjection as required, to meet the performance requirements.
2. Start injection into each crack or joint at lowest elevation entry port for vertical or diagonal cracks and joints and at one end for horizontal cracks and joints in vertical structure. Continue injection at first port until pure uncontaminated resin begins to flow out of next port. Plug first port and start injection at second port until polyurethane resin flows from next port. Inject crack or joint in a sequential manner until the full length of the crack or joint has been injected. At no time inject more than 6 feet length of vertical crack or joint before verifying that the first 12 inches of injected crack or joint is set and cured.
3. Prior to commencing the injection work along a crack or joint in horizontal structure when packers with zerk couplings are used, remove the zerk couplings from the injection packers or ports except for the two packers located where the injection work will commence. Commence injection work in the first two packers. Once clean resin is vented from the third injection packer, cease injection at the first packer, and install the zerk coupling and commence injection at the third packer. Repeat the process for the fourth and subsequent packers until the full length of the crack or joint has been injected.

E. Finishing:

1. Cure polyurethane resins after crack or joints has been completely filled without draining or runback of polyurethane resin material from crack or joints.
2. Remove surface seal and injection packers or ports from along the crack or joints.
3. Finish surface flush and to match surrounding concrete.
4. Indentations or protrusions caused by placement of entry ports drill holes, or damage from removal of surface seal, is not acceptable.
5. Grind off protrusions and patch indentations and holes from packers and ports with a suitable patch material to the satisfaction of the Contracting Officer.
6. Remove surplus surface seal material on splatters and injection material runs and spills from concrete surfaces.

3.05 FIELD QUALITY CONTROL

A. Injection Pressure Test:

1. Disconnect mixing head of injection equipment and connect polyurethane component delivery line to pressure check device.

2. Pressure Check Device:
   a. Two independent valved nozzles capable of controlling flow rate and pressure by opening or closing of valve.
   b. Pressure gauge capable of sensing pressure buildup behind each valve.
3. Close valves on pressure check device and operate equipment until gauge pressure on each line reads 160 psi.
4. Stop pumps and observe pressure; do not allow pressure gauge to drop below 150 psi within 3 minutes.
5. Run pressure Test for Each Injection Equipment Unit:
   a. Beginning and end of each injection work day.
   b. When injection work has stopped for more than 45 minutes.
6. Check tolerance to verify equipment capable of meeting specified ratio tolerance.

B. Bottled Samples:

1. During the injection operation, provide at least one sample of the mixed polyurethane injection resins per shift per injection pump in a sample bottle.
2. Half fill each sample bottle, containing a small amount of water (5 percent by volume) with polyurethane injection resin material from the pump discharge hose. Swirl or lightly shake sample to thoroughly mix resin with the water. When foaming rises near the top of the bottle, install the cap to contain the expanding resin material.
3. Label each bottled sample with Contractor’s name, date and time sample was taken, and location in structure where sample was taken. Maintain a log of bottle samples.
4. Place filled sample bottle upright in a box or pail and allow sample to cure.
5. After sample cured, cut bottled sample open and visually inspect contents to verify that polyurethane injection resins material has completely reacted and cured.
6. Evaluation and Assessment of Test:
   a. If a bottled sample(s) indicates a problem with the polyurethane injection resins, such as polyurethane resin not cured; take verifying core sample immediately from the cracks or joints, where the material was used.
   b. If the above-referenced bottle sample(s) and core sample(s) indicate a problem with the polyurethane injection resins, have a Technical Representative of the polyurethane injection resins manufacturer come to site to review bottled sample(s) and core drilled sample(s) with Contracting Officer and provide technical advice on corrective measures.

c. Carry out further investigation work or corrective measures recommended by the Technical Representative of the polyurethane injection resins manufacturer.

END OF SECTION

SECTION 04 03 43
HISTORIC STONE MASONRY REPOINTING

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 historic treatment work consisting of removing, reinstalling and repointing stone masonry joints with mortar.

1.03 UNIT PRICES

A. Mortar Materials:

1. Basis of Measurement: By cubic yard.
2. Basis of Payment: Includes mortar materials and preparation ready for placement.

B. Mortar in Place Stone:

1. Basis of Measurement: By linear feet.
2. Basis of Payment: Includes tooled mortar placement.

1.04 DEFINITIONS

A. Low-Pressure Spray:

1. Pressure: 100 psi to 400 psi (690 kPa to 2750 kPa).
2. Flow Rate: 4 gpm to 6 gpm (0.25 L/s to 0.4 L/s).

B. Rift: The most pronounced direction of splitting or cleavage of a stone. Rift may be obscure in igneous rocks such as granite. Often it is obvious, as with bedding planes in many sedimentary stones.

1.05 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference on historic masonry repair and repointing at Project Site.

1. Review minutes of Preliminary Historic Treatment Conference that pertain to masonry historic treatment and repointing.

2. Review methods and procedures related to repointing historic stone masonry including, but not limited to, the following:
    a. Verify historic treatment 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. Fire-protection plan.
    e. Stone historic treatment program.
    f. Coordination with building occupants.

1.06 SEQUENCING AND SCHEDULING

A. Work Sequence:

1. Perform stone historic treatment work in the following sequence, which includes work specified in this and other sections:
    a. Remove plant growth.
    b. Inspect stonework 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.
    c. Rake out mortar from joints surrounding stone to be replaced and from joints adjacent to stone repairs along joints.
    d. Remove stone as required for new utility work.
    e. Clean stone.
    f. Store stone in a safe manner to prevent any damage to the stone.
    g. Reinstall stone in same positions as removed using the same bedding as original.
    h. Repair stonework, including replacing existing stone with new stone if required. If new stone is used, it must be compatible in color, size, shape and texture as surrounding stones and materials.
    i. Point mortar and sealant joints.
    j. After repairs and repointing have been completed and cured, perform a final cleaning to remove residues from this work.

1.07 ACTION SUBMITTALS

A. Product Data:

1. For each type of product:
    a. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
    b. Include recommendations for product application and use.
    c. Include test data substantiating that products comply with requirements.

B. Shop Drawings:

1. Include plans, elevations, sections, and locations of repointing work on the structure/pathways.
2. Show provisions for expansion joints or other sealant joints.

C. Samples for Initial Selection:

1. For the following:
   a. Pointing Mortar: Submit sets of mortar for pointing in the form of sample mortar strips, 6 inches (150 mm) long by 1/2 inch (13 mm) wide, set in aluminum or plastic channels.
      1) Submit with precise measurements on ingredients, proportions, gradations, and sources of colored sands from which each Sample was made.
   b. Each type of sand used for pointing mortar; minimum 8 ounces (240 mL) of each in plastic screw-top jars.
      1) For blended sands, provide Samples of each component and blend. Identify blend ratio.
      2) Identify sources, both supplier and quarry, of each type of sand.
   c. Include similar Samples of accessories involving color selection.

D. Samples for Verification:

1. For the following:
   a. Each type, color, and texture of pointing mortar in the form of sample mortar strips, 6 inches (150 mm) long by 1/2 inch (13 mm) wide, set in aluminum or plastic channels.
      1) Include with each Sample a list of ingredients with proportions of each. Identify sources, both supplier and quarry, of each type of sand and pigments if any.
   b. Accessories: Each type of anchor, accessory, and miscellaneous support.

1.08 INFORMATIONAL SUBMITTALS

A. Qualification Data: For including field supervisors and workers.

B. Preconstruction Test Reports: For existing stone types and mortar.

C. Quality-control program.

D. Stone historic treatment program.

1.09 QUALITY ASSURANCE

A. Quality-Control Program: Prepare a written quality-control program for this Project 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.

B. Stone Historic Treatment Program: Prepare a written, detailed description of materials, methods, equipment, and sequence of operations to be used for each phase of the historic treatment work, including protection of surrounding materials and Project Site.

1. Include methods for keeping pointing mortar damp during curing period.
2. If materials and methods other than those indicated are proposed for any phase of historic treatment 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 Project.

C. Mockups: Prepare mockups of historic treatment on existing surfaces to demonstrate aesthetic effects and to set quality standards for materials and execution.

1. Repointing: Rake out joints in two separate areas each approximately 36 inches (900 mm) high by 48 inches (1200 mm) wide for each type of repointing required, and repoint one of the areas.
2. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect 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.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Deliver packaged materials to Project Site in manufacturer's original and unopened containers, labeled with manufacturer's name and type of products.

B. Store hydrated lime in manufacturer's original and unopened containers. Discard lime if containers have been damaged or have been opened for more than 2 days.

C. Store lime putty covered with water in sealed containers.

D. Store sand where grading and other required characteristics can be maintained, and contamination avoided.

1.11 FIELD CONDITIONS

A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit repointing work to be performed according to product manufacturers' written instructions and specified requirements.

B. Temperature Limits: Repoint mortar joints only when air temperature is between 40 degrees F and 90 degrees F (4 degrees C and 32 degrees C) and is predicted to remain so for at least seven days after completion of the Work unless otherwise indicated.

C. Cold-Weather Requirements:

1. Comply with the following procedures for mortar-joint pointing unless otherwise indicated:
   a. When air temperature is below 40 degrees F (4 degrees C), heat mortar ingredients and existing stone to produce temperatures between 40 degrees F and 120 degrees F (4 degrees C and 49 degrees C).
   b. When mean daily air temperature is below 40 degrees F (4 degrees C), provide enclosure and heat to maintain temperatures above 32 degrees F (0 degree C) within the enclosure for seven days after pointing.

D. Hot-Weather Requirements: Protect mortar-joint pointing when temperature and humidity conditions produce excessive evaporation of water from mortar 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 degrees F (32 degrees C) and above unless otherwise indicated.

PART 2 PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Source Limitations: Obtain each type of material for repointing historic masonry (sand, etc.) from single source with resources to provide materials of consistent quality in appearance and physical properties. The new mortar must match the historic mortar in color, texture and tooling. (If a laboratory analysis is undertaken, it may be possible to match the binder components and their proportions with the historic mortar, if those materials are available). The sand must match the sand in the historic mortar. (The color and texture of the new mortar will usually fall into place if the sand is matched successfully.)

2.02 MORTAR MATERIALS

A. Natural Hydraulic Lime.

B. Factory-Prepared Lime Putty: ASTM C1489.

C. Quicklime: ASTM C5, pulverized lime.

D. Mortar Sand: ASTM C144 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. Color: Natural sand or ground marble, granite, or other sound stone of color necessary to produce required mortar color.
3. Provide sand with rounded edges.

E. Mortar Pigments: ASTM C979/C979M, compounded for use in mortar mixes, and having a record of satisfactory performance in masonry mortars.

F. Water: ASTM C270, potable.

2.03 MORTAR MIXES

A. Preparing Lime Putty: Slake quicklime and prepare lime putty according to appendix in ASTM C5 and to manufacturer's written instructions.

B. Measurement and Mixing: Measure 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. Colored Mortar: Produce mortar of color required by using specified ingredients. Do not alter specified proportions without Architect's approval.

1. Mortar Pigments: 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. Mixes: Mix mortar materials in the following proportions:

1. Rebuilding Lime Based Mortar by Volume: Proportion Specification, 4 parts plastering sand to 1 part Portland cement to 1 part Natural Hydraulic Lime (NHL).
2. Colored Mortar: 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 surrounding flagstones, steps, retaining walls and other projecting items to protect them from mortar droppings.
2. Keep surrounding area wet around pointing work to discourage mortar from adhering.
3. Immediately remove mortar splatters in contact with exposed stone and other surfaces.

3.02 STONE REPOINTING, GENERAL

A. Have repointing work performed only by qualified historic treatment specialist.

B. Appearance Standard: Repointed surfaces are to match the appearance of surrounding historic stones and joints as viewed from 20 feet (6 m) away by Architect.

3.03 REPOINTING

A. Rake out and repoint joints to the following extent:

1. All joints in areas indicated.
2. Joints indicated as sealant-filled joints.
3. Joints at locations of the following defects:
   a. Holes and missing mortar.
   b. Cracks that can be penetrated 1/4 inch (6 mm) or more by a knife blade 0.027 inch (0.7 mm) thick.
   c. Cracks 1/16 inch (1.6 mm) or more in width and of any depth.
   d. Hollow-sounding joints when tapped by metal object.
   e. Eroded surfaces 1/4 inch (6 mm) or deeper.
   f. Deterioration to point that mortar can be easily removed by hand, without tools.
   g. Joints filled with substances other than mortar.

B. Do not rake out and repoint joints where not required.

C. Rake out joints as follows, according to procedures demonstrated in approved mockup:

1. Remove mortar from joints to depth of joint width plus 1/8 inch (3 mm) and not less than that required to expose sound, unweathered mortar. Do

not remove unsound mortar more than 2 inches (50 mm) deep; consult Architect for direction.

2. Remove mortar from stone surfaces within raked-out joints to provide reveals with square backs and to expose stone for contact with pointing mortar. Brush, vacuum, or flush joints to remove dirt and loose debris.
3. Do not spall edges of stone units or widen joints: Replace or patch damaged stone units as directed by Architect.
    a. Cut out mortar by hand with chisel and resilient mallet. Do not use power-operated grinders without Architect's written approval based on approved quality-control program.
    b. Cut out center of mortar bed joints using angle grinders with diamond-impregnated metal blades. Remove remaining mortar in bed joints and mortar in head joints by hand with chisel and resilient mallet. Strictly adhere to approved quality-control program.

D. Notify Architect of unforeseen detrimental conditions, including voids in mortar joints, cracks, loose stone, rotted wood, rusted metal, and other deteriorated items.

E. 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 (9 mm) until a uniform depth is formed. Fully compact each layer thoroughly, 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 (9 mm). Fully compact each layer, and allow it to become thumbprint hard before applying next layer. Where existing stone has worn or rounded edges, slightly recess finished mortar surface below face of stone to avoid widened joint faces. Take care not to spread mortar beyond joint edges onto exposed stone 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 72 consecutive hours, including weekends and holidays:
    a. Acceptable curing methods include covering with wet burlap and plastic sheeting, periodic hand misting, and periodic mist spraying using system of pipes, mist heads, and timers.

b. Adjust curing methods to ensure that pointing mortar is damp throughout its depth without eroding surface mortar.

6. Hairline cracking within the mortar or mortar separation at edge of a joint is unacceptable. Remove mortar and repoint.

F. Where repointing work precedes cleaning of existing stone, allow mortar to harden at least 30 days before beginning cleaning work.

3.04 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 nonstone surfaces. Use detergent and soft brushes or cloths.

C. Clean mortar and debris from work area; remove debris from work area and pathways. Rinse off work areas and pathways.

D. Remove masking materials, leaving no residues that could trap dirt.

3.05 FIELD QUALITY CONTROL

A. Architect's Project Representatives: Architect will assign Project representatives to help carry out Architect's responsibilities at the Site, including observing progress and quality of portion of the Work completed. Allow Architect's Project representatives use of lift devices and scaffolding, as needed, to observe progress and quality of portion of the Work completed.

END OF SECTION

SECTION 05 05 19
POST-INSTALLED ANCHORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 318, Building Code Requirements for Structural Concrete.
   b. 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
2. American Iron and Steel Institute (AISI): Stainless Steel Type 316.
3. American National Standards Institute (ANSI).
4. ASTM International (ASTM):
   a. A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A143, Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   c. A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   e. A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   f. A380, Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   g. A385, Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
   h. A563, Specification for Carbon and Alloy Steel Nuts.
   i. A780, Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
   j. A967, Specification for Chemical Passivation Treatments for Stainless Steel Parts.
   k. E488, Standard Test Methods for Strength of Anchors in Concrete Elements.
   l. F436, Specification for Hardened Steel Washers.
   m. F468, Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
   n. F568M, Specification for Carbon and Alloy Steel Externally Threaded Metric Fasteners.

o. F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
p. F594, Specification for Stainless Steel Nuts.
q. F1554, Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

5. International Association of Plumbing and Mechanical Officials Uniform ES (IAPMO-UES): Evaluation Reports for Concrete and Masonry Anchors.
6. International Code Council Evaluation Service (ICC-ES):
   a. Evaluation Reports for Concrete and Masonry Anchors.
   b. AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
   c. AC70, Acceptance Criteria for Fasteners Power-driven into Concrete, Steel and Masonry Elements.
   d. AC106, Acceptance Criteria for Predrilled Fasteners (Screw Anchors) in Masonry Elements.
   e. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
   f. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements. Evaluation Reports for Concrete and Masonry Anchors.
7. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

B. Exterior Area: Location not protected from weather by a building or other enclosed structure to include buried roof structures.

C. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or wash down, and where wall or roof slab is not common to a water-holding or earth-retaining structure.

D. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or wash down, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

E. Submerged: Location at or below top of wall of open water-holding structure, such as a basin or channel, or wall, ceiling, or floor surface inside a covered

water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Specific instructions for concrete anchor installation, including drilled hole size and depth, preparation, placement, procedures, and instructions for safe handling of anchoring systems.

B. Informational Submittals:

1. Concrete and Masonry Anchors:
   a. Manufacturer's product description and installation instructions.
   b. Current ICC-ES or IAPMO-UES Report for each type of post-installed anchor to be used.
   c. Adhesive Anchor Installer Certification.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Installers of adhesive anchors horizontally or upwardly inclined to support sustained tension loads shall be certified by an applicable certification program. Certification shall include written and performance tests in accordance with the ACI/CRSI Adhesive Installer Certification Program or equivalent.
2. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Package stainless steel items in a manner to provide protection from carbon impregnation.

B. Protect hot-dip galvanized finishes from damage as a result of metal banding and rough handling.

PART 2 PRODUCTS

2.01 POST-INSTALLED CONCRETE ANCHORS

A. Physical Characteristics:

1. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Stainless Steel:	
Threaded Rods	F593, AISI Type 316, Condition CW
Nuts*	F594, AISI Type 316, Condition CW
Carbon Steel:	
Threaded Rods	F1554, Grade 36 or F568M Class 5.8
Flat and Beveled Washers (Hardened)	F436
Nuts*	A194/A194M, Grade 2H
Galvanized Steel:	
All	A153/A153M
*Nuts of other grades and styles having specified proof load stresses greater than specified grade and style are also suitable. Nuts must have specified proof load stresses equal to or greater than minimum tensile strength of specified threaded rod.	

2. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, and zinc-plated steel material types as indicated in Fastener Schedule at end of this section.
3. AISI Type 316 stainless, hot-dip galvanized or zinc-plated steel, as shown in Fastener Schedule at end of this section.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. Post-installed anchor systems used in concrete shall be approved by ICC Evaluation Services Report or equivalent for use in cracked concrete and for short-term and long-term loads including wind and earthquake.
2. Mechanical Anchors: Comply with the requirements of ICC-ES AC193 or ACI 355.2.
3. Adhesive Anchors: Comply with the requirements of ICC-ES AC308 or ACI 355.4.

D. Torque-Controlled Expansion Anchors (Wedge Anchors):

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; Kwik-Bolt –TZ (KB-TZ) Anchors (ESR-1917).
   b. Or equal.
2. Physical Characteristics: Torque-controlled, mechanical expansion type anchor consisting of stud, wedge, nut, and washer.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

E. Self-Tapping Concrete Screw Anchors:

1. Manufacturers and Products:
   a. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen HD Screw Anchor (ESR-2713).
   b. Or equal.
2. Physical Characteristics: Threaded anchor with a hex-washer head.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

F. Adhesive Anchors:

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT Doweling Anchor System, HIT RE 500 V3 (ESR-3814), or HIT-HY 200-R V3 (ESR-4868).
   b. Or equal.
2. Physical Characteristics:
   a. Threaded Rod:
      1) Diameter as shown on the Drawings.
      2) Length as required to provide minimum depth of embedment indicated and thread projection required.
      3) Clean and free of grease, oil, or other deleterious material.
   b. Adhesive:
      1) Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.
      2) Cure Temperature, Pot Life, and Workability: Compatible for intended use and anticipated environmental conditions.
   c. Packaging and Storage:
      1) Disposable, self-contained system capable of dispensing both components in proper mixing ratio and fitting into a manually or pneumatically operated caulking gun.
      2) Package Markings: Include manufacturer’s name, product name, batch number, product expiration date, ANSI hazard classification, and appropriate ANSI handling precautions.

3. Functional Characteristics: None.
4. Performance Characteristics: None.

2.02 POST-INSTALLED MASONRY ANCHORS

A. General:

1. Physical Characteristics: AISI Type 316 stainless, hot-dip galvanized, or zinc-plated steel, as shown in Fastener Schedule at end of section.
2. Functional Characteristics: None.
3. Performance Characteristics: Current ICC Evaluation Report indicating acceptance for anchors at structural applications in masonry.

B. Torque Controlled Expansion Anchors:

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; Kwik-Bolt-3 (KB-3).
   b. Or equal.
2. Physical Characteristics: Torque-controlled, mechanical expansion type anchor consisting of stud, wedge, nut, and washer.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

C. Self-Tapping Screw Anchors:

1. Manufacturers and Products:
   a. Simpson Strong-Tie Co., Inc., Pleasanton, CA; Titen-HD (ESR-1056).
   b. Or equal.
2. Physical Characteristics: Threaded anchor with a hex-washer head.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

D. Adhesive Anchors:

1. Manufacturers and Products:
   a. Hilti, Inc., Tulsa, OK; HIT-HY 200-R V3 (ESR-4878).
   b. Or equal.
2. Physical Characteristics:
   a. Threaded Rod:
      1) Diameter as shown on the Drawings.
      2) Length as required to provide minimum depth of embedment indicated and thread projection required.
      3) Clean and free of grease, oil, or other deleterious material.
   b. Adhesive: Two-component, insensitive to moisture, designed to be used in adverse freeze/thaw environments.

3. Functional Characteristics: None.
4. Performance Characteristics: None.

PART 3 EXECUTION

3.01 CONCRETE AND MASONRY ANCHORS

A. Begin installation only after concrete or masonry to receive anchors has attained design strength.

B. Locate existing reinforcing with Ground Penetrating Radar or other method approved by Contracting Officer prior to drilling. Coordinate with Contracting Officer to adjust anchor locations where installation would result in hitting reinforcing.

C. Install in accordance with written manufacturer's instructions.

D. Provide minimum embedment, edge distance, and spacing as indicated on the Drawings.

E. Use only drill type and bit type and diameter recommended by anchor manufacturer.

F. Clean hole of debris and dust per manufacturer's requirements.

G. When unidentified embedded steel, rebar, or other obstruction is encountered in drill path, slant drill to clear obstruction. If drill must be slanted more than indicated in manufacturer's installation instructions to clear obstruction, notify Contracting Officer for direction on how to proceed.

H. Adhesive Anchors:

1. Unless otherwise approved by Contracting Officer and adhesive manufacturer:
   a. Do not install adhesive anchors when temperature of concrete or masonry is below 40 degrees F or above 100 degrees F.
   b. Do not install prior to concrete attaining an age of 21 days.
   c. Remove any standing water from hole with oil-free compressed air. Inside surface of hole shall be dry.
   d. Do not disturb anchor during recommended curing time.
   e. Do not exceed maximum torque as specified in manufacturer's instructions.

I. Prestressed Concrete: Do not use drilled-in anchors in prestressed or post-tensioned concrete members without Contracting Officer's prior approval unless specifically shown on the Drawings.

3.02 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Assurance, in accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan as shown on the Drawings. Contractor responsibilities and related information are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control: Inspection and testing as required in Section 01 40 00, Quality Requirements.

3.03 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Post-Installed Anchors for Metal Components to Cast-in-Place Concrete (such as, Ladders, Handrail Posts, Electrical Panels, Platforms, and Equipment)		
Interior Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel adhesive anchors	Verify product acceptability and manufacturer's requirements if anchor installation will occur in an overhead application
2. Anchors in Grout-Filled Concrete Masonry Units		
Interior Dry Areas	Anchor material type to match material being anchored (for example, stainless steel anchors to anchor stainless steel equipment, zinc-plated anchors to anchor painted equipment, galvanized anchors to anchor galvanized equipment).	
Exterior, Interior Wet, and Corrosive Areas	Stainless steel anchors	

Service Use and Location	Product	Remarks
3. All Others		
All service uses and locations	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on all stainless steel threads.

C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 120 degrees F.

END OF SECTION

SECTION 05 50 00
METAL FABRICATIONS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. The Aluminum Association, Inc. (AA): The Aluminum Design Manual.
2. American Galvanizers Association (AGA):
   a. Inspection of Hot-Dip Galvanized Steel Products.
   b. Quality Assurance Manual.
3. American Iron and Steel Institute (AISI): Stainless Steel Types.
4. American National Standards Institute (ANSI).
5. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. D1.2/D1.2M, Structural Welding Code - Aluminum.
   c. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
6. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Specification for Gray Iron Castings.
   c. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   d. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
   e. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   f. A143/A143M, Standard for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural Steel Products and Procedure for Detecting Embrittlement.
   g. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   j. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   k. A276, Standard Specification for Stainless Steel Bars and Shapes.
   l. A283/A283M, Standard Specification for Low and Intermediate Tensile Strength Carbon Steel Plates.

m. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
n. A325, Standard Specification for Structural Bolts, Steel, Heat Treated 120/105 ksi Minimum Tensile Strength.
o. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
p. A384/A384M, Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
q. A385/A385M, Standard Practice for Providing High-Quality Zinc Coatings (Hot-Dip).
r. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
s. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
u. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
v. A780/A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
w. A786/A786M, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
x. A793, Standard Specification for Rolled Floor Plate, Stainless Steel.
y. A967, Standard Specification for Chemical Passivation Treatments for Stainless Steel Parts.
z. A992/A992M, Standard Specification for Structural Steel Shapes.
aa. A1085, Standard Specification for Cold-Formed Welded Carbon Steel Hollow Structural Sections (HSS).
bb. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
cc. B308/B308M, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
dd. B429/B429M, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
ee. B632/B632M, Standard Specification for Aluminum-Alloy Rolled Tread Plate.
ff. C881/C881M, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
gg. D1056, Standard Specification for Flexible Cellular Materials - Sponge or Expanded Rubber.
hh. F436, Standard Specification for Hardened Steel Washers.

ii. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
jj. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
kk. F594, Standard Specification for Stainless Steel Nuts.
ll. F844, Standard Specification for Washers, Steel, Plain (Flat), Unhardened for General Use.
mm. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.

7. NSF International (NSF): 61, Drinking Water System Components—Health Effects.
8. Occupational Safety and Health Administration (OSHA):
   a. 29 CFR 1910.27, Fixed Ladders.
   b. 29 CFR 1926.105, Safety Nets.
   c. 29 CFR 1926.502, Fall Protection Systems Criteria and Practices.
9. Specialty Steel Industry of North America (SSINA):
   a. Specifications for Stainless Steel.
   b. Design Guidelines for the Selection and Use of Stainless Steel.
   c. Stainless Steel Fabrication.
   d. Stainless Steel Fasteners.

1.02 DEFINITIONS

A. Anchor Bolt: Cast-in-place anchor; concrete or masonry.

B. Corrosive Area: Containment area or area exposed to delivery, storage, transfer, or use of chemicals.

C. Exterior Area: Location not protected from weather by building or other enclosed structure.

D. Interior Dry Area: Location inside building or structure where floor is not subject to liquid spills or washdown, nor where wall or roof slab is common to a water-holding or earth-retaining structure.

E. Interior Wet Area: Location inside building or structure where floor is sloped to floor drains or gutters and is subject to liquid spills or washdown, or where wall, floor, or roof slab is common to a water-holding or earth-retaining structure.

F. Submerged: Location at or below top of wall of open water-holding structure, such as basin or channel, or wall, ceiling or floor surface inside a covered water-holding structure, or exterior belowgrade wall or roof surface of water-holding structure, open or covered.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Metal fabrications, including welding and fastener information.
2. Samples: Color samples of abrasive stair nosings.

B. Informational Submittals: Passivation method for stainless steel members.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Galvanized Coating Applicator: Company specializing in hot-dip galvanizing after fabrication and following procedures of Quality Assurance Manual of the American Galvanizers Association.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Insofar as practical, factory assemble specified items. Package assemblies, which have to be shipped unassembled to protect materials from damage and tag to facilitate identification and field assembly.

B. Package stainless steel items to provide protection from carbon impregnation.

C. Protect painted coatings and hot-dip galvanized finishes from damage as a result of metal banding and rough handling. Use padded slings and straps.

D. Store fabricated items in dry area, not in direct contact with ground.

1.06 SPECIAL GUARANTEE

A. Manufacturer’s extended guarantee or warranty, with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction, or at option of Owner, removal and replacement of sidewalk doors found defective during a period of 5 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in the Contract clauses.

PART 2 PRODUCTS

2.01 GENERAL

A. For hot-dip galvanized steel that is exposed to view and does not receive paint, limit the combined phosphorus and silicon content to 0.04 percent. For steels that require a minimum of 0.15 percent silicon (such as plates over

1.5 inches thick for ASTM A36/A36M steel), limit maximum silicon content to 0.21 percent and phosphorous content to 0.03 percent.

B. Unless otherwise indicated, meet the following requirements:

Item	ASTM Reference
Steel Wide Flange Shapes	A992/992M
Other Steel Shapes and Plates	A36/A36M or A572/A572M, Grade 50 or A992/A992M for other steel shapes
Steel Pipe	A500, Grade B
Hollow Structural Sections (HSS)	A500/A500M, Grade C
Aluminum:	
Aluminum Plates	B209, Alloy y6061-T6
Aluminum Structural Shapes	B308/B308M, Alloy 6061-T6
Stainless Steel:	
Bars and Angles	A276, AISI Type 316 (316L for welded connections)
Shapes	A276, AISI Type 304 (304L for welded connections)
Steel Plate, Sheet, and Strip	A240/A240M, AISI Type 316 (316L for welded connections)
Bolts, Threaded Rods, Anchor Bolts, and Anchor Studs	F593, AISI Type 316, Group 2, Condition SH
Nuts	F594, AISI Type 316, Condition CW
Steel Bolts and Nuts:	
Carbon Steel	A307 bolts, with A563 nuts
High-Strength	A325, Type 1 bolts, with A563 nuts
Anchor Bolts and Rods	F1554, Grade 36, with weldability supplement S1.
Eyebolts	A489
Threaded Rods	A36/A36M

Item	ASTM Reference
Flat Washers (Unhardened)	F844
Flat and Beveled Washers (Hardened)	F436
Thrust Ties for Steel Pipe:	
Threaded Rods	A193/A193M, Grade B7
Nuts	A194/A194M, Grade 2H
Plate	A283/A283M, Grade D
Welded Anchor Studs	A108, Grades C-1010 through C-1020
Aluminum Bolts and Nuts	F468, Alloy 2024-T4
Cast Iron	A48/A48M, Class 35

C. Bolts, Washers, and Nuts: Use stainless steel, hot-dip galvanized steel, zinc-plated steel, and aluminum material types as indicated in Fastener Schedule at end of this section.

2.02 ANCHOR BOLTS AND ANCHOR BOLT SLEEVES

A. Cast-in-Place Anchor Bolts:

1. Headed type, unless otherwise shown on the Drawings.
2. Material type and protective coating as shown in Fastener Schedule at end of this section.

B. Anchor Bolt Sleeves:

1. Plastic:
   a. Single unit construction with corrugated sleeve.
   b. Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
   c. Material: High-density polyethylene.
2. Fabricated Steel: ASTM A36/A36M.

2.03 POST-INSTALLED CONCRETE AND MASONRY ANCHORS

A. See Section 05 05 19, Post-Installed Anchors.

2.04 STUD SHEAR CONNECTORS

A. Headed anchor studs (HAS), or threaded anchor studs (TAS), or stud shear connectors, as indicated on the Drawings.

1. Manufacturers:
   a. Nelson Stud Welding, FabriSteel Co., Elyria, OH.
   b. Or equal.
2. Physical Characteristics:
   a. Carbon Steel: ASTM A108, Standard Quality Grades 1010 through 1020, inclusive either semikilled or killed aluminum or silicon dioxidation, unless indicated otherwise.
   b. Stainless Steel: ASTM F593, AISI Type 316, Condition CW, where indicated.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

2.05 STEEL LINTELS AND SHELF ANGLES

A. Carbon Steel: ASTM A36/A36M, hot-dip galvanize after fabrication in accordance with ASTM A123/A123M.

B. Stainless Steel: ASTM A276 for angles, ASTM A240 for bent plate. AISI Type 316L.

2.06 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

A. Steel angle support frames to be embedded in concrete shall be stainless steel, ASTM A276, AISI Type 316, unless indicated otherwise.

B. Welded anchors for stainless steel support frames shall also be stainless steel.

2.07 ABRASIVE NOSING FOR STAIRS

A. Unless otherwise shown on the Drawings, furnish flush type abrasive nosings on stairs.

B. Nosing Components:

1. Manufacturers and Products:
   a. Wooster Products, Inc., Wooster, OH; Spectra Type WP3C.
   b. Or equal.
2. Physical Characteristics:
   a. Homogeneous epoxy abrasive, with minimum 50 percent aluminum oxide content, formed and cured upon an extruded aluminum base.

b. Epoxy abrasive shall extend over, and form curved front edge of nosing.
c. Base of Nosing: Extruded aluminum alloy, 6063-T5, heat-treated.
d. Anchoring System: Double-set anchors consisting of two rows of integrally extruded anchors.
e. Size: 3 inches wide by 1/4 inch to 3/8 inch thick by length as shown.
f. Color: Selected by Contracting Officer from manufacturer's standard color range.

3. Functional Characteristics: None.
4. Performance Characteristics: None.

2.08 FLOOR PLATE

A. Material:

1. Galvanized Steel: Carbon steel, ASTM A786/A786M, commercial grade, hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
2. Stainless Steel: ASTM A793, AISI Type 304.
3. Aluminum: ASTM B632/B632M, Alloy 6061-T6.

B. Minimum Thickness:

1. Steel: 1/4 inch, unless shown otherwise on the Drawings.
2. Aluminum: 3/8 inch, unless shown otherwise on the Drawings.

C. Surface: Raised-lug pattern or diamond tread, unless shown otherwise on the Drawings.

2.09 SIDEWALK DOORS AND ACCESS HATCHES

A. Manufacturers and Products:

1. Halliday Products, Orlando FL; W, F, or H Series.
2. Or equal.

B. Physical Characteristics:

1. Access Door Leaf(s): 1/4-inch aluminum diamond pattern plate. Provide stainless steel safety chain and attachments for end of double-leaf door assembly when open.
2. Channel Frame: 1/4-inch-thick extruded aluminum trough frame with continuous anchor flange around perimeter. Weld 1-1/2-inch diameter drain coupling, and drain pipe, to frame trough at front right corner, unless indicated otherwise on the Drawings.

3. Aluminum: Mill finished with protective coating applied to surfaces to be in contact with concrete, as specified in Section 09 90 00, Painting and Coating.
4. Door Hardware:
   a. Hinges: Heavy-duty brass or stainless steel with stainless steel pins through-bolted to cover plate with tamper-proof stainless steel bolts flush with top of cover and to outside leg of channel frame with stainless steel bolts and locknuts.
   b. Lifting Mechanism: Stainless steel compression lift springs enclosed in telescoping vertical housing or stainless steel torsion lift springs.
   c. Snap Lock:
      1) Stainless steel snap lock mounted on bottom of door leaf with removable topside key wrench and inside fixed lever handle.
      2) Threaded plug for flush outside surface with key wrench removed.
5. Safety Grate: Aluminum grating with 5-inch by 5-inch grate openings, permanent hinging system that locks grate in 90-degree position, and opening arm with vinyl grip handle and locking device.

C. Functional Characteristics:

1. Door Hardware:
   a. Hold-Open Arm:
      1) Locks automatically in open position.
      2) Disengages with slight pull on vinyl grip with one hand.
      3) Door can be easily closed with one hand by pulling forward and down on vinyl grip.

D. Performance Characteristics:

1. Load Capacity: 300 psf with maximum deflection of 1/150th of span. Provide H-20 wheel loading capacity where indicated on the Drawings.
2. Safety Grate: Aluminum grating with 300 psf live load capacity.

2.10 ACCESSORIES

A. Antiseizing Lubricant for Stainless Steel Threaded Connections:

1. Manufacturers and Products:
   a. Bostik, Middleton, MA; Neverseez.
   b. Or equal.
2. Physical Characteristics: None.
3. Functional Characteristics: None.

4. Performance Characteristics:
   a. Suitable for potable water supply.
   b. Resists washout.

B. Neoprene Gasket:

1. ASTM D1056, 2C1, soft, closed-cell neoprene gasket material, suitable for exposure to sewage and sewage gases, unless otherwise shown on the Drawings.
2. Thickness: Minimum 1/4 inch.
3. Furnish without skin coat.

2.11 FABRICATION

A. General:

1. Finish exposed surfaces smooth, sharp, and to well-defined lines.
2. Furnish necessary rabbets, lugs, and brackets so work can be assembled in neat, substantial manner.
3. Conceal fastenings where practical; where exposed, flush countersink.
4. Drill metalwork and countersink holes as required for attaching hardware or other materials.
5. Grind cut edges smooth and straight. Round sharp edges to small uniform radius. Grind burrs, jagged edges, and surface defects smooth.
6. Fit and assemble in largest practical sections for delivery to Site.

B. Materials:

1. Use steel shapes, unless otherwise noted.
2. Steel to be hot-dip galvanized: Limit silicon content to less than 0.04 percent or to between 0.15 percent and 0.25 percent.
3. Fabricate aluminum in accordance with AA Specifications for Aluminum Structures–Allowable Stress Design.

C. Welding:

1. Weld connections and grind exposed welds smooth. When required to be watertight, make welds continuous.
2. Welded fabrications shall be free from twisting or distortion caused by improper welding techniques.
3. Steel: Meet fabrication requirements of AWS D1.1/D1.1M, Section 5.
4. Aluminum: Meet requirements of AWS D1.2/D1.2M.
5. Stainless Steel: Meet requirements of AWS D1.6/D1.6M.
6. Welded Anchor Studs: Prepare surface to be welded and weld with stud welding gun in accordance with AWS D1.1/D1.1M, Section 7, and manufacturer’s instructions.
7. Complete welding before applying finish.

D. Painting:

1. Shop prime with rust-inhibitive primer as specified in Section 09 90 00, Painting and Coating, unless otherwise indicated.
2. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
3. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.

E. Galvanizing:

1. Fabricate steel to be galvanized in accordance with ASTM A143/A143M, ASTM A384/A384M, and ASTM A385/A385M. Avoid fabrication techniques that could cause distortion or embrittlement of the steel.
2. Provide venting and drain holes for tubular members and fabricated assemblies in accordance with ASTM A385/A385M.
3. Remove welding slag, splatter, burrs, grease, oil, paint, lacquer, and other deleterious material prior to delivery for galvanizing.
4. Remove by blast cleaning or other methods surface contaminants and coatings not removable by normal chemical cleaning process in the galvanizing operation.
5. Hot-dip galvanize steel members, fabrications, and assemblies after fabrication in accordance with ASTM A123/A123M.
6. Hot-dip galvanize bolts, nuts, washers, and hardware components in accordance with ASTM A153/A153M. Oversize holes to allow for zinc alloy growth. Shop assemble bolts and nuts.
7. Galvanized steel sheets in accordance with ASTM A653/A653M.
8. Galvanize components of bolted assemblies separately before assembly. Galvanizing of tapped holes is not required.

F. Electrolytic Protection: Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.

G. Watertight Seal: Where required or shown, furnish neoprene gasket of a type that is satisfactory for use. Cover full bearing surfaces.

H. Fitting: Where movement of fabrications is required or shown, cut, fit, and align items for smooth operation. Make corners square and opposite sides parallel.

I. Accessories: Furnish as required for a complete installation. Fasten by welding or with stainless steel bolts or screws.

2.12 SOURCE QUALITY CONTROL

A. Visually inspect all fabrication welds and correct deficiencies.

1. Steel: AWS D1.1/D1.1M, Section 6 and Table 6.1, Visual Inspection Acceptance Criteria.
2. Aluminum: AWS D1.2/D1.2M.
3. Stainless Steel: AWS D1.6/D1.6M.

B. Hot-Dip Galvanizing:

1. An independent testing agency, shall be retained by Contractor to inspect and test hot-dip galvanized fabricated items in accordance with ASTM A123/A123M and ASTM A153/A153M.
2. Visually inspect and test for thickness and adhesion of zinc coating for minimum of three test samples from each lot in accordance with ASTM A123/A123M and ASTM A153/A153M.
3. Reject and retest nonconforming articles in accordance with ASTM A123/A123M and ASTM A153/A153M.

PART 3 EXECUTION

3.01 INSTALLATION OF METAL FABRICATIONS

A. General:

1. Install metal fabrications plumb and level, accurately fitted, free from distortion or defects.
2. Install rigid, substantial, and neat in appearance.
3. Install manufactured products in accordance with manufacturer's recommendations.
4. Obtain Contracting Officer approval prior to field cutting steel members or making adjustments not scheduled.

B. Aluminum:

1. Do not remove mill markings from concealed surfaces.
2. Remove inked or painted identification marks on exposed surfaces not otherwise coated after installed material has been inspected and approved.
3. Fabrication, mechanical connections, and welded construction shall be in accordance with the AA Aluminum Design Manual.

C. Pipe Sleeves:

1. Provide where pipes pass through concrete or masonry.
2. Holes drilled with a rotary drill may be provided in lieu of sleeves in existing walls.
3. Provide center flange for water stoppage on sleeves in exterior or water-bearing walls.
4. Provide rubber caulking sealant or a modular mechanical unit to form watertight seal in annular space between pipes and sleeves.

D. Steel Lintels and Shelf Angles: Provide as required for support of masonry and other construction not attached to structural steel framing, unless otherwise shown on the Drawings.

3.02 CAST-IN-PLACE ANCHOR BOLTS

A. Locate and hold anchor bolts in place with templates at time concrete is placed.

B. Use anchor bolt sleeves for location adjustment and provide two nuts and one washer per bolt of same material as bolt.

C. Minimum Bolt Size: 1/2-inch diameter by 12 inches long, unless otherwise shown.

3.03 ABRASIVE NOSINGS

A. Provide abrasive nosings on concrete steps not being supplied or coated with another type of nosing or nonskid material.

3.04 ACCESS COVERS

A. Install access covers, including sidewalk doors, floor hatches, and hinged manhole covers in accordance with manufacturer’s instructions.

B. Accurately position prior to placing concrete, such that covers are flush with floor surface.

C. Protect from damage resulting from concrete placement. Thoroughly clean exposed surfaces of concrete spillage to obtain a clean, uniform appearance.

D. Route drain pipe to exterior face of concrete curb or as shown on the Drawings.

E. Position cover so that hinge is on side opposite ladder.

3.05 ELECTROLYTIC PROTECTION

A. Aluminum and Galvanized Steel:

1. Coat surfaces of galvanized steel and aluminum fabricated items to be in direct contact with concrete, grout, masonry, or dissimilar metals, as specified in Section 09 90 00, Painting and Coating, unless indicated otherwise.
2. Do not apply protective coating to galvanized steel anchor bolts or galvanized steel welded anchor studs, unless indicated otherwise.
3. Allow coating to dry before installation of the material.
4. Protect coated surfaces during installation.
5. Should coating become marred, prepare and touch up in accordance with paint manufacturer’s written instructions.

B. Stainless Steel:

1. During handling and installation, take necessary precautions to prevent carbon impregnation of stainless steel members.
2. After installation, visually inspect stainless steel surfaces for evidence of iron rust, oil, paint, and other forms of contamination.
3. Remove contamination using cleaning and passivation methods in accordance with requirements of ASTM A380 and ASTM A967.
4. Brushes used to remove foreign substances shall utilize only stainless steel or nonmetallic bristles.
5. After treatment, visually inspect surfaces for compliance.

3.06 PAINTING

A. Painted Galvanized Surfaces: Prepare as specified in Section 09 90 00, Painting and Coating.

B. Repair of Damaged Hot-Dip Galvanized Coating:

1. Conform to ASTM A780/A780M.
2. For minor repairs at abraded areas, use sprayed zinc conforming to ASTM A780/A780M.
3. For flame cut or welded areas, use zinc-based solder, or zinc sticks, conforming to ASTM A780/A780M.
4. Use magnetic gauge to determine thickness is equal to or greater than base galvanized coating.

C. Field Painting of Shop Primed Surfaces: Prepare surfaces and field finish in accordance with Section 09 90 00, Painting and Coating.

3.07 FIELD QUALITY ASSURANCE AND QUALITY CONTROL

A. Contractor-Furnished Quality Assurance:

1. In accordance with IBC Chapter 17 requirements, is provided in the Statement of Special Inspections Plan as shown on the Drawings.
2. Contractor responsibilities and related information on special inspection, observation, and testing are included in Section 01 45 33, Special Inspection, Observation, and Testing.

B. Contractor-Furnished Quality Control:

1. Inspection and testing required in Section 01 40 00, Quality Requirements.
2. Manufacturer's Certificate of Compliance per Section 01 67 00, Product Requirements, for test results, or calculations, or drawings that ensure material and equipment design and design criteria meet requirements of Section 01 67 00, Product Requirements and Section 01 88 15, Anchorage and Bracing.

C. Stud Shear Connectors:

1. At start of each production period, conduct the following test to determine proper generator, control unit, and stud welding gun settings, in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Weld two test studs and visually inspect for full 360-degree flash.
   b. Bend test studs 30 degrees from vertical for headed anchor studs (HAS). Torque test threaded anchor studs (TAS) studs per AWS D1.1/D1.1M, Section 7.6.6.2.
   c. Test studs will be acceptable if there is no failure of welds.
   d. If weld fails, repeat test until two consecutive test studs test to be satisfactory.
2. During production, if visual inspection reveals weld does not exhibit full 360-degree flash or that stud has been repaired by welding, conduct the following test in accordance with AWS D1.1/D1.1M, Chapter 7:
   a. Bend HAS studs or stud shear connectors approximately 15 degrees from vertical, away from missing portion of flash. For TAS studs, torque test per AWS D1.1/D1.1M, Section 7.6.6.2.
   b. Studs meeting this test without exhibiting cracks in weld will be considered acceptable and left in bent position.
   c. Replace studs failing test.
3. Special inspection shall be provided by Contractor where indicated in Statement of Special Inspections Plan as shown on the Drawings.

3.08 FASTENER SCHEDULE

A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Plain uncoated steel headed anchor bolts, unless indicated otherwise	
Exterior and Interior Wet Areas	Hot-dip galvanized steel headed anchor bolts	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating	See Section 09 90 00, Painting and Coating
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts with fusion bonded coating, unless otherwise specified with equipment	See Section 09 90 00, Painting and Coating
3. Post-Installed Anchors: See Section 05 05 19, Post-Installed Anchors		
4. Anchors Cast in Grout-Filled Concrete Masonry Units		
Dry Areas	Hot-dip galvanized steel headed anchor bolts or zinc-plated steel sleeve anchors	
Exterior and Interior Wet Areas	Hot-dip galvanized steel headed anchor bolts, zinc-plated or stainless steel sleeve anchors	

Service Use and Location	Product	Remarks
5. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members.
6. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	
7. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

B. Antiseizing Lubricant: Use on stainless steel threads.

END OF SECTION

SECTION 07 21 01
THERMAL INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
   b. D4397, Standard Specification for Polyethylene Sheeting for Construction, Industrial, and Agricultural Applications.

1.02 SUBMITTALS

A. Informational Submittals:

1. Manufacturer’s literature showing types and sizes for insulation product.
2. Manufacturer’s installation instructions.
3. Manufacturer’s instructions for handling and care of products.

1.03 MATERIAL STORAGE

A. Store off ground and keep dry at all times. Protect against weather condensation and damage.

PART 2 PRODUCTS

2.01 RIGID INSULATION

A. Physical Characteristics:

1. Expanded Polystyrene (XPS) Foam:
   a. ASTM C578, Type IV.
   b. R-Value: As shown on the Drawings.

B. Functional Characteristics:

1. Adhesives and Fasteners: As recommended by insulation manufacturer.

C. Performance Characteristics:

1. Flame Spread: Less than 25 when tested in accordance with ASTM E84.
2. Compressive Strength:
   a. Interior walls and foundation: Minimum 25 psi at 10 percent deformation in accordance with ASTM D1621.

2.02 VAPOR RETARDER

A. Physical Characteristics:

1. Polyethylene Film: 6 mils minimum thickness.

B. Functional Characteristics:

1. Sealant and Tape: As recommended by vapor retarder manufacturer.

C. Performance Characteristics:

1. Water Vapor Permeance: ASTM E96, 0.1 maximum perm.
2. Fire Hazard Classification:
   a. ASTM E84.
   b. Maximum Flame Spread Index: 20.
   c. Maximum Smoke Developed Index: 55.

PART 3 EXECUTION

3.01 INSTALLATION

A. Vapor Retarder:

1. Apply to exterior wall and ceiling framing in sheets as large as possible, lapping all joints 6 inches and sealing with sealant and tape recommended by manufacturer.
2. Fit tightly and seal around all penetrations.
3. Replace torn and punctured sheets.
4. Repair minor tears or holes with tape.
5. Repair by replacement major tears or holes that require more than a 6-inch length of tape to repair.

B. Rigid Insulation:

1. Install with fasteners or adhesive recommended by manufacturer.
2. Butt joints tightly together.
3. Where thicker than 1-1/2 inches, install in two layers, staggering all joints.

3.02 CLEANUP AND PROTECTION

A. Remove from Site all containers, wrappings, and scrap insulation material. Leave floors broom clean.

B. Protect installed insulation from tears or other damage until covered with finish material. Replace damaged material.

END OF SECTION

SECTION 08 16 13
FIBERGLASS DOORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
   a. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   b. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
2. Warnock Hersey Certification Listings.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's literature, and drawings prepared for this Project showing types, sizes, fire ratings, complete details of door and frame construction, including resin used, glass/resin ration, cutouts and anchorage for units.
2. Samples: Two Samples to verify custom color match, if any.

B. Informational Submittals:

1. Manufacturer's installation instructions.
2. Manufacturer's instructions for handling and care of products.
3. Executed guarantee.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Deliver doors to Job Site after moisture-producing construction operations are complete and building has reached average prevailing relative humidity of locality.
2. Deliver doors and frames in unopened packages, clearly marked with manufacturer's name, brand name, size, thickness, and identifying symbol or mark related to door numbers used in Contract Documents.

B. Storage and Handling:

1. In strict compliance with manufacturer's instructions and recommendations.
2. Minimize onsite storage time.
3. Handle with clean gloves.
4. Do not drag doors across one another or across other surfaces.
5. Store in dry area and protect from damage.

1.04 SPECIAL GUARANTEE

A. As special guarantee, provide manufacturer's extended guarantee or warranty, with Government named in writing as beneficiary. Special guarantee shall provide for correction, or at option of Government, removal and replacement of Work specified in this specification section found defective during a period of 10 years after date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work as specified in Section 01 67 00, Product Requirements.

B. Defects include warp, separation or delamination from core, expansion of core, and failures due to corrosion.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Chem-Pruf Door Company.

B. Or equal.

2.02 MAINTENANCE BUILDING DOOR

A. Physical Characteristics:

1. Flush construction, minimum 1-3/4 inches thick, with no seams, cracks, or joints.
2. Full length integral edge reinforcement.
3. Face shall not deviate more than 1/4 inch from a true plane at any point.
4. Molded in one continuous piece.
5. Door shall be hung in field.
6. Resins:
   a. Formulate for extremely corrosive and humid environments above 50 percent relative humidity that may contain chloride gas.
   b. Fire retardant formulation plus antimony trioxide to achieve an ASTM E84 flame spread of 25 or less and be self-extinguishing in accordance with ASTM D635.
   c. Contain Ultraviolet light inhibitor additives.

7. Finish: Factory primed and painted with polyester primer and two-coat urethane glass finish.

B. Functional Characteristics:

1. Reinforced to receive hardware specified.
2. Prepare doors and frames for hardware only after receipt of hardware templates.
3. Core of end-grain balsa wood or closed cell, non-absorptive, 2 pounds per square foot density, isocyanurate or urethane rigid foam.

C. Performance Characteristics: Minimum R-Value 2.7.

2.03 FRAMES

A. Physical Characteristics:

1. Manufacturer's standard one-piece-pultruded, three-piece built-up, or one-piece molded FRP with double rabbeted profile.
2. Furnished by door manufacturer with finish to match doors and prepared for hardware specified.

B. Functional Characteristics: Reinforced for specified hardware, assembled with stainless steel fasteners, and furnished with wall anchors for installation after wall opening is complete.

C. Performance Characteristics: Minimum R-Value 2.7.

PART 3 EXECUTION

3.01 INSPECTION

A. Verify doors and frames comply with approved Shop Drawings and meet indicated requirements for type, size, hardware, location, and swing.

B. Examine openings for conditions that would prevent proper installation.

C. Do not proceed with installation until defects are corrected.

D. Do not install doors in frames that would hinder operation of doors.

3.02 INSTALLATION

A. Install, following manufacturer's written instructions, using only noncorrosive materials and methods.

B. Tolerances:

1. From Door Bottom to Floor Covering: 1/2 inch.
2. From Bottom to Top of Threshold: 1/4 inch.
3. Maximum From Top: 1/8 inch.
4. Bevel Lock and Hinge Edges: 1/8 inch in 2 inches.

C. Install frames square, plumb, rigid, and in true alignment. Brace securely during construction to retain proper position and clearances. Anchor firmly in place.

D. Do not cut or otherwise alter integrity of door to allow door to fit frame.

E. Frames Set in Concrete: Secure each jamb with four stainless steel expansion anchors following manufacturer's instructions.

3.03 ADJUST AND CLEAN

A. Replace or rehang doors that are hinge-bound and do not swing, latch or operate smoothly and freely.

B. Remove and install new prefinished doors in place of those damaged during installation.

C. Refinish, or replace with new, job finished doors damaged during installation.

D. Modify doors and frames only at manufacturer's factory.

END OF SECTION

SECTION 08 71 00
DOOR HARDWARE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Builders Hardware Manufacturer's Association (BHMA):
   a. A156.1, Butts and Hinges.
   b. A156.3, Exit Devices.
   c. A156.4, Door Controls - Closers.
   d. A156.13, Mortise Locks & Latches.
   e. A156.16, Auxiliary Hardware.
   f. A156.18, Materials and Finishes.
2. International Code Council (ICC): A117.1, Accessible and Usable Buildings and Facilities.
3. UL: Fire Protection Equipment List.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Manufacturer's literature for each item of finish hardware required herein, clearly marked.
   b. Finish Hardware Schedule: Furnish complete and detailed schedule, show product items, numbers, and finishes for hardware for each separate opening.
   c. Special Tools: Provide listing and description of usage.

B. Informational Submittals:

1. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
2. Manufacturer's Field Service Report.
3. Certification of Hardware Consultant.

1.03 QUALITY ASSURANCE

A. Qualifications of Supplier: Recognized supplier of architectural finish hardware, with warehousing facilities, who has been furnishing hardware in vicinity of Project for not less than 5 years, and who is, or who employs, architectural hardware consultant.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Before delivery, clearly identify and tag each item of hardware with respect to specified description and location of installation.

B. Provide secure storage for finish hardware until installation is made.

1.05 EXTRA MATERIALS

A. Special Tools: Two sets for installation and maintenance of hardware.

PART 2 PRODUCTS

2.01 MATERIALS

A. Provide end products of one manufacturer for each product in order to achieve standardization for appearance, maintenance, and replacement.

B. Finishes: BHMA A156.18.

2.02 FASTENERS

A. Type 316 stainless steel.

2.03 BUTT HINGES (H1)

A. Manufacturers:

1. McKinney.
2. Or equal.

B. Physical Characteristics:

1. Width: Minimum for clearance of trim and 180-degree swing.
2. Exterior Hinges: Nonremovable pin.
3. Joint Tolerance: 0.012 inch maximum, gauged in CLOSED position.
4. Finish: Satin stainless steel No. 630.

C. Functional Characteristics:

1. Quantity per Door Leaf (Minimum):

Door Height	**Hinges**
5'-1" to 7'-7"	1-1/2 pair

2. Hinge Height (Minimum):

Door Width	Hinge Height
Up to 3'-0"	4-1/2"
3'-1" to 4'-0"	5"

3. Extra heavy-weight, four ball races, full mortise, stainless steel.

D. Performance Characteristics: BHMA A156.1.

2.04 LOCK SET (L1)

A. Manufacturers:

1. Von Duprin.
2. Or equal.

B. Physical Characteristics:

1. Materials: Brass or stainless steel.
2. Trim: Wrought or forged lever handles.
3. Finish: Satin Steel No. 630.

C. Functional Characteristics:

1. Core cylinders: Interchangeable, removable, six pins.
2. Bolt Throw: 5/8 inch minimum.
3. Lever Backset: 2-3/4 inches.
4. Lock by exit device manufacturer; furnish cylinders for keying to other locks as required.
5. Keying:
   a. Lock Cylinders: Operate by master key system (Bandelier Standard) that allows for future expansion.
   b. Keylocks: As directed by Government.
   c. Keys: Two per lock; tag with schedule information.
   d. Master Keys: Four; send by registered mail to Government.
   e. Furnish lock manufacturer’s removable core maximum security keying system.

D. Performance Characteristics: BHMA A156.2, BHMA A156.5, and BHMA A156.28.

2.05 CONSTRUCTION KEY SYSTEM

A. Removable construction core system for locks.

B. See Article Manufacturer’s Services, under Part 3, Execution.

2.06 CONSTRUCTION KEY SYSTEM

A. Assemble permanent cylinders with construction inserts and ship with all lock sets.

B. Change Keys: Pack in separately identified envelopes and ship.

C. Construction Keys: Pack in cartons marked “packing list” and ship.

D. Construction Insert Extractor Keys, Master Keys, and Grand Master Keys: Ship by registered mail to Government.

E. On completion of Job, deliver construction keys to Government.

2.07 EXIT DEVICE (X1)

A. Manufacturers:

1. Von Duprin.
2. Or equal.

B. Physical Characteristics:

1. Finish: Satin chromium plated No. 626.

C. Functional Characteristics:

1. Rim type, active leaf.
2. Exit Doors: Always openable from inside by simple push on panic bar/exit device without use of key or any special knowledge or effort.

D. Performance Characteristics: BHMA A156.3.

2.08 CLOSER (C1)

A. Manufacturers:

1. Sargent.
2. Or equal.

B. Physical Characteristics:

1. Arm Material: Forged steel.
2. Body Material: Die cast aluminum.
3. Closer Cover: High impact flame retardant grade plastic, aluminum color.
4. Finish: Satin chromium-plated No. 626.

C. Functional Characteristics:

1. Full rack and pinion type with steel spring and nonfreezing hydraulic fluid.
   a. Adjustability: Furnish controls for regulating closing, latching speed, and back checking.
   b. Mount parallel arm closer on push side of door.
   c. Maximum operating pressure: 8.5-force-pounds.
   d. Closing Speed (from 90-degree position to 12 degrees from latch): 5-second minimum.
2. Parallel arm with hold-open function.

D. Performance Characteristics:

1. ADA and ANSI A117.1 compliant.
2. BHMA A156.4.
3. Size closers in accordance with manufacturer's standards.

2.09 THRESHOLD (T1)

A. Manufacturers:

1. Pemko.
2. Or equal.

B. Physical Characteristics:

1. One-piece full width of opening.
2. Height: 1/2 inch.
3. Width: 4 inches.
4. Finish: Mill finish aluminum.

C. Functional Characteristics:

1. Provide with stainless steel machine screws in threaded expansion anchors at concrete.
2. Smooth, saddle style.

D. Performance Characteristics:

1. ADA and ANSI A117.1 compliant.
2. BHMA A156.21.

2.10 WEATHERSTRIP (W1)

A. Manufacturers:

1. By door and frame manufacturer.
2. Or equal.

B. Physical Characteristics: Rubber or vinyl.

C. Functional Characteristics: Adhesive backing for mounting to door frame.

D. Performance Characteristics:

1. Air Infiltration: Maximum 0.9 cfm.
2. Meet ASTM E283.

2.11 TEMPLATES

A. Fabricate to template hardware applied to fiberglass doors and frames.

B. Ensure that required templates are furnished to various manufacturers for fabrication purposes.

C. Templates: Make available not more than 10 days after receipt of approved Hardware Schedule.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s written instructions.

B. Make Work neat and secure, develop full strength of components, and provide proper function.

C. Prevent marring, scratching, or otherwise damaging adjacent finishes during hardware installation.

D. Latchbolts:

1. Install to engage in strikes automatically, whether activated by closers or manually.
2. In no case shall additional manual pressure be required to engage latchbolt in strike.

E. Stops and Holders: Set to allow doors to open as far as possible.

F. Thresholds:

1. Cope ends neatly to profile of jamb.
2. Set in sealant and seal ends to jambs.

G. Hardware: Adjust for easy, noise-free operation.

H. Replace damaged hardware items.

3.02 MOUNTING DIMENSIONS

A. Standard Door Hardware Locations: As recommended and published by Door and Hardware Institute, except as noted or detailed otherwise.

B. Door Silencers: Install 3 inches from top and bottom of jamb and 1 inch above strike at single doors, and 3 inches from edges of doors in head for pairs of doors.

C. Nameplates: Attach to doors 5 feet 6 inches above floor using permanent adhesive.

3.03 MANUFACTURER'S SERVICES

A. Deliver permanent lock cores to Site.

B. Remove temporary construction cores and insert permanent cores.

C. Inspect each lock set to ensure permanent cores are operating satisfactorily.

D. Deliver to Government change and control keys for permanent system.

E. Return temporary construction cores to manufacturer.

3.04 PROTECTION

A. Cover and protect exposed surfaces of hardware during installation and until Substantial Completion.

B. Fit, dismantle, and reinstall finish hardware as required for finish painting work.

C. Protect and prevent staining of hardware during construction in accordance with manufacturer's recommendations.

D. Remove protective measures and permanent lock cylinders installed prior to final cleaning.

3.05 HARDWARE SCHEDULE

A. Hardware Schedule is a guide to the functional requirements of the Maintenance Building door.

B. Provide finish hardware as scheduled. Sizes omitted shall be as recommended by manufacturer.

C. Coordinate door installation with Instrumentation and Control door position sensor. Refer to Instrumentation and Control specifications in Division 40, Process Interconnections.

3.06 HARDWARE SET

HDW-1:	**Item**	**Type**
	1 1/2 Pair butts	H1
	1 Exit device (rim type) with cylinder for keying to other locks as required	X1
	1 Closer	C2
	1 Threshold	T1
	1 Set weatherstrip	W1

END OF SECTION

SECTION 09 90 00
PAINTING AND COATING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines—Enamel and Tape—Hot-Applied.
   b. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   c. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   d. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
2. Environmental Protection Agency (EPA).
3. NACE International (NACE): SP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
4. NSF International (NSF): 61, Drinking Water System Components - Health Effects.
5. Occupational Safety and Health Act (OSHA).
6. Research Council on Structural Connections (RCSC): Specification for Structural Joints using High-Strength Bolts.
7. The Society for Protective Coatings (SSPC):
   a. PA 2, Procedure for Determining Conformance to Dry Coating Thickness Requirements.
   b. PA 10, Guide to Safety and Health Requirements for Industrial Painting Projects.
   c. SP 1, Solvent Cleaning.
   d. SP 2, Hand Tool Cleaning.
   e. SP 3, Power Tool Cleaning.
   f. SP 5, White Metal Blast Cleaning.
   g. SP 6, Commercial Blast Cleaning.
   h. SP 7, Joint Surface Preparation Standard Brush-Off Blast Cleaning.
   i. SP 10, Near-White Blast Cleaning.
   j. SP 11, Power Tool Cleaning to Bare Metal.
   k. SP 16, Brush-Off Blast Cleaning of Coated and Uncoated Galvanized Steel, Stainless Steels, and Non-Ferrous Metals.
   l. SP 13, Surface Preparation of Concrete.
   m. Guide 15, Field Methods for Retrieval and Analysis of Soluble Salts on Steel and Other Nonporous Substrates.

1.02 DEFINITIONS

A. Terms used in this section:

1. Coverage: Total minimum dry film thickness in mils or square feet per gallon.
2. FRP: Fiberglass Reinforced Plastic.
3. HCl: Hydrochloric Acid.
4. MDFT: Minimum Dry Film Thickness, mils.
5. MDFTPC: Minimum Dry Film Thickness per Coat, mils.
6. Mil: Thousandth of an inch.
7. PPDS: Paint Product Data Sheet.
8. PSDS: Paint System Data Sheet.
9. PVC: Polyvinyl Chloride.
10. SFPG: Square Feet per Gallon.
11. SFPGPC: Square Feet per Gallon per Coat.
12. SP: Surface Preparation.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Data Sheets:
      1) For each product, furnish a Paint Product Data Sheet (PPDS), the manufacturer's technical data sheets, and paint colors available (where applicable). The PPDS form is appended to the end of this section.
      2) For each paint system, furnish a Paint System Data Sheet (PSDS). The PSDS form is appended to the end of this section.
      3) Technical and performance information that demonstrates compliance with specification.
      4) Furnish copies of paint system submittals to the coating applicator.
      5) Indiscriminate submittal of only manufacturer's literature is not acceptable.
   b. Detailed chemical and gradation analysis for each proposed abrasive material.

2. Samples:
   a. Proposed Abrasive Materials: Minimum 5-pound sample for each type.
   b. Reference Panel:
      1) Surface Preparation:
         a) Prior to start of surface preparation, furnish a 4-inch by 4-inch steel panel for each grade of sandblast specified herein, prepared to specified requirements.
         b) Provide panel representative of the steel used; prevent deterioration of surface quality.
         c) Panel to be reference source for inspection upon approval by Government.
      2) Paint:
         a) Unless otherwise specified, before painting work is started, prepare minimum 8-inch by 10-inch sample with type of paint and application specified on similar substrate to which paint is to be applied.
         b) Furnish additional samples as required until colors, finishes, and textures are approved.
         c) Approved samples to be the quality standard for final finishes.

B. Informational Submittals:

1. Factory Applied Coatings: Manufacturer's certification stating factory applied coating system meets or exceeds requirements specified.
2. Manufacturer's written verification that submitted material is suitable for the intended use.
3. Coating for Faying Surfaces: Manufacturer's test results that show the proposed coating meets the slip resistance requirements of the AISC Specification for Structural Joints using ASTM A325 or ASTM A490 bolts.
4. If the manufacturer of finish coating differs from that of shop primer, provide finish coating manufacturer's written confirmation that materials are compatible.
5. Manufacturer's written instructions and special details for applying each type of paint.

1.04 QUALITY ASSURANCE

A. Applicator Qualifications: Minimum 5 years' experience in application of specified products.

B. Regulatory Requirements:

1. Meet federal, state, and local requirements limiting the emission of volatile organic compounds.
2. Perform surface preparation and painting in accordance with recommendations of the following:
   a. Paint manufacturer's instructions.
   b. SSPC PA 10.
   c. Federal, state, and local agencies having jurisdiction.

C. Mockup:

1. Before proceeding with Work under this section, finish one complete space or item of each color scheme required showing selected colors, finish texture, materials, quality of work, and special details.
2. After Government approval, sample spaces or items shall serve as a standard for similar work throughout the Project.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Shipping:

1. Where precoated items are to be shipped to the Site, protect coating from damage. Batten coated items to prevent abrasion.
2. Protect shop painted surfaces during shipment and handling by suitable provisions including padding, blocking, and use of canvas or nylon slings.

B. Storage:

1. Store products in a protected area that is heated or cooled to maintain temperatures within the range recommended by paint manufacturer.
2. Primed surfaces shall not be exposed to weather for more than 2 months before being topcoated, or less time if recommended by coating manufacturer.

1.06 PROJECT CONDITIONS

A. Environmental Requirements:

1. Do not apply paint in temperatures or moisture conditions outside of manufacturer's recommended maximum or minimum allowable.
2. Do not perform final abrasive blast cleaning whenever relative humidity exceeds 85 percent, or whenever surface temperature is less than 5 degrees F above dew point of ambient air.

PART 2 PRODUCTS

2.01 PAINT

A. Physical Characteristics:

1. Color:
   a. See Article Colors, Paragraph Pipe System Color Code, or as shown on the Drawings.
   b. Architectural colors to be selected by Government.

B. Functional Characteristics: Minimum of 5 years' verifiable experience in manufacture of specified product.

C. Performance Characteristics: Nationally recognized manufacturers of paints and protective coatings who are regularly engaged in the production of such materials for essentially identical service conditions.

2.02 ABRASIVE MATERIALS

A. Select abrasive type and size to produce surface profile that meets coating manufacturer's recommendations for specific primer and coating system to be applied.

2.03 PAINT MATERIALS

A. Physical Characteristics:

1. Manufacturer's highest quality products suitable for intended service.
2. Compatibility: Only compatible materials from a single manufacturer shall be used in the Work. Particular attention shall be directed to compatibility of primers and finish coats.
3. Thinners, Cleaners, Driers, and Other Additives: As recommended by coating manufacturer.
4. Products:

Product	Definition
Acrylic Latex	Single-component, finish as required
Alkyd (Semigloss)	Semigloss alkyd
Alkyd Enamel	Optimum quality, gloss or semigloss finish as required, medium long oil
Bituminous Paint	Single-component, coal-tar pitch based

Product	Definition
Coal-Tar Epoxy	Amine, polyamide, or phenolic epoxy type 70% volume solids minimum, suitable for immersion service
DTM Acrylic Primer	Surface tolerant, direct-to-metal water borne acrylic primer
DTM Acrylic Finish	Surface tolerant, direct-to-metal water borne acrylic finish coat
Epoxy Filler/Surfacer	100% solids epoxy trowel grade filler and surfacer, nonshrinking, suitable for application to concrete and masonry. Approved for potable water contact and conforming to NSF 61, where required
Epoxy Nonskid (Aggregated)	Polyamidoamine or amine converted epoxies aggregated; aggregate may be packaged separately
Epoxy Primer—Ferrous Metal	Anticorrosive, converted epoxy primer containing rust-inhibitive pigments
Epoxy Primer—Other	Epoxy primer, high-build, as recommended by coating manufacturer for specific galvanized metal, copper, or nonferrous metal alloy to be coated
Fusion Bonded Coating	100% solids, thermosetting, fusion bonded, dry powder epoxy, suitable for the intended service
TFE Lube or Grease Lube	Tetrafluoroethylene, liquid coating, or open gear grease
High Build Epoxy	Polyamidoamine epoxy, minimum 69% volume solids, capability of 4 to 8 MDFT per coat
Inorganic Zinc Primer	Solvent or water based, having 85% metallic zinc content in the dry film; follow manufacturer's recommendation for topcoating
Latex Primer Sealer	Waterborne vinyl acrylic primer/sealer for interior gypsum board and plaster. Capable of providing uniform seal and suitable for use with specified finish coats
NSF Epoxy	Polyamidoamine epoxy, approved for potable water contact and conforming to NSF 61
Epoxy, High Solids	Polyamidoamine epoxy, 80% volume solids, minimum, suitable for immersion service
Polyurethane Enamel	Two-component, aliphatic or acrylic based polyurethane; high gloss finish

Product	Definition
Organic Zinc Rich Primer	Epoxy or moisture cured urethane with 85-percent zinc content in the dry film, meeting the requirements of RCSC Specification for Structural Joints using High Strength Bolts, Class A or Class B, as required
Rust-Inhibitive Primer	Single-package steel primers with anticorrosive pigment loading
Silicone/Silicone Acrylic	Elevated temperature silicone or silicone/acrylic based
Stain, Concrete	Acrylic, water repellant, penetrating stain
Water Base Epoxy	Two-component, polyamide epoxy emulsion, finish as required

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.04 MIXING

A. Multiple-Component Coatings:

1. Prepare using each component as packaged by paint manufacturer.
2. No partial batches will be permitted.
3. Do not use multiple-component coatings that have been mixed beyond their pot life.
4. Furnish small quantity kits for touchup painting and for painting other small areas.
5. Mix only components specified and furnished by paint manufacturer.
6. Do not intermix additional components for reasons of color or otherwise, even within the same generic type of coating.

B. Colors: Formulate paints with colorants free of lead, lead compounds, or other materials that might be affected by presence of hydrogen sulfide or other gas likely to be present at Site.

2.05 SHOP FINISHES

A. Shop Blast Cleaning: Reference Paragraph Shop Coating Requirements.

B. Surface Preparation: Provide Government minimum 7 days' advance notice to start of shop surface preparation work and coating application work.

C. Shop Coating Requirements:

1. When required by equipment specifications, such equipment shall be primed, and finish coated in shop by manufacturer and touched up in field with identical material after installation.
2. Where manufacturer's standard coating is not suitable for intended service condition, Government may approve use of a tie-coat to be used between manufacturer's standard coating and specified field finish. In such cases, tie-coat shall be surface tolerant epoxy as recommended by manufacturer of specified field finish coat. Coordinate details of equipment manufacturer's standard coating with field coating manufacturer.

D. Pipe:

1. Ductile Iron Pipe:
   a. Use SSPC standards as a guide for desired prepared surface. Follow recommendations of pipe and coating manufacturers for means and methods to achieve SSPC-equivalent surface.
   b. The surface preparation and application of the primer and finish coats shall be performed by pipe manufacturer.
   c. For high performance (epoxy) coatings, follow additional recommendations of pipe and coating manufacturers.
   d. Prior to blast cleaning, grind smooth surface imperfections, including, but not limited to delaminating metal or oxide layers.
   e. For conventional (alkyd) coatings, clean asphalt varnish supplied on pipe and apply one full coat of a tar stop before two full coats of the color coats specified.
2. Steel Pipe:
   a. Surface preparation and application of primer and finish coats shall be performed by pipe manufacturer.
   b. For pipe with epoxy lining, do not place end cap seals until pipe lining material has sufficiently dried.

PART 3 EXECUTION

3.01 GENERAL

A. Provide Government minimum 7 days' advance notice to start of field surface preparation work and coating application work.

B. Perform the Work only in presence of Government, unless Government grants prior approval to perform the Work in Government's absence.

C. Schedule inspection of cleaned surfaces and all coats prior to succeeding coat in advance with Government.

3.02 EXAMINATION

A. Factory Finished Items:

1. Schedule inspection with Government before repairing damaged factory-finished items delivered to Site.
2. Repair abraded or otherwise damaged areas on factory-finished items as recommended by coating manufacturer. Carefully blend repaired areas into original finish. If required to match colors, provide full finish coat in field.

B. Surface Preparation Verification: Inspect and provide substrate surfaces prepared in accordance with these Specifications and printed directions and recommendations of paint manufacturer whose product is to be applied. The more stringent requirements shall apply.

3.03 PROTECTION OF ITEMS NOT TO BE PAINTED

A. Remove, mask, or otherwise protect hardware, lighting fixtures, switchplates, aluminum surfaces, machined surfaces, couplings, shafts, bearings, nameplates on machinery, and other surfaces not specified elsewhere to be painted.

B. Provide drop cloths to prevent paint materials from falling on or marring adjacent surfaces.

C. Protect working parts of mechanical and electrical equipment from damage during surface preparation and painting process.

D. Mask openings in motors to prevent paint and other materials from entering.

E. Protect surfaces adjacent to or downwind of Work area from overspray.

3.04 SURFACE PREPARATION

A. Field Abrasive Blasting:

1. Perform blasting for items and equipment where specified and as required to restore damaged surfaces previously shop or field blasted and primed or coated.
2. Refer to coating systems for degree of abrasive blasting required.
3. Where the specified degree of surface preparation differs from manufacturer’s recommendations, the more stringent shall apply.

B. Surface Contamination Testing:

1. A surface contamination analysis test shall be performed every 500 square feet by means of a Chlor Test CSN Salts, or approved equivalent.
2. Surface with chloride levels exceeding 3 µg/square centimeter for submerged surfaces and 5 µg/square centimeter for exposed surfaces shall be treated with a liquid soluble salt remover.
3. Follow manufacturer's recommendations and procedures for the use of this product to remove the surface contamination.

C. Metal Surface Preparation:

1. Where indicated, meet requirements of SSPC Specifications summarized below:
   a. SP 1, Solvent Cleaning: Removal of visible oil, grease, soil, drawing and cutting compounds, and other soluble contaminants by cleaning with solvent.
   b. SP 2, Hand Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using nonpower hand tools.
   c. SP 3, Power Tool Cleaning: Removal of loose rust, loose mill scale, loose paint, and other loose detrimental foreign matter, using power-assisted hand tools.
   d. SP 5, White Metal Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter by blast cleaning.
   e. SP 6, Commercial Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 33 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.
   f. SP 7, Brush-Off Blast Cleaning: Removal of visible rust, oil, grease, soil, dust, loose mill scale, loose rust, and loose coatings. Tightly adherent mill scale, rust, and coating may remain on surface.
   g. SP 10, Near-White Blast Cleaning: Removal of visible oil, grease, dust, dirt, mill scale, rust, coatings, oxides, corrosion products, and other foreign matter, except for random staining limited to no more than 5 percent of each unit area of surface which may consist of light shadows, slight streaks, or minor discolorations caused by stains of rust, stains of mill scale, or stains of previously applied coatings.

h. SP 11, Power Tool Cleaning to Bare Metal: Removal of visible oil, grease, dirt, dust, mill scale, rust, paint, oxide, corrosion products, and other foreign matter using power-assisted hand tools capable of producing suitable surface profile. Slight residues of rust and paint may be left in lower portion of pits if original surface is pitted.

i. SP 16, Brush Blasting of Non-Ferrous Metals: A brush-off blast cleaned non-ferrous metal surface, when viewed without magnification, shall be free of all visible oil, grease, dirt, dust, metal oxides (corrosion products), and other foreign matter. Intact, tightly adherent coating is permitted to remain. A coating is considered tightly adherent if it cannot be removed by lifting with a dull putty knife. Bare metal substrates shall have a minimum profile of 19 micrometers (0.75 mil).

2. The words “solvent cleaning”, “hand tool cleaning”, “wire brushing”, and “blast cleaning”, or similar words of equal intent in these Specifications or in paint manufacturer’s specification refer to the applicable SSPC Specification.

3. Where OSHA or EPA regulations preclude standard abrasive blast cleaning, wet or vacu-blast methods may be required. Coating manufacturers’ recommendations for wet blast additives and first coat application shall apply.

4. Ductile Iron Pipe Supplied with Asphaltic Varnish Finish: Remove asphaltic varnish finish prior to performing specified surface preparation.

5. Hand tool clean areas that cannot be cleaned by power tool cleaning.

6. Round or chamfer sharp edges and grind smooth burrs, jagged edges, and surface defects.

7. Welds and Adjacent Areas:

   a. Prepare such that there is:

      1) No undercutting or reverse ridges on weld bead.

      2) No weld spatter on or adjacent to weld or any area to be painted.

      3) No sharp peaks or ridges along weld bead.

   b. Grind embedded pieces of electrode or wire flush with adjacent surface of weld bead.

8. Preblast Cleaning Requirements:

   a. Remove oil, grease, welding fluxes, and other surface contaminants prior to blast cleaning.

   b. Cleaning Methods: Steam, open flame, hot water, or cold water with appropriate detergent additives followed with clean water rinsing.

   c. Clean small isolated areas as above or solvent clean with suitable solvent and clean cloth.

9. Blast Cleaning Requirements:
    a. Type of Equipment and Speed of Travel: Design to obtain specified degree of cleanliness. Minimum surface preparation is as specified herein and takes precedence over coating manufacturer's recommendations.
    b. Select type and size of abrasive to produce surface profile that meets coating manufacturer's recommendations for particular primer to be used.
    c. Use only dry blast cleaning methods.
    d. Do not reuse abrasive, except for designed recyclable systems.
    e. Meet applicable federal, state, and local air pollution and environmental control regulations for blast cleaning, confined space entry (if required), and disposition of spent aggregate and debris.
10. Post-Blast Cleaning and Other Cleaning Requirements:
    a. Clean surfaces of dust and residual particles from cleaning operations by dry (no oil or water vapor) air blast cleaning or other method prior to painting. Vacuum clean enclosed areas and other areas where dust settling is a problem and wipe with a tack cloth.
    b. Paint surfaces the same day they are blasted. Reblast surfaces that have started to rust before they are painted.

D. Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation:

1. Remove soil, cement spatter, and other surface dirt with appropriate hand or power tools.
2. Brush blast in accordance with SSPC SP 16.
3. Obtain and follow coating manufacturer's recommendations for additional preparation that may be required.

E. Concrete Surface Preparation:

1. Do not begin until 30 days after concrete has been placed.
2. Meet requirements of SSPC SP 13.
3. Remove grease, oil, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent, or other suitable cleaning methods.
4. Brush-off blast clean to remove loose concrete and laitance, and provide a tooth for binding. Upon approval by Government, surface may be cleaned by acid etching method. Approval is subject to producing desired profile equivalent to No. 80 grit flint sandpaper. Acid etching of vertical or overhead surfaces shall not be allowed.

5. Secure coating manufacturer's recommendations for additional preparation, if required, for excessive bug holes exposed after blasting.
6. Unless otherwise required for proper adhesion, ensure surfaces are dry prior to painting.

F. Plastic and FRP Surface Preparation:

1. Hand sand plastic surfaces to be coated with medium grit sandpaper to provide tooth for coating system.
2. Large areas may be power sanded or brush-off blasted, provided sufficient controls are employed so surface is roughened without removing excess material.

G. Masonry Surface Preparation:

1. Complete and cure masonry construction for 14 days or more before starting surface preparation work.
2. Remove oil, grease, dirt, salts or other chemicals, loose materials, or other foreign matter by solvent, detergent washing, or other suitable cleaning methods.
3. Clean masonry surfaces of mortar and grout spillage and other surface deposits using one of the following:
   a. Nonmetallic fiber brushes and commercial muriatic acid followed by rinsing with clean water.
   b. Brush-off blasting.
   c. Water blasting.
4. Do not damage masonry mortar joints or adjacent surfaces.
5. Leave surfaces clean and, unless otherwise required for proper adhesion, dry prior to painting.
6. Masonry Surfaces to be Painted: Uniform texture and free of surface imperfections that would impair intended finished appearance.
7. Masonry Surfaces to be Clear Coated: Free of discolorations and uniform in texture after cleaning.

H. Wood Surface Preparation:

1. Replace damaged wood surfaces or repair in a manner acceptable to Government prior to start of surface preparation.
2. Solvent clean (mineral spirits) knots and other resinous areas and coat with shellac or other knot sealer, prior to painting. Remove pitch by scraping and wipe clean with mineral spirits or turpentine prior to applying knot sealer.
3. Round sharp edges by light sanding prior to priming.

4. Filler:
    a. Synthetic-based wood putty approved by paint manufacturer for paint system.
    b. For natural finishes, color of wood putty shall match color of finished wood.
    c. Fill holes, cracks, and other surface irregularities flush with surrounding surface and sand smooth.
    d. Apply putty before or after prime coat, depending on compatibility and putty manufacturer's recommendations.
    e. Use cellulose type putty for stained wood surfaces.
5. Ensure surfaces are clean and dry prior to painting.

I. Gypsum Board Surface Preparation: Typically, new gypsum board surfaces need no special preparation before painting.

1. Surface Finish: Dry, free of dust, dirt, powdery residue, grease, oil, or any other contaminants.

J. Existing Painted Surfaces to be Repainted Surface Preparation:

1. Detergent wash and freshwater rinse.
2. Clean loose, abraded, or damaged coatings to substrate by hand or power tool, SP 2 or SP 3.
3. Feather surrounding intact coating.
4. Apply one spot coat of specified primer to bare areas, overlapping prepared existing coating.
5. Apply one full finish coat of specified primer to entire surface.
6. If an aged, plural-component material is to be topcoated, contact coating manufacturer for additional surface preparation requirements.
7. Application of Cosmetic Coat:
    a. It is assumed that existing coatings have oxidized sufficiently to prevent lifting or peeling when overcoated with paints specified.
    b. Check compatibility by application to a small area prior to starting painting.
    c. If lifting or other problems occur, request disposition from Government.
8. Perform blasting as required to restore damaged surfaces. Materials, equipment, procedures shall meet requirements of SSPC.

3.05 SURFACE CLEANING

A. Brush-off Blast Cleaning:

1. Equipment, procedure, and degree of cleaning shall meet requirements of SSPC SP 7.
2. Abrasive: Either wet or dry blasting sand, grit, or nutshell.

3. Select various surface preparation parameters, such as size and hardness of abrasive, nozzle size, air pressure, and nozzle distance from surface such that surface is cleaned without pitting, chipping, or other damage.
4. Verify parameter selection by blast cleaning a trial area that will not be exposed to view.
5. Government will review acceptable trial blast cleaned area and use area as a representative sample of surface preparation.
6. Repair or replace surface damaged by blast cleaning.

B. Acid Etching:

1. After precleaning, spread the following solution by brush or plastic sprinkling can: One part commercial muriatic acid reduced by two parts water by volume. Adding acid to water in these proportions gives an approximate 10 percent solution of HCl.
2. Application:
   a. Rate: Approximately 2 gallons per 100 square feet.
   b. Work acid solution into surface by hard-bristled brushes or brooms until complete wetting and coverage is obtained.
   c. Acid will react vigorously for a few minutes, during which time brushing shall be continued.
   d. After bubbling subsides (10 minutes), hose down remaining slurry with high pressure clean water.
   e. Rinse immediately to avoid formation on the surface of salts that are difficult to remove.
   f. Thoroughly rinse to remove any residual acid surface condition that may impair adhesion.
3. Ensure surface is completely dry before application of coating.
4. Apply acid etching to obtain a “grit sandpaper” surface profile. If not, repeat treatment.

C. Solvent Cleaning:

1. Consists of removal of foreign matter such as oil, grease, soil, drawing and cutting compounds, and any other surface contaminants by using solvents, emulsions, cleaning compounds, steam cleaning, or similar materials and methods that involve a solvent or cleaning action.
2. Meet requirements of SSPC SP 1.

3.06 APPLICATION

A. General:

1. The intention of these Specifications is for new, interior and exterior concrete, metal, and submerged metal surfaces to be painted, whether specifically mentioned or not, except as specified otherwise. Do not paint exterior concrete surfaces, unless specifically indicated.

2. Extent of Coating (Immersion): Coatings shall be applied to internal vessel and pipe surfaces, nozzle bores, flange gasket sealing surfaces, carbon steel internals, and stainless steel internals, unless otherwise specified.
3. For coatings subject to immersion, obtain full cure for completed system. Consult coatings manufacturer's written instructions for these requirements. Do not immerse coating until completion of curing cycle.
4. Apply coatings in accordance with these Specifications and paint manufacturers' printed recommendations and special details. The more stringent requirements shall apply. Allow sufficient time between coats to assure thorough drying of previously applied paint.
5. Sand wood lightly between coats to achieve required finish.
6. Vacuum clean surfaces free of loose particles. Use tack cloth just prior to applying next coat.
7. Fusion Bonded Coatings Method Application: Electrostatic, fluidized bed, or flocking.
8. Coat units or surfaces to be bolted together or joined closely to structures or to one another prior to assembly or installation.
9. Water-Resistant Gypsum Board: Use only solvent type paints and coatings.
10. On pipelines, terminate coatings along pipe runs to 1 inch inside pipe penetrations.
11. Keep paint materials sealed when not in use.
12. Where more than one coat is applied within a given system, alternate colors to provide a visual reference showing required number of coats have been applied.

B. Galvanized Metal, Copper, and Nonferrous Metal Alloys:

1. Concealed galvanized, copper, and nonferrous metal alloy surfaces (behind building panels or walls) do not require painting, unless specifically indicated herein.
2. Prepare surface and apply primer in accordance with System No. 10 specification.
3. Apply intermediate and finish coats of the coating system appropriate for the exposure.

C. Porous Surfaces, Such as Concrete:

1. Filler/Surfacer: Use coating manufacturer's recommended product to fill air holes, bug holes, and other surface voids or defects.
2. Prime Coat: May be thinned to provide maximum penetration and adhesion.
   a. Type and Amount of Thinning: Determined by paint manufacturer and dependent on surface density and type of coating.

3. Surface Specified to Receive Water Base Coating: Damp, but free of running water, just prior to application of coating.

D. Film Thickness and Coverage:

1. Number of Coats:
   a. Minimum required without regard to coating thickness.
   b. Additional coats may be required to obtain minimum required paint thickness, depending on method of application, differences in manufacturers' products, and atmospheric conditions.
2. Application Thickness:
   a. Do not exceed coating manufacturer's recommendations.
   b. Measure using a wet film thickness gauge to ensure proper coating thickness during application.
3. Film Thickness Measurements and Electrical Inspection of Coated Surfaces:
   a. Perform with properly calibrated instruments.
   b. Recoat and repair as necessary for compliance with specification.
   c. Coats are subject to inspection by Government and coating manufacturer's representative.
4. Visually inspect concrete, masonry, nonferrous metal, plastic, and wood surfaces to ensure proper and complete coverage has been attained.
5. Give particular attention to edges, angles, flanges, and other similar areas, where insufficient film thicknesses are likely to be present, and ensure proper millage in these areas.
6. Apply additional coats as required to achieve complete hiding of underlying coats. Hiding shall be so complete that additional coats would not increase the hiding.

3.07 PROTECTIVE COATINGS SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Engineer before starting work in question.

B. Note: Not all finishes will be required.

C. System No. 1 Submerged Metal—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	NSF Epoxy	3 coats, 3 MDFTPC

1. Use on the following items or areas:
   a. Metal surfaces new and existing below a plane 1 foot above the maximum liquid surface; metal surfaces above the maximum liquid surface that are a part of the immersed equipment; surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel that are embedded in concrete; and the following specific surfaces:
      1) Interior surfaces of steel piping noted in the Piping Schedule.

D. System No. 2 Submerged Metal—Domestic Sewage:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Coal-Tar Epoxy -OR- High Build Epoxy	2 coats, 16 MDFT 2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Metal surfaces new and existing below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface that are a part of immersed equipment, concrete embedded surfaces of metallic items, such as wall pipes, pipes, pipe sleeves, access manholes, gate guides and thimbles, and structural steel, and the following specific surfaces:
      1) Interior surfaces of steel piping noted in the Piping Schedule.

E. System No. 3 Submerged Metal—Other:

1. Use on the following items or areas:
   a. Metal surfaces new and existing below a plane 1 foot above maximum liquid surface, metal surfaces above maximum liquid surface which are a part of immersed equipment.

F. System No. 4 Exposed Metal—Highly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	High Build Epoxy	1 coat, 4 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather.

G. System No. 5 Exposed Metal—Mildly Corrosive:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Polyurethane Enamel	1 coat, 3 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures and exposed to weather or in a highly humid atmosphere, such as pipe galleries and similar areas.

H. System No. 6 Exposed Metal—Atmospheric:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Rust-Inhibitive Primer	1 coat, 2 MDFT
	Alkyd Enamel	2 coats, 4 MDFT

1. Use on the following items or areas:
   a. Exposed metal surfaces, new and existing located inside or outside of structures or exposed to weather, including vents, louvers, exterior metal ductwork, flashing, sheet metalwork and miscellaneous architectural metal.
   b. Apply surface preparation and primer to surfaces prior to installation. Finish coats need only be applied to surfaces exposed after completion of construction.

I. System No. 7 Concrete Encased Metal:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Coal-Tar Epoxy	2 coats, 16 MDFT

1. Use on the following items or areas:
   a. Use on concrete encased ferrous metals including wall pipes, pipe sleeves, access manholes, gate guides, and thimbles.

J. System No. 8 Buried Metal—General:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Standard Hot Coal-Tar Enamel -OR- Coal-Tar Epoxy	AWWA C203 2 coats, 16 MDFT
	For Highly Abrasive Soil, Brackish Water: Tape Coat System	AWWA C214 with Double Outer Wrap

1. For steel pipe and fittings, follow AWWA C209 and AWWA C214 with double outer wrap.
2. Use on the following items or areas:
   a. Buried, belowgrade portions of steel items, except buried stainless steel or ductile iron.

K. System No. 10 Galvanized Metal, Copper, and Nonferrous Metal Alloy Conditioning:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation	Epoxy Primer—Other	As recommended by coating manufacturer Remaining coats as required for exposure

1. Use on the following items or areas:
   a. Galvanized surfaces requiring painting.
   b. After application of System No. 10, apply finish coats as required for exposure.

L. System No. 11 Faying Surfaces of Slip Critical Bolted Connections:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Organic Zinc Rich Primer	1 coat, 3 MDFT

1. Use on faying surfaces of slip critical joints as specified and as shown on the Drawings.
2. Provide primer in accordance with RCSC Specification for Structural Joints using High-Strength Bolts.

M. System No. 12 Skid-Resistant—Steel:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Epoxy Primer—Ferrous Metal	1 coat, 2.5 MDFT
	Epoxy Nonskid (Aggregated)	1 coat, 16 MDFT

N. System No. 13 Skid-Resistant—Aluminum and FRP:

Surface Prep.	Paint Material	Min. Coats, Cover
Aluminum: In accordance with Paragraph Galvanized Metal, Copper, and Nonferrous Metal Alloy Surface Preparation -OR- FRP: In accordance with Paragraph Plastic and FRP Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 16 MDFT

O. System No. 14 High Heat-Resistant—700 Degrees F Maximum:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Inorganic Zinc Primer	1 coat, 2.5 MDFT
	Silicone	1 coat, 2 MDFT

P. System No. 15 Heat-Resistant—425 Degrees F Maximum:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 6, Commercial Blast Cleaning	Inorganic Zinc Primer	1 coat, 2.5 MDFT
	Silicone Acrylic (limited colors)	2 coats, 2 MDFT

Q. System No. 16 Elastomeric Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
Concrete: In accordance with Paragraph Concrete Surface Preparation -OR-Masonry: In accordance with Paragraph Masonry Surface Preparation -OR- Steel: SP 5, White Metal Blast Cleaning	Prime in accordance with manufacturer's recommendations	
	Elastomeric Polyurethane	1 coat, 32 SFPG

R. System No. 18 Concrete Tank Lining—Potable Water:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Filler/Surfacer (NSF-approved)	As required to fill voids and level surface
	NSF Epoxy	3 coats, 250 SFPGPC

1. Use on the following items or areas:
   a. Concrete surfaces below a plane 1 foot above maximum liquid surface.

S. System No. 18a Concrete Exposed Metal Repair Coating—Potable Water and Non-Submerged:

Surface Prep.	Paint Material	Min. Coats, Cover
Brush blast concrete in accordance with Paragraph Concrete Surface Preparation; blast exposed reinforcing steel to Near White Metal, SSPC SP10. See Note 1	NSF Epoxy; finish color white	2 coats, 4 MDFTPC, see Note 2.
Note 1. Surface Preparation Alternative: Mechanical abrade concrete surfaces to meet International Concrete Restoration Association standard 37/32, Concrete Surface Profile No. 3. Mechanically abrade exposed ends of reinforcing steel in accordance with SSPC SP-11. Note 2. Brush out surface voids and irregularities to provide a monolithic film.		

1. Use this system:
   a. On saw-cut concrete surfaces that will not receive new concrete to cover exposed ends of rebar and metal embeds. Or alternately, where approved, over ends of and minimum 2 inches around ends of exposed metal and rebar in lieu of entire surface.

T. System No. 21 Skid-Resistant—Concrete:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Epoxy Nonskid (Aggregated)	1 coat, 160 SFPG

U. System No. 25 Exposed FRP, PVC:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Plastic and FRP Surface Preparation	Acrylic Latex Gloss	2 coats, 320 SFPGPC

1. Use on the following items or areas:
   a. All exposed-to-view PVC and CPVC surfaces, and FRP surfaces without integral UV-resistant gel coat.

V. System No. 27 Aluminum and Dissimilar Metal Insulation:

Surface Prep.	Paint Material	Min. Coats, Cover
Solvent Clean (SP 1)	Prime in accordance with manufacturer's recommendations	
	Bituminous Paint	1 coat, 10 MDFT

W. System No. 29 Fusion Bonded Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT

1. For steel pipe and fittings, meet all requirements of AWWA C213.

X. System No. 29A Fusion Bonded, Steel Dowel Coating:

Surface Prep.	Paint Material	Min. Coats, Cover
SP 10, Near-White Blast Cleaning	Fusion Bonded Coating 100% Solids Epoxy	1 or 2 coats, 7 MDFT
TFE Lube, Shop Applied; Grease Lube Alternative, Field Applied Just Prior to Installation	TFE Lube or Grease Lube	1 coat, as required

1. Use on steel expansion joint dowels as specified in Section 03 15 00, Concrete Joints and Accessories.

3.08 ARCHITECTURAL PAINT SYSTEMS AND APPLICATION SCHEDULE

A. Unless otherwise shown or specified, paint surfaces in accordance with the following application schedule. In the event of discrepancies or omissions in the following, request clarification from Government before starting work in question.

B. Note: Not all finishes will be required.

C. System No. 113 Concrete, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Concrete Surface Preparation	Acrylic Latex (Semigloss)	2 coats, 240 SFPGPC

1. Use on the following items or areas:
   a. Exterior wall finish at Mechanical Building.

D. System No. 115 Gypsum Board, Semigloss:

Surface Prep.	Paint Material	Min. Coats, Cover
In accordance with Paragraph Gypsum Board Surface Preparation	Latex Primer/Sealer	1 coat, 350 SFPG
	Acrylic Latex (Semigloss) or Alkyd (Semigloss	2 coats, 400 SFPGPC

1. Use on the following items or areas:
   a. Interior wall finish at Mechanical Building.

3.09 COLORS

A. Provide as selected by Government.

B. Proprietary identification of colors is for identification only. Selected manufacturer may supply matches.

C. Equipment Colors:

1. Equipment includes the machinery or vessel itself plus the structural supports and fasteners and attached electrical conduits.

2. Paint nonsubmerged portions of equipment the same color as the piping it serves, except as itemized below:
   a. Dangerous Parts of Equipment and Machinery: OSHA Orange.
   b. Fire Protection Equipment and Apparatus: OSHA Red.
   c. Radiation Hazards: OSHA Purple.
   d. Physical hazards in normal operating area and energy lockout devices, including, but not limited to, electrical disconnects for equipment and equipment isolation valves in air and liquid lines under pressure: OSHA Yellow.

D. Pipe Identification Painting:

1. Color code nonsubmerged metal piping, except electrical conduit. Paint fittings and valves the same color as pipe, except equipment isolation valves.
2. Pipe Color Coding: As shown in table below.
3. On exposed stainless steel piping, apply color 24 inches in length along pipe axis at connections to equipment, valves, or branch fittings, at wall boundaries, and at intervals along piping not greater than 9 feet on center.
4. Pipe Supports: Painted light gray, as approved by Government.

E. Pipe System Color Code:

Pipe System	**Color**
Air, Process	Federal Safety Green
Air, Instrument	Federal Safety Purple
Ammonia, Liquid	Federal Safety Orange
Ammonia, Solution	Federal Safety Orange
Alum	Dark Green
Chlorine, Gas	Federal Safety Yellow
Chlorine, Liquid	Federal Safety Yellow
Chlorine, Residual Sampling	Silver/Gray
Chlorine Solution	Federal Safety Yellow
Chlorine Ejector Water	Silver/Gray
Chlorine Vent	Federal Safety Yellow
Compressed Air	Federal Safety Purple
Carbon	Black
Drains and Sludge	Light Brown

Pipe System	Color
Decant	Light Brown
Dewatering	Black
Drains	Black
Effluent, Final	Silver/Gray
Effluent, Primary	Silver/Gray
Effluent, Flushing Water, High Pressure	Dark Green
Effluent, Flushing	Dark Green
Fuel Oil Supply	Federal Safety Orange
Fuel Oil Return	Federal Safety Orange
Flocculation Basin Influent	Buff
Filter Backwash Supply	Medium Blue
Filter Surface Wash Supply	Medium Blue
Hot Flushing Loop	Federal Safety Blue
Headworks	Buff
Lime	White
Mixed Liquor	Silver/Gray
Overflow	Silver/Gray
Plant Service Water	Medium Blue
Potable Water	Light Blue
Polymer/Cationic	Buff
Polymer Nonionic or Anionic	Buff
Raw Sewage	Dark Gray
Rapid Mix Influent	Light Brown
Scum	Light Brown
Sample	Medium Green
Seal Water	Federal Safety Blue
Sludge, Digested	Dark Brown
Sludge, Primary	Dark Brown
Sludge, Return Activated	Light Brown
Sludge, Thickened	Light Brown

Pipe System	Color
Sludge, Waste Activated	Dark Brown
Sludge, Stored	Dark Brown
Sludge, Recirculated	Dark Brown
Sludge, Mixed	Light Brown
Thickener Dilution Water	Dark Green

3.10 FIELD QUALITY CONTROL

A. Testing Equipment:

1. Provide calibrated electronic type dry film thickness gauge to test coating thickness specified in mils.
2. Provide low-voltage wet sponge electrical holiday detector to test completed coating systems, 20 mils dry film thickness or less, except zinc primer, high-build elastomeric coatings, and galvanizing, for pinholes, holidays, and discontinuities.
3. Provide high-voltage spark tester to test completed coating systems in excess of 20 mils dry film thickness. Unit as recommended by coating manufacturer.

B. Testing:

1. Thickness and Continuity Testing:
   a. Measure coating thickness specified in mils with a magnetic type, dry film thickness gauge, in accordance with SSPC PA 2. Check each coat for correct millage. Do not make measurement before a minimum of 8 hours after application of coating.
   b. Holiday detect coatings 20 mils thick or less, except zinc primer and galvanizing, with low voltage wet sponge electrical holiday detector in accordance with NACE SP0188.
   c. Holiday detect coatings in excess of 20 mils dry with high voltage spark tester as recommended by coating manufacturer and in accordance with NACE SP0188.
   d. After repaired and recoated areas have dried sufficiently, retest each repaired area. Final tests may also be conducted by Government.

C. Inspection: Leave staging and lighting in place until Government has inspected surface or coating. Replace staging removed prior to approval by Government. Provide additional staging and lighting as requested by Government.

D. Unsatisfactory Application:

1. If item has an improper finish color or insufficient film thickness, clean surface and topcoat with specified paint material to obtain specified color and coverage. Obtain specific surface preparation information from coating manufacturer.
2. Evidence of runs, bridges, shiners, laps, or other imperfections is cause for rejection.
3. Repair defects in accordance with written recommendations of coating manufacturer.

E. Damaged Coatings, Pinholes, and Holidays:

1. Hand or power sand visible areas of chipped, peeled, or abraded paint, and feather edges. Follow with primer and finish coat. Depending on extent of repair and appearance, a finish sanding and topcoat may be required.
2. Remove rust and contaminants from metal surface. Provide surface cleanliness and profile in accordance with surface preparation requirements for specified paint system.
3. Feather edges and repair in accordance with recommendations of paint manufacturer.
4. Apply finish coats, including touchup and damage-repair coats in a manner that will present a uniform texture and color-matched appearance.

3.11 CLEANUP

A. Place cloths and waste that might constitute a fire hazard in closed metal containers or destroy at end of each day.

B. Upon completion of the Work, remove staging, scaffolding, and containers from Site or destroy in a legal manner.

C. Remove paint spots, oil, or stains upon adjacent surfaces and floors and leave entire job clean.

3.12 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. Paint System Data Sheet (PSDS).
2. Paint Product Data Sheet (PPDS).

END OF SECTION

PAINT SYSTEM DATA SHEET (PSDS)

Complete this PSDS for each coating system, include all components of the system (surface preparation, primer, intermediate coats, and finish coats). Include all components of a given coating system on a single PSDS.

Paint System Number (from Spec.):		
Paint System Title (from Spec.):		
Coating Supplier:		
Representative:		
Surface Preparation:		
Paint Material (Generic)	**Product Name/Number (Proprietary)**	**Min. Coats, Coverage**

PAINT PRODUCT DATA SHEET (PPDS)

Complete and attach manufacturer's Technical Data Sheet to this PPDS for each product submitted. Provide manufacturer's recommendations for the following parameters at temperature (F)/relative humidity:

Temperature/RH	50/50	70/30	90/25
Induction Time			
Pot Life			
Shelf Life			
Drying Time			
Curing Time			
Min. Recoat Time			
Max. Recoat Time			

Provide manufacturer's recommendations for the following:

Mixing Ratio: _____

Maximum Permissible Thinning:_____

Ambient Temperature Limitations: min.:_____ max.:_____

Surface Temperature Limitations: min.:_____ max.:_____

Surface Profile Requirements: min.:_____ max.:_____

SECTION 10 14 00
SIGNAGE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Society of Mechanical Engineers (ASME): A13.1, Scheme for the Identification of Piping Systems.
2. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
   b. D709, Standard Specification for Laminated Thermosetting Materials.
3. The Chlorine Institute, Inc.: WC-1, Wall Chart: Handling Chlorine Cylinders and Ton Containers.
4. International Code Council (ICC):
   a. A117.1, Accessible and Usable Buildings and Facilities.
   b. International Fire Code (IFC): Chapter 27, Hazardous Materials-General Provisions.
5. National Fire Protection Association (NFPA):
   a. 704, Standard System for the Identification of the Hazards of Materials for Emergency Response.
   b. HAZ-01, Fire Protection Guide to Hazardous Materials.
6. Occupational Safety and Health Act (OSHA).
7. U.S. Department of Transportation, Federal Highway Administration: Manual on Uniform Traffic Control Devices for Streets and Highways.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Drawings showing layouts, actual letter sizes and styles, and Project-specific mounting details.
   b. Manufacturer’s literature showing letter sizes and styles, sign materials, and standard mounting details.

B. Informational Submittals: Manufacturer’s installation instructions.

PART 2 PRODUCTS

2.01 BUILDING NAME PLAQUE

A. Physical Characteristics:

1. Text Material: Type 630 stainless steel.
2. Background Material: Type 630 stainless steel.
3. Size: 6 inches by 18 inches and minimum 1/4-inch thick.
4. Lettering and Trim: Raised 1/8 inch, minimum.
5. Border Face and Edge, and Lettering Face: Fine satin hand finish.
6. Background: Dark statuary bronze, finely pebbled surface.
7. Lettering and Border Outlines: Hand-tool, clean, and sharp.
8. Lettering Style: Condensed block.
9. Tablet Inscription Text: To be furnished by Government.
10. Fasteners: Concealed.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.02 PIPE LABELS

A. Physical Characteristics:

1. Labels: Self-adhesive tape, with separate directional flow arrows.
2. Material: Pressure sensitive vinyl.
3. Letters and Arrows: Black on OSHA safety yellow background.
4. Color Field and Letter Height: ASME A13.1.
5. Message: Piping system name.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.03 TRAFFIC SIGNS

A. Physical Characteristics:

1. Aluminum reflectorized signs, standard design meeting requirements of MUTCD.
2. Substrate Aluminum: Refer to ASTM B209 Alloy 6061-T6, or 5052-H38.
3. Wood Posts: Preservative treated 4-inch by 4-inch wood.
   a. Fir or pine, cut from sound timber with no loose or unsound knots.

4. Retroreflective and Nonreflective Sheeting:
    a. Sheeting: The retroreflective or non-reflective material that comprises the background, legend (word messages and symbols), and border.
        1) Conform to ASTM D4956, including supplementary requirements.
        2) Components: The matched component products required for the manufacture of highway signs consist of the sheeting, cutout letters and borders, adhesives, inks, and overlay films.
            a) Failure of the sheeting inks or overlay films, provided, sold, or recommended for use, constitute a failure of the entire sign and replacement under manufacturer's warranty replacement obligations.
            b) All components and warranties will be compatible with substrates used by the Park, including Aluminum ASTM B209 5052, H 38 or 6061-T6.
            c) Use only acrylic EC film to achieve color. Do not use vinyl EC film to achieve color.
        3) Permanent Signs: Include sign installations that are in their final configuration and that are expected to have a multi-year life. Examples include regulatory signs, warning signs, barrier markers, crash cushion markers, and delineation.
        4) Work Zone Standard Signs: MUTCD standard application signs including but not limited to Road Work Ahead, Work Zone Speed Limit, Flagger Symbols, Business Access, and Regulatory signing within the work zone.
            a) Meet or exceed the minimum requirements of ASTM Type XI.
            b) Use fluorescent retroreflective sheeting for orange, yellow, and yellow-green.
        5) Work Zone Project Specific Signs:
            a) Signs that have legends specific to the project and that cannot be reused on a future project. Examples include: "Alder Street closed from 1st to 2nd Avenue – use Birch Street" or Project notification signs. These are typically used for only one construction season.
                (1) Meet or exceed the minimum requirements of ASTM Type III high intensity prismatic sheeting.
                (2) Use fluorescent retroreflective sheeting for orange, yellow, and yellow-green.

6) Flexible Work Zone Devices: Include such devices as roll up signs, cones, tall cones, and flags with retroreflective sheeting.

a) Use ASTM Type VI with minimum Coefficient of Retroreflection as shown in Table 2-1.

Table 2-1
Coefficient of Retroreflection (Candelas/Lux/Square Meter)

Observation Angle	Entrance Angle	White	Fluorescent Yellow-Green	Fluorescent Yellow	Fluorescent Orange	Fluorescent Pink
0.2º	-4º	500	400	300	200	180
0.2º	+30º	200	160	120	80	72
0.5º	-4º	225	180	135	90	80
0.5º	+30º	95	68	51	34	30
1.0º	-4º	50	40	30	20	18
1.0º	+30º	20	16	12	8	7

7) Work Zone Channelization Devices: Include such devices as drums, vertical panels, barricades, tubular markers, and pavement marking tabs.

a) Vertical panels, barricade Types I, II, and III, and directional indicator barricades.

(1) Meet or exceed the minimum requirements of ASTM Type XI.

(2) Use of standard orange acceptable.

b) Meet or exceed the minimum requirements of ASTM Type IV with the minimum requirements of the Coefficient of Retroreflection as shown in Table 2-2 and the minimum requirements of the Color Specification Limits (daytime) of Table 2-3 for all other channelization devices.

Table 2-2
Coefficient of Retroreflection (Candelas/Lux/Square Meter)

Observation Angle	Entrance Angle	White	Fluorescent Orange
0.2º	-4º	500	200
0.2º	+30º	200	80
0.5º	-4º	225	90
0.5º	+30º	85	34
1.0º	-4º	50	20
1.0º	+30º	20	8

Table 2-3 Color Specification Limits (daytime)										
Color	**Chromaticity Coordinates**								**Luminance Factor (Y%)**	
	1		2		3		4			
	x	y	x	y	x	y	x	y	Min.	Max.
White	0.303	0.306	0.368	0.0366	0.340	0.393	0.274	0.329	27	--
Fluorescent Orange	0.645	0.355	0.562	0.348	0.506	0.404	0.570	0.429	20	

c) Use fluorescent retroreflective sheeting for orange and yellow.

d) Do not obscure retroreflective sheeting with paint or other materials.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.04 ANCILLARY MATERIALS

A. Fasteners: Stainless steel screws or bolts of appropriate sizes.

PART 3 EXECUTION

3.01 INSTALLATION—GENERAL

A. In accordance with manufacturer’s recommendations.

B. Mount securely, plumb, and level.

3.02 MAINTENANCE BUILDING NAME PLAQUE

A. Mount with concealed fasteners.

3.03 SIGNS

A. General:

1. Fasten building sign to wall, traffic sign(s) to posts.
2. Anchor in place for easy removal and reinstallation with ordinary hand tools.

3.04 IDENTIFICATION LABELS

A. Pipe Labels:

1. Locate at connections to equipment, valves, or branching fittings at wall boundaries.
2. At intervals along piping not greater than 18 feet on center with at least one label applied to each exposed horizontal and vertical run of pipe.
3. At exposed piping not normally in view, such as above suspended ceilings and in closets and cabinets.
4. Supplementary Labels: Provide to Government those listed on Piping Schedule that do not receive arrows.
5. Apply to pipe after painting in vicinity is complete, or as approved by Government.
6. Install in accordance with manufacturer’s instructions.

END OF SECTION

SECTION 10 44 00
FIRE PROTECTION SPECIALTIES AND SAFETY EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Factory Mutual (FM).
2. Mine Safety and Health Administration (MSHA).
3. National Fire Protection Association (NFPA):
   a. 10, Standard for Portable Fire Extinguishers.
   b. 30, Flammable and Combustible Liquids Code.
4. National Institute for Occupational Safety and Health (NIOSH).
5. Occupational Safety and Health Administration (OSHA).
6. UL: Fire Protection Equipment Directory.

1.02 PERFORMANCE REQUIREMENTS

A. Conform to NFPA 10.

B. Provide extinguishers classified and labeled by testing firm acceptable to authority having jurisdiction for purpose specified and indicated.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Fire Extinguishers: Manufacturer’s product data for each item, including sizes, ratings, UL listings, or other certifications, and mounting information.
   b. Product Data: Extinguisher operational features, color and finish, and anchorage details.

B. Informational Submittals:

1. Manufacturer’s Installation Instructions:
2. Operation and Maintenance Data: Submit test, refill or recharge schedules and recertification requirements.

1.04 QUALITY ASSURANCE

A. Perform Work in accordance with State standard.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Section 01 67 00, Product Requirements: Environmental conditions affecting products onsite.

B. Do not install extinguishers when ambient temperatures are capable of freezing extinguisher ingredients.

PART 2 PRODUCTS

2.01 PORTABLE FIRE EXTINGUISHERS

A. Manufacturers:

1. JL Industries.
2. Or equal.

B. Physical Characteristics:

1. Pressurized, red enameled steel shell cylinder.
2. Conform to NFPA 10 for fire extinguishers.
3. Furnish fire extinguishers and cabinets from one manufacturer.
4. UL listed, charged and ready for service.

C. Functional Characteristics:

1. Multipurpose Hand Extinguisher (F. Ext-1):
   a. Tri-class dry chemical extinguishing agent.
   b. Activated by top squeeze handle.
   c. Agent propelled through hose or opening at top of unit.

D. Performance Characteristics:

1. For use on A, B, and C class fires.
2. Minimum UL Rating: 4A-60B:C, 10-pound capacity.

2.02 FIRST-AID CABINETS AND SUPPLIES

A. Manufacturers:

1. Zee Medical Products Co., Inc.
2. Or equal.

B. Physical Characteristics:

1. Enameled metal or break-resistant plastic.
2. Graphic Identification: Provide graphic identification marking for each fire extinguisher type. OSHA approved pictorial markings to indicate the extinguisher uses and non-uses on a single label.
3. Carrying handles.
4. Made to hang on wall.
5. Fasteners: Furnish necessary screws, bolts, brackets, and other fastenings of suitable type and size to secure items of fire and safety equipment in position.
6. Metal expansion shields for machine screws at concrete and masonry.
7. Interior: Stainless steel.

C. Functional Characteristics: Quantities to serve 10 people.

D. Performance Characteristics: None.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install where indicated or directed and in accordance with manufacturer's recommendations.

B. Secure brackets rigidly to structure.

C. Provide adequate backing for mounting surfaces.

D. Place extinguishers on wall brackets.

3.02 PORTABLE FIRE EXTINGUISHERS

A. Provide near door inside Mechanical Building.

B. Mount cabinet securely in position, following manufacturer's recommendations.

C. Top of Extinguisher: No more than 54 inches above floor.

END OF SECTION

SECTION 13 34 20
PRECAST CONCRETE BUILDING

PART 1 GENERAL

1.01 SUMMARY

A. Contractor to furnish precast, post-tensioned concrete transportable building. Building to be delivered and placed on cast-in-place concrete foundation in accordance with manufacturer's recommendations.

1.02 CODES, STANDARDS, AND REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Concrete Institute (ACI): 318-19, Building Code Requirements for Structural Concrete.
2. American Society of Civil Engineers (ASCE): 7-16, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
3. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   c. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   d. A185, Standard Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
   e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
   f. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
   g. A615, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   h. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
   i. C33, Standard Specification for Concrete Aggregates.
   j. C150, Standard Specification for Type I and Type II – Low Alkali Portland Cement.
4. 2021 New Mexico Building Code, based on the 2021 International Building Code (IBC).
5. 2021 International Energy Conservation Code (IECC).
6. National Fire Protection Association (NFPA): 70, National Electrical Code, 2017 edition.
7. PCI Design Handbook, Precast/Prestressed Concrete Institute.
8. UL: 752, Standard for Safety for Bullet Resisting Equipment, UL "Manual of Standard Practice", Concrete Reinforcing Institute.

1.03 QUALITY ASSURANCE

A. Building fabricator must have a minimum of 5 years' experience manufacturing and setting precast concrete buildings.

B. No alternate building designs to the pre-engineered EASI-SET building will be allowed unless pre-approved by the Contracting Officer.

C. Provide 20-year structural warranty and 5-year finish and watertightness warranty.

1.04 DESIGN REQUIREMENTS

A. Dimensions:

1. Interior: 15 feet 6 inches long by 11 feet 6 inches wide by 9 feet high minimum.
2. Exterior: 16 feet long by 12 feet wide (based on nominal 3-inch wall thickness).

B. Code Data: IBC Type VB structure, U Occupancy, Occupant load = unoccupied.

C. Design Loads: Refer to General Structural Notes as shown on the Drawings.

D. Concrete Roof by Manufacturer: Roof panels shall be sloped 3 to 4 inches rise for each 12 inches of run. The roof shall extend a minimum of 3 inches beyond the wall panel on each side and have a turndown design which extends 1/2 inch below the top edge of the wall panels to prevent water migration into the building along top of wall panels. Roof shall also have an integral architectural ribbed edge. Roof shall be water and weather tight.

E. Wall panels must each be produced as single component monolithic panels. No roof or vertical wall joints will be allowed, except at corners. Wall panels shall set on top of floor slab.

F. Wall panels shall have penetrations in excess of 4 inches incorporated into the design by the manufacturer for:

1. Mechanical: Location and quantities as shown on the mechanical drawings.
2. Plumbing: Location and quantities as shown on the plumbing drawings.
3. Process: Location and quantities as shown on the plumbing drawings.

G. Door, frame and hardware shall be provided and installed by building fabricator/installer. See Section 08 16 13, Fiberglass Doors, and Section 08 71 00, Door Hardware, for requirements.

1.05 SUBMITTALS

A. Shop Drawings of the Building:

1. Plan View:
   a. Drawn to scale at not smaller than 1/2 inch equals 1 foot 0 inch when plotted on 11-inch by 17-inch paper.
   b. Show installation of all accessories.
2. Exterior elevations.
3. Construction details.
4. General notes.
5. Product data sheets.
6. Electrical equipment as shown on the electrical drawings and as specified in Section 26 05 02, Basic Electrical Requirements.

B. Building engineering calculations that are designed and sealed by a licensed professional engineer, currently registered in the State of New Mexico.

PART 2 PRODUCTS

2.01 GENERAL BUILDING SYSTEMS

A. Manufacturers:

1. EASI-SET brand as manufactured by Lonestar Prestress Mfg., Inc., Houston, Texas.
2. Or equal.

B. Physical Characteristics:

1. Precast concrete Mechanical Building delivered to Site in panels and assembled onsite on prepared concrete slab foundation.
2. Finishes:
   a. Interior of Building: Smooth steel form finish on all interior panel surfaces.
   b. Exterior of Building: Stucco finish surface on all exterior panel surfaces.
   c. Roof: Simulated standing seam metal.
   d. Finish and Color: To be selected by Contracting Officer.

C. Functional Characteristics:

1. Reinforcing Steel: Per manufacturer’s requirements.
2. Caulking: All joints between panels and all penetrations shall be caulked on the exterior and interior surface of the joints. Caulking shall be SIKAFLEX-IA elastic sealant, or equal. Exterior caulk joint to be 3/8-inch by 3/8-inch square so that sides of joint are parallel for correct

caulk adhesion. Back of joint to be taped with bond breaking tape to ensure adhesion of caulk to parallel sides of joint and not the back. Provide backer rod at both surfaces of penetrations.

3. Panel Connections: All panels shall be securely fastened together with 3/8-inch thick steel brackets. Steel is to be of structural quality, hot-rolled carbon complying with ASTM A36 and hot dipped galvanized after fabrication. All fasteners to be 1/2-inch diameter bolts complying with ASTM A307 for low-carbon steel bolts. Cast-in anchors used for panel connections to be Dayton-Superior No. F-63, or equal. All inserts for corner connections must be secured directly to form before casting panels. Floating of connection inserts will not be allowed.

D. Performance Characteristics:

1. Meets or exceeds: American Concrete Institute (ACI): 318-19.
2. American Society of Civil Engineers (ASCE): 7-16.Waterproof roof coating with 20-year warranty.

2.02 ELECTRICAL

A. General Requirements: In accordance with Section 26 05 02, Basic Electrical Requirements, and electrical drawings.

B. Conductors: In accordance with Section 26 05 02, Basic Electrical Requirements.

C. Grounding: In accordance with Section 26 05 02, Basic Electrical Requirements.

1. Provide a main grounding bar on the interior building wall beneath the electrical panelboard.
2. Raceway and Boxes: In accordance with Section 26 05 02, Basic Electrical Requirements.
3. Panelboard: Provide one panelboard in accordance with Section 26 05 02, Basic Electrical Requirements.
4. Wiring Devices: Provide in accordance with Section 26 05 02, Basic Electrical Requirements.
5. Lighting: Provide in accordance with Section 26 05 02, Basic Electrical Requirements.

2.03 ACCESSORIES

A. Door and Frame: Refer to Section 08 16 13, Fiberglass Doors.

B. Door Hardware: Refer to Section 08 71 00, Door Hardware.

C. Heating, Ventilation, Air Conditioning: Provide one ceiling-mounted heat pump. Refer to the mechanical drawings.

PART 3 EXECUTION

3.01 SITE PREPARATION REQUIREMENTS (MANUFACTURER'S RECOMMENDATIONS)

A. Building floor slab shall bear fully on a 10-mil vapor barrier over firm undisturbed soils with an approved fill or pad. The existing material shall be removed, and a minimum 6-inch layer of approved fill material shall be placed. Where unacceptable material occurs, excavate and replace with an approved compacted fill material. The minimum recommended allowable bearing shall be 1,500 pounds per square foot.

B. No building shall bear directly on rock. Where rock is closer than 2 feet from the bottom of the building floor slab or foundation slab, it shall be undercut to a minimum of 2 feet below the building and replaced with an approved fill material.

C. Provide positive drainage for the fill, pad, and slab, as required.

D. Approved fill or pad material shall be stone which conforms to ASTM C33. Allowable sizes are No. 56, No. 67, No. 6, No. 7, and No. 8.

E. All fills, pads, or slabs shall be level to within a 0.042-foot (1/2-inch) differential over the entire building area.

F. The entire granular fill or pad shall be kept within the confines of the soil or other surrounding objects. Do not allow the fill or pad material to be undermined so that it may wash, erode, or otherwise be undermined.

G. The finished floor slab elevation shall be a minimum of 2 inches and a maximum of 6 inches above the exterior grade. The grade shall have positive slope and drainage away from the building at all points.

H. Stone base or pad shall be a minimum of 2 feet larger in length and width of building.

3.02 ACCESS

A. Subcontractor must provide level unobstructed area large enough for crane and tractor/trailer to park adjacent to pad. Crane must be able to place outriggers within 5 feet of edge of pad and truck and crane must be able to get side-by-side under their own power. No overhead lines may be within 75-foot radius of center of pad.

END OF SECTION

SECTION 22 07 00
PLUMBING PIPING INSULATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Heating, Refrigerating & Air-Conditioning Engineers Inc. (ASHRAE): 90.1, Energy-Efficient Design of New Buildings except Low-Rise Residential Buildings.
2. ASTM International (ASTM):
   a. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
   b. C533, Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.
   c. C534, Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.
   d. C547, Standard Specification for Mineral Fiber Pipe Insulation.
3. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.

1.02 SUBMITTALS

A. Action Submittals: Product description, include list of materials, thickness for each service scheduled, and locations.

B. Informational Submittals:

1. Proof of compliance for test of products for fire rating, corrosiveness, and compressive strength.
2. Manufacturer’s installation instructions.

1.03 QUALITY ASSURANCE

A. Provide standard, cataloged products, new and commercially available, suitable for service requiring high performance and reliability with low maintenance, and free from all defects.

B. Provide materials by firms engaged in the manufacture of insulation products of the types and characteristics specified herein, whose products have been in use for not less than 5 years.

C. UL Listing or satisfactory certified test report from an approved testing laboratory is required to indicate fire hazard ratings for materials proposed for use do not exceed those specified.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Stamp or Label:

1. Deliver insulation, jackets, cements, adhesives and coatings with a manufacturer's stamp or label attached, giving name of manufacturer, brand, and description of material.
2. Insulation Packages and Containers: Mark "asbestos-free."

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics:

1. Insulation Exterior: Cleanable, grease-resistant, nonflaking, and nonpeeling.
2. Insulation for Fittings, Flanges, and Valves: Premolded, precut, or job-fabricated insulation of same thickness and conductivity as used on adjacent piping.

B. Functional Characteristics: Conform to referenced publications and specified temperature ranges and densities in pounds per cubic foot.

C. Performance Characteristics:

1. Fire Resistance:
   a. Provide noncombustible insulation, adhesives, vapor barrier materials and other accessories, except as specified herein.
   b. Use no fugitive or corrosive treatments to impart flame resistance.
   c. Flame proofing treatments subject to deterioration as a result of effects of moisture or high humidity are not acceptable.
   d. Fire Hazard Rating for Materials including Facings, Mastics, and Adhesives: Not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke, developed as per tests conducted in accordance with NFPA 255 methods.
   e. Materials exempt from fire-resistant rating:
      1) Nylon anchors.
      2) Treated wood inserts.

f. Materials exempt from fire-resistant rating when installed in outside locations, buried, or encased in concrete:
   1) Polyurethane insulation.
   2) PVC casing.
   3) Fiberglass-reinforced plastic casing.

2.02 PIPE INSULATION

A. Type P3—Elastomeric (ASTM C534, Minus 40 Degrees F to 220 Degrees F):

1. Manufacturers and Products:
   a. Armacell; AP Armaflex.
   b. Or equal.
2. Physical Characteristics: Flexible, closed cell elastomeric.
3. Functional Characteristics: Nominal 6 pcf density, K factor 0.27 maximum at 75 degrees F mean.
4. Performance Characteristics: Water Vapor Transmission: 0.1 perm-inch, or less.

PART 3 EXECUTION

3.01 INSTALLATION OF INSULATION

A. Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices.

B. Apply insulation over clean and dry surfaces.

C. Install insulation after piping system has been pressure tested and leaks corrected.

D. Use insulating cements, lagging adhesives, and weatherproof mastics recommended by insulation manufacturer.

E. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete the run. Do not use cut pieces of scraps abutting each other.

F. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

G. Cover valves, flanges, fittings, and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job-fabricated units.

H. Insulate valve bodies, flanges, and pipe couplings.

I. Do not allow insulation to cover nameplates or code inspection stamps.

J. Install removable insulation sections on devices that require access for maintenance of equipment or removal, such as unions and strainer end plates.

K. Placement:

1. Slip insulation on pipe or tubing before assembly, when practical, to avoid longitudinal seams.
2. Insulate valves and fittings with sleeved or cut pieces of same material.
3. Seal and tape joints.

L. Insulation at Hangers and Supports: Install under piping, centered at each hanger or support.

3.02 INSULATION APPLICATIONS

A. Potable Cold Water and HVAC Condensate Drains:

1. Type P3, elastomeric.
2. 1/2-inch thickness for all pipe sizes.

3.03 INSULATION FINISH APPLICATIONS

A. Piping Insulation (Mechanical Spaces): Factory finish.

END OF SECTION

SECTION 22 10 01
PLUMBING PIPING AND ACCESSORIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA):
   a. B109.1, Diaphragm Type Gas Displacement Meters (under 500 Cubic Feet Per Hour Capacity).
   b. B109.2, Diaphragm Type Gas Displacement Meters (500 Cubic Feet Per Hour Capacity and Over).
2. American National Standards Institute (ANSI).
3. American Public Works Association (APWA): Uniform Color Code.
4. American Society of Sanitary Engineering (ASSE):
   a. 1010, Performance Requirements for Water Hammer Arresters.
   b. 1050, Performance Requirements for Stack Air Admittance Valves for Sanitary Drainage Systems.
   c. 1070, Performance Requirements for Water Temperature Limiting Devices.
5. ASTM International (ASTM):
   a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
   d. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   f. A179/A179M, Standard Specification for Seamless Cold-Drawn Low-Carbon Steel Heat-Exchanger and Condenser Tubes.
   g. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   h. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   i. A194/A194M, Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   j. A197/A197M, Standard Specification for Cupola Malleable Iron.

k. A234/A234M, Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
m. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
n. A518/A518M, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
o. A536, Standard Specification for Ductile Iron Castings.
p. A563, Standard Specification for Carbon and Alloy Steel Nuts.
q. A861, Standard Specification for High-Silicon Iron Pipe and Fittings.
r. A888, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
s. B32, Standard Specification for Solder Metal.
t. B61, Standard Specification for Steam or Valve Bronze Castings.
u. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.
v. B75/B75M, Standard Specification for Seamless Copper Tube.
w. B88, Standard Specification for Seamless Copper Water Tube.
x. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
y. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
z. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
aa. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
bb. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
cc. B306, Standard Specification for Copper Drainage Tube (DWV).
dd. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
ee. C1277, Standard Specification for Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
ff. C1460, Standard Specification for Shielded Transition Couplings for use with Dissimilar DWV Pipe and Fittings Above Ground.
gg. C1540, Standard Specification for Heavy Duty Shielded Couplings Joining Hubless Cast Iron Soil Pipe and Fittings.
hh. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
ii. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

jj. D2000, Standard Classification System for Rubber Products in Automotive Applications.
kk. D2239, Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
ll. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
mm. D2513, Standard Specification for Polyethylene (PE) Gas Pressure Pipe, Tubing, and Fittings.
nn. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
oo. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
pp. D2855, Standard Practice for Making Solvent-Cemented Joints with Poly(Vinyl Chloride) (PVC) Pipe and Fittings.
qq. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
rr. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
ss. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
tt. E438, Standard Specification for Glasses in Laboratory Apparatus.
uu. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
vv. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
ww. F1412, Standard Specification for Polyolefin Pipe and Fittings for Corrosive Waste Drainage Systems.
xx. F1924, Standard Specification for Plastic Mechanical Fittings for Use on Outside Diameter Controlled Polyethylene Gas Distribution Pipe and Tubing.
yy. F1973, Standard Specification for Factory Assembled Anodeless Risers and Transition Fittings in Polyethylene (PE) and Polyamide 11 (PA11) and Polyamide 12 (PA12) Fuel Gas Distribution Systems.

6. American Water Works Association (AWWA):
   a. C104/A21.4, Standard for Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
   b. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   c. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

e. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast.
f. C203, Coal-Tar Protective Coatings and Linings for Steel Water Pipelines, Enamel and Tape, Hot-Applied.
g. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
h. C606, Grooved and Shouldered Joints.
i. C651, Disinfecting Water Mains.

7. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
   b. 310, Specification for Couplings for Use in Connection with Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Strom Drain, Waste, and Vent Piping Applications.
8. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
9. Plumbing and Drainage Institute (PDI): WH 201, Water Hammer Arresters Standard.

1.02 DESIGN REQUIREMENTS

A. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Building Service Piping: ASME B31.9, as applicable.
2. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code.

1.03 SUBMITTALS

A. Action Submittals:

1. Product data sheets.
2. Shop Drawings: Show Contractor recommended changes in location of fixtures or equipment.
3. Changes in location of equipment or piping that affect connecting or adjacent work, before proceeding with the work.
4. Test records.
   a. Manufacturer’s test of meters.
   b. Manufacturer’s test of pressure reducing valve.
   c. Installed system pressure testing.
   d. Installed system tracer wire continuity testing.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPING

A. Plumbing Piping Schedule: Refer to Article Supplements.

B. Piping Material: Refer to Piping Data Sheet(s) and Article Supplements.

2.03 HOSE VALVES AND HYDRANTS

A. NFWH-1, Wall Hydrant:

1. Manufacturers and Products:
   a. J. R. Smith; Figure 5609.
   b. Or equal.
2. Physical Characteristics: Nonfreeze exposed with chrome-plated face, integral vacuum breaker, bronze casing, T-handle key, and 3/4-inch inlet and hose connection.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

2.04 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

2.05 VALVES

A. General:

1. Physical Characteristics:
   a. Furnish complete with necessary operating hand wheels, chain wheels, extension stems, floor stands, worm and gear operators, operating nuts, chains, and wrenches.
   b. Renewable Parts Including Discs, Packing, and Seats: Types as recommended by valve manufacturer for intended service.

c. Units shall have name of manufacturer and size of valve cast on body or bonnet or shown on a permanently attached plate in raised letters.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

B. Design Features:

1. Physical Characteristics:
   a. Brass and bronze components, including appurtenances in contact with water.
   b. Alloys containing less than 16 percent zinc and 2 percent aluminum.
   c. Alloys are of the following ASTM designations:
      1) B61, B62, B98/B98M (Alloy A, B, or D), B139 (Alloy A), B164, B194, and B127.
      2) Stainless steel Alloy 18-8 may be substituted for bronze as an option with approval of Contracting Officer.
   d. Gland Bolts on Iron Body Valves: Bronze, fitted with brass nuts.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

C. Valve Operators:

1. Physical Characteristics:
   a. Open by turning counterclockwise.
   b. Self-locking type to prevent the disc or plug from creeping.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

D. Gate Valves:

1. Manufacturers and Products for Threaded Ends:
   a. Crane; No. 438.
   b. Or equal.
2. Manufacturers and Products for Soldered Ends:
   a. Crane; No. 1701S.
   b. Or equal.
3. Physical Characteristics:
   a. Type V100, 3 Inches and Smaller for Water and Air Services: All-bronze with screwed bonnet, single solid wedge gate with non-rising stem, and handwheel operator.
4. Functional Characteristics: None.
5. Performance Characteristics: Rated 125-pound SWP, 200-pound WOG.

E. Ball Valves:

1. Manufacturers and Products:
   a. Threaded Ends:
      1) Milwaukee; BA-300.
      2) Or equal.
   b. Soldered Ends:
      1) Milwaukee; BA-350.
      2) Or equal.
2. Physical Characteristics:
   a. 2 Inches and Smaller for General Water and Air Service: Three-piece body type, bronze body and end pieces, hard-chrome plated bronze or brass ball, full bore port, RTFE seats and packing, blowout-proof stem, zinc-plated steel hand lever operator with vinyl grip.
3. Functional Characteristics: None.
4. Performance Characteristics: Rated 600-pound WOG, 150-psi SWP.

F. Thermoplastic Ball Valves 2 Inches and Smaller for Water Service:

1. Manufacturers:
   a. Asahi/America.
   b. Or equal.
2. Physical Characteristics:
   a. Type I, Grade 1 polyvinyl chloride (PVC) body, ball, and stem.
   b. End entry, double union design, with replaceable polytetrafluoroethylene (PTFE) seats and fluoroelastomer (FKM) or polytetrafluoroethylene O-ring stem seals.
   c. Furnish with hand lever operator.
   d. Single union ball valves with flanged ends drilled to 150-pound ANSI Standard are acceptable.
3. Functional Characteristics: None.
4. Performance Characteristics: Rated 150 psi at 105 degrees F, with ASTM D1784.

2.06 MISCELLANEOUS PIPING SPECIALTIES

A. Strainers for Water Service:

1. Manufacturers and Products:
   a. Crane; No. 988-1/2.
   b. Or equal.
2. Physical Characteristics:
   a. Iron body, Y-pattern, with screwed bronze or bolted iron cap.
   b. Screen: Heavy-gauge stainless steel or monel, 30 mesh.

3. Functional Characteristics: 125-pound rated.
4. Performance Characteristics: None.

B. Sleeves:

1. Manufacturers and Products:
   a. J. R. Smith; Figure 1720.
   b. Or equal.
2. Physical Characteristics:
   a. Duco coated cast, iron, flashing clamp.
   b. See the Drawings to determine sizes required.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

C. Joint Solder:

1. Physical Characteristics: 95-5 wire solder, ASTM B32, Grade 95 TA. Lead free. Do not use cored solder.
2. Functional Characteristics: None.
3. Performance Characteristics:
   a. NSF Certified Pipe Joint Sealer:
      1) Physical Characteristics: None.
      2) Functional Characteristics: None.
      3) Performance Characteristics: Compound insoluble in water or tetrafluoroethylene tape; approved by NFS for use in potable water.

D. Rubber Gaskets: ASTM C564.

2.07 MEASURING DEVICES

A. Pressure Gauge:

1. Manufacturers and Products:
   a. Ashcroft; Type 1008.
   b. Or equal.
2. Physical Characteristics:
   a. Construction: 3-1/2-inch gauge size, steel case, glass crystal, brass movement, and 1/4-inch NPT lower connection.
   b. Furnish with 1/4-inch brass gauge cock.
3. Functional Characteristics: None.
4. Performance Characteristics:
   a. 0 kPa to 690 kPa range.
   b. 0 psi to 160 psi range.

2.08 NATURAL GAS PIPING AND EQUIPMENT

A. Fuel Gas Piping Above Ground:

1. Manufacturers:
   a. American Steel Pipe.
   b. Or equal.
2. Physical Characteristics: Refer to Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

B. Fuel Gas Piping Below Grade:

1. Manufacturers and Products:
   a. Chevron Phillips; DriscoPlex 6500.
   b. Or equal.
2. Physical Characteristics: Refer to Section 22 10 01.12, Polyethylene (PE) Pipe and Fittings—Natural Gas Service Data Sheet.
3. Functional Characteristics: None.
4. Performance and Physical Characteristics:
   a. Thermoplastic (Polyethylene - PE): PE pipe and heat fusion fittings shall conform to ASTM D2513, SDR 11 and manufactured for 861 kPa (80 psig) working pressure. Pipe and fittings shall have heat fusion joints PE pipe and fitting materials for heat fusion shall be compatible to ensure uniform melting and a proper bond.

C. Flex Connector (Gas Transition Fitting):

1. Manufacturers:
   a. Metraflex
   b. Or equal.
2. Physical Characteristics: Braided stainless steel connector, manufacturer’s model No. GASCT0200, suitable for natural gas service.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

D. Anodeless Riser (Gas Transition Fitting):

1. Manufacturers:
   a. Hubbell.
   b. Or equal.
2. Physical Characteristics: Manufacturer’s standard anodeless type riser, transition from plastic to steel pipe with fusion bonded epoxy coating. Inlet connection socket or butt weld or swaged gas-tight construction with O-ring seals, metal insert, and protective sleeve. Outlet or above

ground connection end shall be threaded or flanged. Riser shall comply with ASTM A53/A53M, Type E or S, Grade A, Schedule 40.

3. Functional Characteristics: None.
4. Performance Characteristics: None.

E. Above Grade Ball Valve (Isolation):

1. Manufacturers and Products:
   a. Jomar; T-SS-1001N (2-Piece).
   b. Jomar; T-SS-1000N-4B (3-Piece).
   c. Or equal.
2. Physical Characteristics: Two-piece or three-piece stainless body, full port, rated for minimum 1,000 WOG, reinforced TFM seat, Type 316 stem seal; end entry, threaded ends, UL-listed 842 for natural gas shut off service.
3. Functional Characteristics: 100 percent leak tested, and 29-inch HGV rated.
4. Performance Characteristics: None.

F. Lockwing Ball Valve (Isolation):

1. Manufacturers and Products:
   a. Jomar; 175-LWN.
   b. Or equal.
2. Physical Characteristics:
   a. Brass body with tamper resistant lockwing cap with full port design rated at 175 psig. Must be 100 percent leak tested. Furnish with a painted body. MSS SP 110 and CSA certified.
   b. Valve shall be lockable using standard barrel lock.
3. Functional Characteristics: Must be 100 percent leak tested.
4. Performance Characteristics: None.

G. Below Grade Polyethylene Ball Valves (Isolation):

1. Manufacturers:
   a. Broen.
   b. Or equal.
2. Physical Characteristics: ASME B16.40 shall be manufactured and rated for underground gas service. Operating pressure to 80 psig and SDR 11 pipe stubs. Valve shall be maintenance and corrosion free. Polyethylene valves shall be full port opening type. Valves shall be wrench operated. Wrench operated valves shall have a 50-mm (2-inch) square adaptor securely fastened to the valve stem. Polyethylene valves shall be installed by butt fusion method.
3. Functional Characteristics: 80 psi rated valve (Gas US).
4. Performance Characteristics: None.

H. Natural Gas Pressure Reducing Valves:

1. Manufacturers and Products:
   a. Fisher; S201H, S202H or S202K.
   b. Or equal.
2. Physical Characteristics:
   a. Direct diaphragm, spring controlled cast-iron body, spring aluminum diaphragm and spring case, nitrile disc/diaphragm/O-rings, internal relief, NPT thread ends, 125-psig rated.
   b. Valve Body Size: 1/2 inch to 2 inches, as indicated.
   c. Valve Orifice Size: 1/4 inch to 1-3/16 inches, as indicated.
3. Functional Characteristics: None.
4. Performance Characteristics:
   a. Inlet pressure of 5 psig to 50 psig.
   b. Outlet Pressure: Set at 2 psig.

I. Natural Gas Pressure Gauge:

1. Manufacturers and Products:
   a. Winters; PFQ.
   b. Or equal.
2. Physical Characteristics: Natural gas pressure gauge with a 2-1/2-inch face, bottom connection, stainless steel wetted parts and all stainless steel construction suitable for outdoor environment with glass face (rated IP 65). Furnish with 1/2-inch NPT male thread.
3. Functional Characteristics: Gauge shall be rated for 0 psig to 60 psig. Install gauge with 1/2-inch ball valve.
4. Performance Characteristics: 1.5 percent accuracy for full range.

J. Natural Gas Meters:

1. Manufacturers:
   a. Elster American Meter.
   b. Or equal.
2. Physical Characteristics:
   a. Type: Diaphragm gas displacement incompliance with AGA B109.2.
   b. Construction: Aluminum body, cover, and handhole plate; nitrile rubber diaphragm or equivalent molded reinforced material; polyester primer with polyurethane top coat grey finish.
   c. Indexing: Direct read in units of cubic feet. Provide UV protected index cover for outdoor locations.
3. Functional Characteristics: Plus or minus 2 percent from minus 20 degrees to 120 degrees.

4. Performance Characteristics:
   a. Maximum Working Pressure: 25 psig.
   b. Minimum Flow Rate: 500 cubic feet per hour for 0.6 SG gas at 0.25 psig and 1/2-inch WC differential pressure drop if no other information is provided. Meter selected shall be capable of a minimum of 50 percent greater capacity than the peak sum of all connected loads on the meter.
   c. Compensation: Temperature.
   d. Temperature Rating: Minus 30 degrees F to plus 150 degrees F.
   e. Connection: Contractor shall coordinate the meter connection type with the Contracting Officer to match the existing conditions.

PART 3 EXECUTION

3.01 GENERAL

A. Install plumbing systems to meet applicable plumbing code.

B. Field Obstructions:

1. Drawings do not attempt to show exact details of piping. Provide offsets around obstructions.
2. Do not modify structural components, unless approved by Contracting Officer.

C. Sleeves:

1. Pipe sizes shown are nominal sizes, unless shown or specified otherwise.
2. Provide piping passing through walls, floors, or ceilings with standard-weight pipe sleeves.
3. Provide pipes passing through finished walls with chrome-plated canopy flanges.
4. Dry pack sleeves in existing work in-place and provide finished appearance.
5. Pack holes left by removal of existing piping with grout and finish to match adjacent surface.

D. Provide unions in piping systems at connections to equipment.

E. Provide isolation valves and strainers at pressure regulators.

3.02 INSTALLATION

A. Copper Tubing:

1. Cut tubing square and remove burrs.
2. Clean both inside of fittings and outside of tubing with steel wool and hydrochloric acid before soldering.
3. Prevent annealing of fittings and hard-drawn tubing when making connections.
4. Do not use mitered joints for elbows or notching of straight runs of pipe for tees.

B. Steel Pipe (above ground only):

1. Ream, clean, and remove burrs and mill scale from piping before making up.
2. Seal joints with pipe joint sealer or polytetrafluoroethylene (PTFE) tape.
3. Steel pipe used for natural gas shall gas rated per Fuel Gas Code.

C. PEX-A Polyethylene Piping:

1. Comply with manufacturer’s product data, including product technical bulletins, installation instructions and design drawings.
2. Install in compliance with the PEX Piping Systems Design and Installation Manual, and Systems Installation Guide.
3. PEX piping shall be installed per ASTM E84 requirements for plenum applications.
4. Support and provide all required hangers and supporting strapping as required by manufacturer to provide a code compliant installation.
5. Install in straight runs free of sags and kinks and provide bend supports at all 1/2-inch and 3/4-inch drops.
6. All penetrations through wall plates shall be protected or shielded as required to prevent damage to piping.
7. Tubing passing through metal studs shall use grommets or sleeves at the penetration.
8. Provide supports, fixed anchor points, and hangers in compliance with the Piping Systems Design and Installation Manual and Piping Systems Installation Guide, current edition, to minimize expansion and contraction.
9. Install piping at each fixture with out of the wall support bracket to secure piping and prevent excess movement when water stops or shut valves are operated.
10. Where manifolds are used, install centered in access panels to permit servicing.

D. Rigid PVC or CPVC:

1. Cut, make up, and install in accordance with pipe manufacturer's recommendations.
2. Ream, clean, and remove burrs from cut ends before joining pipe.
3. Lay in trench by snaking pipe from one side to other.
4. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and final use.
5. Do not lay pipe when temperature is below 40 degrees F or above 90 degrees F when exposed to direct sunlight.
6. Shield ends to be joined from direct sunlight prior to and during laying operation.
7. Use strap wrenches only for tightening threaded plastic joints. Do not over tighten fittings.
8. Use transition fittings when making threaded connections. Do not cut threads in PVC or CPVC pipe.

E. Polyethylene Piping for Natural Gas:

1. All polyethylene gas distribution piping shall be installed in accordance with Manufacturers written instructions and applicable federal, state, and local codes and shall have at least 24 inches of cover. Do not install piping in standing groundwater. Pipe shall be laid on grade and on a stable foundation of a minimum of 4 inches of sand. A trench cut in rocky soil shall be excavated to 6 inches below pipe bottom grade, and brought back to grade with appropriate bedding material. All ledge rock, boulders and large stones shall be removed. Piping shall be covered with a minimum of 4 inches of sand followed by suitable trench material.
2. Place pipe in trench to allow for expansion and contraction of the piping. Do not exceed the bending radius of the piping. If during the installation of the piping the bend radius is exceeded the damaged pipe shall be cut out and shall be repaired as required.
3. Bury appropriate detectable utility warning and identification tape with printed side up at a depth of 12 inches below the top surface of earth.
4. Provide a #10 insulated copper tracer wire laid over the top of the gas piping. Tracer wire shall terminate above grade near where the piping terminates and within each buried line valve. Provide a stainless-steel stamped tag securely attached to the tracer wire identifying its intended use.
5. Verify continuity of all tracer wire installation using low frequency (512-Hz or similar) line locating equipment. Continuity testing of tracer wire system in lieu of using locating equipment is not permitted.
6. Visually inspect all butt joints by comparing with, manufacturer's visual joint appearance chart. Inspect fusion joints for proper fused connection. Replace defective joints by cutting out defective joints or replacing

fittings. Inspect 100 percent of all joints and re-inspect all corrections. Arrange with the pipe manufacturer's representative in the presence of the Contracting Officer.

7. Use an initial test pressure of 25 psi pneumatic test. Following an initial test follow with a final 50 psig pneumatic test. Do not test until every joint has set and cooled at least 8 hours at temperatures above 50 degrees F. Conduct testing before backfilling; however, place sufficient backfill material between fittings to hold pipe in place during tests. Test system gas tight in accordance with NFPA 54. Use nitrogen or carbon dioxide, for testing. Make tests on entire system or on sections that can be isolated by valves. After pressurization, isolate entire piping system from sources of air during test period. Maintain initial and final test pressure for at least 2 hours between times of first and last reading of pressure and temperature. Take first reading at least one hour after test pressure has been applied. Do not take test readings during rapid weather changes. Provide temperature same as actual trench conditions. There shall be no reduction in the applied test pressure other than that due to a change in ambient temperature. Allow for ambient temperature change in accordance with the relationship PF (P1 + 12.0) (T2 + 460) / T1 + 460), in which "T" and "PF" represent Fahrenheit temperature and gage pressure, respectively, subscripts "1" and "2" denote initial and final readings, and "PF" is the calculated final pressure. If "PF" exceeds the measured final pressure (final gage reading) by 3-1/2 kPa, 1/2 psi or more, isolate sections of the piping system, retest each section individually, and apply a solution of warm soapy water to joints of each section for which a reduction in pressure occurs after allowing for ambient temperature change. Repair leaking joints and repeat test until no reduction in pressure occurs. In performing tests, use a test gage calibrated in one psi increments and readable to 1/2 psi.

8. After completing pressure tests, and before testing a gas contaminated line, purge line with nitrogen at junction with main line to remove all air and gas. Clear completed line by attaching a test pilot fixture at capped stub-in line at building location and let gas flow until test pilot ignites. Procedures shall conform to NFPA 54 and ASME B31.8.

F. Valves: Install in accordance with manufacturer's recommendations.

G. Miscellaneous Piping Specialties: Install in accordance with manufacturer's recommendations. Adjust all pressure regulating valves for proper settings.

H. Measuring Devices: Install in accordance with manufacturer's recommendations.

3.03 SANITARY AND WASTE DRAINS AND VENTS PIPING

A. Installation:

1. Set piping above floor slab true and plumb.
2. Set exposed risers as close to walls as possible.
3. Slope drain lines at minimum 2 percent slope, unless otherwise noted. Vent lines shall be installed level or sloped, with no low spots.
4. Where vent stacks pass through roof slab, fit with flashing sleeve secured to roof.
5. Extend vents minimum 1 foot above roof.
6. Provide cleanouts where shown and where required by code.

3.04 HVAC CONDENSATE PIPING

A. Set piping true and plumb.

B. Slope piping 1/8 inch per foot minimum.

3.05 WATER SUPPLY PIPING

A. Water supply piping includes potable water PW1, PW2, and system.

B. Flush water piping systems clean of internal debris, clean faucet aerators, and adjust plumbing fixture valves for manufacturer’s recommended flow.

C. Do not run water piping through electrical rooms, stairwells, or immediately over or within a 3-foot horizontal clearance of electrical panels, motor starters, or environmental control panels.

D. Hose Valves and Hydrants: Attach handle with setscrew and provide manufacturer’s recommended gravel fill around drain hole of post hydrants.

3.06 NATURAL GAS

A. Install in compliance with applicable local gas code.

B. Provide dirt leg, ground union joint, and isolation valve adjacent to each flexible connector hose at each appliance connection.

C. Label “NATURAL GAS, X PSIG” at intervals not to exceed 5 feet, indicating fuel type and pressure.

3.07 INSULATION

A. As specified in Section 22 07 00, Plumbing Piping Insulation.

3.08 HANGERS AND SUPPORTS

A. Install pre-engineered support equipment in accordance with manufacturer's recommendations.

B. Hanger Rod Sizing and Spacing for:

1. Steel Pipe:

Pipe Size	Max. Hanger Spacing (feet)	Min. Rod Size (inches)
1 inch and smaller	6	1/4
1-1/4 through 2-1/2 inches	8	1/4
3 and 4 inches	10	3/8

2. Copper Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: 2 feet less per size than for steel pipe, except pipe 1-1/4 inches and smaller shall be supported every 6 feet.
3. Plastic Pipe:
   a. Rod Size: Same as for steel pipe.
   b. Spacing: As recommended by manufacturer and required by applicable plumbing code for flow and temperature in pipe.
   c. No metal portion of hanger shall contact pipe directly.

C. Attach Support Rods For Horizontal Piping:

1. To concrete with inserts or with flanges fastened with flush shells.
2. To wood with thickness of 2-1/2 inches or more with bolts or angle clips.

D. Vertical Piping:

1. Support by channel type support system and pipe clamps on 10-foot maximum centers.
2. Copper and Plastic Piping: Isolate from channels and pipe clamps with pipe isolators.

E. Insulated Piping: Furnish galvanized protection shield and oversized hangers under insulated piping.

3.09 INTERIM CLEANING

A. Prevent accumulation of weld rod, weld spatter, pipe cuttings and filings, gravel, cleaning rags, and other foreign material within piping during fabrication and assembly.

B. Examine piping to assure removal of foreign objects prior to assembly.

C. Conventional commercial cleaning methods of cleaning are acceptable if method and cleaning material does not corrode, deform, swell, or otherwise alter physical properties of material being cleaned.

D. Flush all pipe segments with compressed air to remove any debris, rocks, or sand prior to final connections to the system.

3.10 TESTING

A. General:

1. Conduct pressure and leakage tests on newly installed pipelines.
2. Provide necessary equipment and material, and make taps in pipe, as required.
3. Contracting Officer will monitor tests. Provide 24-hour advance notice of start of testing.
4. Test Pressures: As specified herein and in Supplement Piping Schedule.
5. Test Records:
   a. Make records of each piping system installation during test to document the following:
      1) Date of test.
      2) Description and identification of piping tested.
      3) Test fluid.
      4) Test pressure.
      5) Remarks, including:
         a) Leaks (type, location).
         b) Repairs made on leaks.
      6) Certification by Contractor and signed acknowledgment by Contracting Officer that tests have been satisfactorily completed.

B. Preparation and Execution:

1. Buried Pressure Piping:
   a. An initial service leak test may be conducted with a partially backfilled trench and the joints left open for inspection, if field conditions permit, as determined by Contracting Officer.
   b. Expose joints for the acceptance test on buried pressure piping to be pneumatically tested or subjected to an initial service leak test.
   c. Conduct final hydrostatic acceptance tests after trench has been completely backfilled.
2. Exposed Piping: Conduct tests after piping has been completely installed including supports, hangers, and anchors, but prior to insulation.

C. Hydrostatic Leak Tests:

1. Equipment:
   a. Provide the following:

Amount	Description
2	Graduated containers
2	Pressure gauges
1	Hydraulic force pump
	Suitable hose and suction pipe as required

2. Procedure:
   a. Use water as the hydrostatic test fluid.
   b. Provide clean test water of such quality as to minimize corrosion of the materials in the piping system.
   c. Open vents at high points of the piping system to purge air pockets while the piping system is filling.
   d. Venting during filling of system may also be provided by loosening flanges with a minimum of four bolts or by the use of equipment vents.
   e. Test piping systems at test pressure specified in Supplement Plumbing Piping Schedule.
   f. Maintain hydrostatic test pressure continuously for 30 minutes minimum and for such additional time as necessary to conduct examinations for leakage.
   g. Examine joints and connections for leakage.
   h. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of weeping or leaking.
   i. Correct visible leakage and retest to satisfaction of Contracting Officer.
3. Buried Water Lines:
   a. A limited amount of leakage is permissible according to formula specified.
   b. Conduct hydrostatic testing as follows:
      1) Pipe with Concrete Thrust Blocking: Do not make pressure test until a minimum of 5 days after thrust blocking is installed.
      2) If high-early strength cement is used for thrust blocking, time may be reduced to 2 days.
   c. Cement-Lined Piping: Slowly fill test section with water and allow to stand for 24 hours under slight pressure to allow cement lining to absorb water.
   d. Expel air from piping system prior to testing.

e. Apply and maintain specified test pressure with hydraulic force pump.
f. Valve off the piping system when test pressure is reached.
g. Conduct pressure test for 2 hours, reopening isolation valve only as necessary to restore test pressure.
h. Accurately measure amount of water required to maintain test pressure by placing pump suction in a barrel or similar device, or by metering.
i. The measurement represents leakage, defined as the quantity of water necessary to maintain the specified test pressure for the duration of the test period.
j. Determine maximum allowable leakage in gallons per hour from the following formula:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour
N = Number of joints in the length of pipe tested
D = Nominal diameter of pipe, in inches
P = Test pressure during the leakage test, in pounds per square inch

k. Correct leakage greater than the allowable determined under this formula, and retest to satisfaction of Contracting Officer.

4. Test Pressure for Water: 1-1/2 times system pressure.
5. Gravity Sewers and Drains:
   a. Test by water or air exfiltration tests as prescribed by local or state plumbing codes and visually examine for leaks.
   b. Repair leaks and retest system until no further leakage is evident.

D. Pneumatic Leak Test (Above Grade Natural Gas):

1. Perform on all natural gas piping above grade.
2. Equipment:
   a. Provide the following:
      1) Pneumatic compressor capable of meeting required test pressure.
      2) Calibrated Test Gauge.
3. Procedure:
   a. Perform pneumatic testing using accurately calibrated instruments and oil-free, dry air.

b. Perform tests only on exposed piping, after piping has been completely installed, including supports, hangers and anchors, and inspected for proper installation.
c. Test piping system at test pressure specified in Supplement Piping Schedule.
d. Protect test personnel and Contracting Officer's operating personnel from hazards associated with air testing.
e. Secure piping to be tested to prevent damage to adjacent piping and equipment in event of a joint failure.
f. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by test.
g. Apply maximum 25 psig preliminary pneumatic test to piping system prior to final leak testing, to locate major leaks.
h. Examine joints and connections for leakage with soap bubbles.
i. Correct visible leaks and retest.
j. Gradually increase pressure in system to not more than one-half of test pressure.
k. Thereafter increase pressure in steps of approximately 1/10 of maximum test pressure until required test pressure is reached.
l. Maintain pneumatic test pressure continuously for minimum 30 minutes for first 500 cubic feet of pipe volume and an additional 30 minutes for each additional 500 cubic feet and for such additional time as necessary to conduct a soap bubble examination for leakage.
m. Piping system, exclusive of possible localized instances at pump or valve packing, shall show no evidence of leakage.
n. Correct visible leakage and retest to satisfaction of Contracting Officer.
o. Following pneumatic testing, thoroughly purge lines that are to carry flammable gases with nitrogen to assure no explosive mixtures will be present in system during filling process.

3.11 CLEANING AND DISINFECTION

A. Disinfect potable water pipelines before placing in service.

1. Refer to Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

3.12 PROTECTION OF INSTALLED WORK

A. Protective Covers:

1. Provide over floor and shower drains during construction, to prevent damage to drain strainers and keep foreign material from entering drainage system.
2. Remove at time of Substantial Completion.

3.13 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Plumbing Piping Schedule.
2. Plumbing Piping Data Sheets.

Section Number	Title
22 10 01.12	Polyethylene (PE) Pipe and Fittings—Natural Gas Service
22 10 01.15	Carbon Steel Pipe and Fittings—Gas Service

END OF SECTION

PLUMBING PIPING SCHEDULE										
Legend	**Service**	**Size(s) (in.)**	**Exposure**	**Piping Material**	**Specification Section**	**Operating Pressure (psig)**	**Test Type**	**Test Pressure (psig)**	**Pipe Colors and Labels**	**Notes**
CD	Condensate Drain, HVAC	All	EXP/BUR	PVC-DWV	22 10 01	NA	H	5		
D	Sanitary Drain	All	EXP/BUR	PVC-DWV	22 10 01	NA	H	5		
PW1	Cold Water, Potable	All	EXP/BUR	CPVC PVC PEX	22 10 01	50	H	125		CPVC, PEX Inside Building; PVC Outside Building
PW2	Cold Water, Potable	All	EXP/BUR	COP PVC	40 27 00.10 40 27 00.13	50	H	125		Copper Inside Building, PVC Outside Building

Notes:

1. Finish all FS piping exposed to view, color to be OSHA red, in accordance with Section 09 90 00, Painting and Coating, Paint System No. 5.
2. Insulate as specified in Section 22 07 00, Plumbing Piping Insulation.
3. Test at 25 psi followed by a 50-psi test.

Legend					
Exposure		**Pressure Test**		**Material**	
BUR	Buried	H	Hydrostatic	ACR	Air-Conditioning and Refrigeration
EXP	Exposed	I	In Service	CISP	Cast Iron Soil Pipe
SUB	Submerged	P	Pneumatic	CLDI	Cement-Lined Ductile Iron
ENC	Concrete Encased	NA	Not Applicable	CMP	Corrugated Metal Pipe
				COP	Copper
				CPVC	Chlorinated PVC
				DI	Ductile Iron
				DWV	Drain Waste and Vent

Legend		
Exposure	**Pressure Test**	**Material**
		PEX Cross-linked Polyethylene
		MDPE Medium Density Polyethylene
		PVC Polyvinyl Chloride

END OF SECTION

SECTION 22 10 01.12 POLYETHYLENE (PE) PIPE AND FITTINGS— NATURAL GAS SERVICE		
Item	**Size**	**Description**
General	All	Physical Characteristics: Pipe lengths, fittings, and connections to be joined by thermal fusion; shall be same type, grade, and class of polyethylene compound and supplied from same raw material supplier. Pipe tubing and fittings manufactured in accordance with ASTM D2513. Functional Characteristics: None. Performance Characteristics: None.
Pipe	1/2" to 12"	Physical Characteristics: ASTM D2513 medium-density polyethylene, maximum allowable hoop stress 1,250 psi at 73.4 degrees F. Polyethylene Resins: Conform to Type PE 2406/2708 or better. Pipe wall thickness shall reflect required SDR* and diameter, as shown in Table 8, ASTM F714. Design Stress Rating: ASTM F1924, 1,250 psi hydrostatic design basis (HDB). Pressure Rating (psi) at 100 degrees F — SDR* 80 — 11.0 80 — 11.5** Note: Installed outdoors and underground only. Operating pressure for natural gas piping shall be limited to 100 psig or less per 2009 IFGC. Identification: Pipe and fittings shall be yellow in color and shall be marked “ASTM D2513”. *SDR: standard dimension ratio = OD/thickness ** SDR 11.5 may be used at contractor’s option. Functional Characteristics: None. Performance Characteristics: None.

SECTION 22 10 01.12 POLYETHYLENE (PE) PIPE AND FITTINGS— NATURAL GAS SERVICE		
Item	**Size**	**Description**
Fittings	4" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Molded Fittings: Conform to PE 2406/2708. Socket Fusion Fittings: Meet requirements of ASTM D2683. Butt Fusion Fittings: Meet requirements of ASTM D3261.
Flanges	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Flanges not permitted underground. Above ground, flanges and bolting shall be part of approved, listed transition fitting.
Risers and Transitions		Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Conform to ASTM F1973.

END OF SECTION

SECTION 22 10 01.15 CARBON STEEL PIPE AND FITTINGS—GAS SERVICE		
Note: For carbon steel pipe for water service, See Section 40 27 00.03, Carbon Steel Pipe and Fittings—General Service Data Sheet.		
Item	**Size**	**Description**
Pipe	All	Physical Characteristics: Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, and flanged joints:
	Screwed: 2" & smaller	Standard weight or Schedule 40.
	Welded: 2-1/2" thru 10"	Standard weight or Schedule 40.
		Functional Characteristics: None. Performance Characteristics: None.
Joints	2" & smaller	Physical Characteristics: Threaded or socket-welded; flanged at equipment as required or shown. Functional Characteristics: None. Performance Characteristics: None.
	2-1/2" & larger	Physical Characteristics: Butt-welded or flanged at valves and equipment. Functional Characteristics: None. Performance Characteristics: None.

SECTION 22 10 01.15 CARBON STEEL PIPE AND FITTINGS—GAS SERVICE		
Note: For carbon steel pipe for water service, See Section 40 27 00.03, Carbon Steel Pipe and Fittings—General Service Data Sheet.		
Item	**Size**	**Description**
Fittings	2" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, 2,000-pound or 3,000-pound WOG, conforming to ASME B16.11; bore to match pipe inside diameter.
	2-1/2" & larger	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise.
Branch Connections	2" & smaller	Physical Characteristics: Threadolet or socket in conformance with Fittings above. Functional Characteristics: None. Performance Characteristics: None.
	2-1/2" & larger	Physical Characteristics: Butt-welding tee in accordance with Fittings above. Functional Characteristics: None. Performance Characteristics: None.

SECTION 22 10 01.15 CARBON STEEL PIPE AND FITTINGS—GAS SERVICE		
Note: For carbon steel pipe for water service, See Section 40 27 00.03, Carbon Steel Pipe and Fittings—General Service Data Sheet.		
Item	**Size**	**Description**
Flanges	2" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 socket-weld raised face. When mating flange is flat face, provide flat face.
	2-1/2" & larger	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 or Class 300 slip-on or welding neck, raised face. Weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside.
Unions	2" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Threaded or socket-weld, forged carbon steel, ASTM A105/A105M, 2,000-pound or 3,000-pound WOG, integral ground steel-to-steel seats, AAR design meeting the requirements of ASME B16.11, bore to match pipe.
Bolting	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Carbon steel ASTM A193/A193M, Grade B7 studs or heavy hex bolts; ASTM A194/A194M, Grade 2H heavy hex head nuts. Torque bolts per gasket manufacturer recommendations.

SECTION 22 10 01.15 CARBON STEEL PIPE AND FITTINGS—GAS SERVICE		
Note: For carbon steel pipe for water service, See Section 40 27 00.03, Carbon Steel Pipe and Fittings—General Service Data Sheet.		
Item	**Size**	**Description**
Gaskets	All flanges	Physical Characteristics: General Service and Oil/Gas: 1/16-inch thick compressed non-asbestos composition flat ring type, rated 400 degrees F continuous. Garlock, Blue-Gard 3000; Durlon 7950. Functional Characteristics: None. Performance Characteristics: None.
Thread Lubricant		Physical Characteristics: General Service: 100 percent virgin PTFE tape.
		Fuel Gas Service: Yellow PTFE tape designed for fuel gas service. Air Force A-A-58092.
		Functional Characteristics: None. Performance Characteristics: None.

END OF SECTION

SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Gas Association (AGA).
2. American Society of Heating, Refrigerating & Air-Conditioning Engineers, Inc. (ASHRAE): 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
3. American Society of Mechanical Engineer's (ASME).
4. American Society of Sanitary Engineering (ASSE):
   a. 1013, Performance Requirements for Reduced Pressure Principle Backflow Preventers and Reduced Pressure Fire Protection Backflow Preventers.
   b. 1015, Performance Requirements for Double Check Backflow Prevention Assemblies and Double Check Backflow Fire Protection Assemblies.
5. American Water Works Association (AWWA):
   a. C510, Double Check Valve Backflow Prevention Assembly.
   b. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   c. C550, Protective Interior Coatings for Valves and Hydrants.
6. ASTM International (ASTM):
   a. A48/A48M, Standard Specification for Gray Iron Castings.
   b. D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
7. Canadian Standards Association (CSA):
   a. B64.4, Backflow Preventers, Reduced Pressure Principle Type (RP).
   b. B64.5, Backflow Preventers, Double Check Valve Type (DCVA).
8. FM Global (FM).
9. Food and Drug Administration (FDA).
10. Foundation for Cross-Connection Control and Hydraulic Research at University of Southern California (FCCHR): Manual of Cross-Connection Control.
11. International Code Council (ICC): International Plumbing Code (IPC).
12. National Electrical Code (NEC).
13. National Electrical Manufacturers Association, (NEMA): MG 1, Motors and Generators.

14. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
15. UL.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's product data.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.03 SPECIAL GUARANTEE

A. Where note below, provide manufacturer's extended guarantee in writing with Contracting Officer named as beneficiary. Special guarantee shall provide for correction, or at the option of the Contracting Officer, removal and replacement of products found defective during the stated period after date of Substantial Completion.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics: None.

B. Functional Characteristics:

1. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

2. Use or reuse of components and materials without a traceable certification is prohibited.

C. Performance Characteristics: All equipment applicable to Energy Star and FEMP designation shall meet associated requirements.

2.02 BACKFLOW PREVENTERS

A. Double Check Backflow Preventer (3/4 Inch Through 2 Inches):

1. Manufacturers and Products:
   a. Febco; Model 850.
   b. Or equal.
2. Physical Characteristics:
   a. Description:
      1) Regulatory Compliance: AWWA C510, CSA B64.5, FCCHR of USC Section 10, ASSE 1015, ICC (IPC).
      2) Valve Body: Bronze.
      3) End Connections: Threaded, NPT.
      4) Maximum Working Pressure: 175 psi (350 psi test).
      5) Temperature Range: 32 degrees F to 140 degrees F.
      6) Shutoff Valve: Full port, resilient seated, bronze ball valve with bronze ball valve test cock.
      7) Inlet Strainer: Bronze wye strainer, 40-mesh perforated, Type 304 stainless steel.
3. Functional Characteristics: None.
4. Performance Characteristics: See data sheet at end of section.

2.03 WATER METER AND METER BOXES

A. Refer to Section 33 12 13, Water Service Connections.

2.04 HYDROPNEUMATIC PRESSURE BOOSTERS

A. Product:

1. Manufacturers and Products:
   a. Amtrol; RP-10HP.
   b. Or equal.
2. Motor and Pump:
   a. Physical Characteristics: Stainless steel pump housing and connections.
   b. Functional Characteristics: Provides the rotational movement to boost pressure.
   c. Performance Characteristics: 1/2 hp motor, prewired 115V ac, power must be on a separate 20 amps circuit for 115V ac.

3. Well Tank:
    a. Physical Characteristics: Steel tank shell, butyl diaphragm, polypropylene liner, and includes a pressure relief valve.
        1) Maximum diameter is 17 inches.
        2) Maximum tank volume is 15 gallons.
    b. Functional Characteristics: Used to increase water pressure by up to 50 psig.
    c. Performance Characteristics: NSF 61 approved, factory pre-charged to 38 psig, 100 psig maximum working pressure, relieve valve preset to 75 psig.
4. Controls:
    a. Physical Characteristics: Integrated digital control and LED display.
    b. Functional Characteristics: None.
    c. Performance Characteristics: None.

2.05 WATER FOUNTAINS

A. Outdoor Water Fountain with Bottle Filler:

1. Manufacturers and Products:
    a. Elkay; LK4420BF1UDB.
    b. Or equal.
2. Physical Characteristics:
    a. Bi-Level with bottle filling station and drinking fountain.
    b. Free standing, outdoor application.
    c. Evergreen color.
    d. Mechanically activated.
3. Functional Characteristics: None.
4. Performance Characteristics:
    a. Vandal resistant.
    b. 1 gpm bottle filler quick fill rate.
    c. Type 300 stainless steel construction.
    d. 20 psi to 105 psi operating pressure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install, arrange, and connect equipment as shown on the Drawings and in accordance with manufacturer’s recommendations.

3.02 FIELD QUALITY CONTROL

A. Startup:

1. Piping Systems: Verify that flushing, cleaning, and testing has been completed prior to startup.

3.03 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Backflow Preventers Data Sheet.

END OF SECTION

Backflow Preventers						
Tag Number	**Valve Type[1]**	**Size (inches)**	**Flow Stream**	**Maximum Operating Flow (gpm)**	**Maximum Pressure Drop (psi)**	**Manufacturer, Model No.**
BFP-01	DC	3/4	PW1	3	5	Febco, Model 850

Notes:

1. Valve Type: RP - Reduced Pressure, DC - Double Check.

2. Flow Streams: DIW - Deionized Water, FP - Fire Protection, IRR - Irrigation Water, LCW - Laboratory Cold Water, TWS - Tempered Water Supply, W1 - Potable Water, W2 - Nonpotable Water, W3 - Plant Water.

SECTION 22 40 00
PLUMBING FIXTURES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Americans with Disabilities Act (ADA).
2. American Gas Association (AGA).
3. American Society of Mechanical Engineers (ASME).
4. American Society of Sanitary Engineering (ASSE): 1010, Performance Requirements for Water Hammer Arresters.
5. ASTM International (ASTM): D4101, Standard Specification for Polypropylene Injection and Extrusion Materials.
6. Food and Drug Administration (FDA).
7. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
8. Plumbing and Drainage Institute (PDI):
   a. Code Guide 302 and Glossary of Industry Terms.
   b. WH-201, Water Hammer Arrester Standard.
9. UL.

1.02 SUBMITTALS

A. Action Submittals: Catalog information and rough-in dimensions for plumbing fixtures, products, and specialties.

1.03 REGULATORY REQUIREMENTS

A. Comply with the Americans with Disabilities Act (ADA), and local and state requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics:

1. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.

Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

2. Use or reuse of components and materials without a traceable certification is prohibited.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.02 GENERAL

A. Plumbing Fixtures: Indicated by fixture number as shown on the Drawings.

B. Drainage Products: Indicated by fixture number as shown on the Drawings.

C. Plumbing Specialties: Indicated by fixture number as shown on the Drawings.

2.03 MATERIALS

A. Drainage Products:

1. CO-1, Cleanout (Exterior):
   a. Manufacturers and Products:
      1) Jay R. Smith Mfg. Co.; Model 4263.
      2) Or equal.
   b. Physical Characteristics:
      1) Material: Taper thread, bronze plug, heavy-duty, scoriated cast-iron top.
   c. Functional Characteristics: None.
   d. Performance Characteristics: None.
2. FD-1, Floor Drain (Finished Areas):
   a. Manufacturers and Products:
      1) Jay R. Smith Mfg. Co.; Model 2210C-MGB.
      2) Or equal.
   b. Physical Characteristics:
      1) Materials: Cast-iron body, cast iron bucket grate.
      2) Options: ASSE 1072 Trap Seal.
   c. Functional Characteristics: None.
   d. Performance Characteristics: None.

PART 3 EXECUTION

3.01 PREPARATION

A. Drawings do not attempt to show exact details of fixtures. Changes in locations of fixtures, advisable in opinion of Contractor, shall be submitted to Contracting Officer for review before proceeding with the Work.

3.02 INSTALLATION

A. Drainage Products:

1. Floor Drains: Set top flush with floor. Provide membrane clamps where required.
2. Cleanouts: Install where shown or required for purposes intended. Set cover flush with finished floor.

B. Plumbing Specialties:

1. Drain Trap Seals: Install trap seals in floor drains and hub drains, where indicated on the Drawings.

C. Caulk penetrations of exterior walls with weatherproof sealant.

D. Adjust water flows in domestic water systems for reasonable water flows at each plumbing fixture, terminal device, and recirculation loop. Flush valve fixtures shall be adjusted for proper flush cycle time and water quantity.

3.03 FIELD QUALITY CONTROL

A. Perform visual inspection for physical damage, blocked access, cleanliness, and missing items.

1. Contracting Officer shall log, date, and initial inspection upon passing flow tests.

B. Verify alarm operation both locally and systemwide. Notify security prior to test if alarm is connected systemwide.

END OF SECTION

SECTION 23 05 48
VIBRATION ISOLATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. A36/A36M, Specification for Carbon Structural Steel.
   b. E488, Standard Test Methods for Strength of Anchors in Concrete and Masonry Elements.
3. American Welding Society (AWS): D1.1/D1.1M, Structural Welding Code—Steel.
4. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): Seismic Restraint Manual: Guidelines for Mechanical Systems.
5. Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

1.02 DEFINITIONS

A. AHJ: Authority Having Jurisdiction.

B. EPDM: Ethylene-Propylene-Diene Monomer.

C. OSHPD: Office of Statewide Health Planning and Development, for the State of California.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings, Vibration Isolators:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Product Data:
      1) Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
      2) Schedule of vibration isolator type with location and static and dynamic load on each.

3) Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment.

2. Shop Drawings:
   a. Include, as a minimum, basic equipment layout, length and width, installed operating weights of equipment to be isolated and distribution of weight at isolation points.
   b. Signed and sealed by a registered professional engineer registered in the state where the Project is located.
   c. Product Data: Manufacturer's product data including details of materials, construction, dimensions of individual components, installation details, and finishes.
   d. Anchorage and bracing data sheets and drawings as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer's Installation Instructions: Indicate special procedures and setting dimensions.

1.04 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M.

B. Isolation materials, flexible connectors, and seismic restraints shall be same manufacturer. Select and certify using published or factory certified data.

C. Vibration isolation manufacturer shall be a member of the Vibration Isolation and Seismic Control Manufacturers Association (VISCMA).

PART 2 PRODUCTS

2.01 EQUIPMENT SCHEDULES

A. Refer to Article Supplement for product type and capacities.

2.02 VIBRATION ISOLATION

A. Manufacturers:

1. Mason Industries, Inc.
2. Or equal.

B. General:

1. Provide for mechanical piping, ductwork, and equipment as identified by this specification.

2. Select in accordance with equipment, pipe, or duct weight distribution to produce reasonably uniform deflections.
3. Physical Characteristics: None.
4. Functional Characteristics:
   a. Springs: Minimum horizontal stiffness equal to 75 percent vertical stiffness, with working deflection between 30 percent and 60 percent of maximum deflection.
5. Performance Characteristics: None.

C. Elastomeric Pad:

1. Physical Characteristics:
   a. Oil-resistant and water-resistant elastomer or natural rubber waffle pads, arranged in single or multiple layers, molded with a nonslip pattern.
   b. Waffle pads bonded each side of minimum 1/4-inch thick galvanized steel separator plate.
   c. Height of waffle ribs shall not exceed 0.7 times width.
   d. Minimum Single Layer Thickness: 1/4 inch.
   e. Factory cut to size that matches requirements of supported equipment.
   f. Waffle Pad Material: Standard neoprene.
   g. Number of Layers: As required to support equipment load; refer to manufacturer's data for load capacities.
2. Functional Characteristics:
   a. Maximum Loading: 60 psi.
   b. Separator plate of sufficient stiffness for uniform loading over pad area.
3. Performance Characteristics: None.

D. Elastomeric Mount:

1. Physical Characteristics:
   a. Double-deflection type, with molded, oil-resistant rubber or neoprene isolator elements.
   b. Factory-drilled, encapsulated top plate for bolting to equipment.
   c. Baseplate for bolting to structure.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

E. Elastomeric Hanger:

1. Physical Characteristics:
   a. Double-deflection type.
   b. Molded, oil-resistant rubber or neoprene isolator elements bonded to steel housing.
   c. Threaded connections for hanger rods.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.03 SHOP/FACTORY FINISHING

A. Manufacturer's standard paint applied to factory-assembled and factory-tested equipment, before shipping.

1. Powder coating on springs and housings.
2. Electro-galvanized hardware.
3. Hot-dip galvanized metal components for exterior use.
4. Baked enamel coat metal components for interior use.

B. Color-code or otherwise mark vibration isolation devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation devices for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. General:

1. Install products in accordance with manufacturers' written instructions.
2. Connect wiring to isolated equipment with flexible hanging loop.
3. Locate isolation hangers as near overhead support structure as possible.

B. Vibration Isolators:

1. Install spring hangers without binding.
2. On closed spring isolators, adjust so side stabilizers are clear under normal operating conditions.

3.03 FIELD QUALITY CONTROL

A. Testing:

1. Conduct the following field quality control testing:
   a. Isolator deflection.

3.04 CLEANING

A. After completing equipment installation, inspect vibration isolation devices. Remove paint splatters and other spots, dirt, and debris.

3.05 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Vibration Isolation Schedule for HVAC Piping and Equipment.

END OF SECTION

VIBRATION ISOLATION SCHEDULE FOR HVAC PIPING AND EQUIPMENT

ISOLATED EQUIPMENT	DESCRIPTION		AC UNIT, SPLIT SYSTEM DX OUTDOOR	AC UNIT, SPLIT SYSTEM DX INDOOR			
	TAG NUMBERS		HP-01	AC-01			
	LOCATION		GROUND	SUSPENDED			
VIBRATION ISOLATOR	TYPE		ELASTOMERIC PAD	ELASTOMERIC HANGER			
	MINIMUM DEFLECTION	INCH					
EQUIPMENT BASE	TYPE		NONE	NONE			
FLEXIBLE CONNECTOR	TYPE		NONE	NONE			
	MINIMUM DEFLECTION	INCH					
ISOLATED EQUIPMENT	DESCRIPTION						
	TAG NUMBERS						
	LOCATION						
VIBRATION ISOLATOR	TYPE						
	MINIMUM DEFLECTION	INCH					
EQUIPMENT BASE	TYPE						
FLEXIBLE CONNECTOR	TYPE						
	MINIMUM DEFLECTION	INCH					

REMARKS:

SECTION 23 81 00
UNITARY AIR-CONDITIONING EQUIPMENT

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air-Conditioning, Heating, and Refrigeration Institute (AHRI): 210/240, Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
2. Air Moving and Conditioning Association (AMCA): Bulletin 300, Setup No. 1.
3. American Gas Association (AGA).
4. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE):
   a. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   b. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
5. American Society of Mechanical Engineers (ASME): BPVC Section IX, Welding and Brazing Qualifications.
6. ASTM International (ASTM):
   a. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
   b. D2370, Standard Test Method for Tensile Properties of Organic Coatings.
   c. D4060, Standard Test Method for Abrasion Resistance of Organic Coatings by the Taber Abraser.
   d. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   e. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
7. Canadian Standards Association (CSA).
8. ETL Testing Laboratories (ETL).
9. International Organization for Standardization (ISO):
   a. 9001, Quality Management Systems - Requirements.
   b. 13256-1, Water-Source Heat Pumps—Testing and Rating for Performance—Part 1: Water-to-Air and Brine-to-Air Heat Pumps.
10. National Electrical Manufacturers Association (NEMA).
11. National Fire Protection Association (NFPA): 255, Standard Method of Test of Surface Burning Characteristics of Building Materials
12. UL: 94, Safety Standard for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Air Conditioning.
2. COP: Coefficient of Performance.
3. DX: Direct Expansion.
4. EER: Energy Efficiency Ratio.
5. HP: Heat Pump.
6. IR: Infra Red.
7. LED: Light Emitting Diode.
8. PSC: Permanent Split Capacitor.
9. PTAC: Packaged Terminal Air Conditioner.
10. SPST: Single Pole, Single Throw.
11. TXV: Thermostatic Expansion Valve.
12. UV: Ultraviolet.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Seismic anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing.
   b. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for all products specified.
   c. Manufacturer’s standard finish color selection for enclosure finishes.
   d. Complete performance data that will indicate full compliance with Specification:
      1) Include fan sound power level data (ref. 10 to 12 watts) at design operating point, based on AMCA Bulletin 300, Setup No. 1.
      2) Include heating and cooling performance data at design operating conditions.
   e. Air Pressurization Unit: Documentation that media filter modules are UL rated Class 1.
   f. Factory dip-applied protective coating product data.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer’s documentation that media filter modules rated UL Class 1.

3. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt arrangement or details shown to equipment furnished.
4. Sample copy of guarantee.
5. Test reports.
6. Operation and Maintenance Data in conformance with Section 01 78 23, Operation and Maintenance Data.
   a. Include wiring and control diagrams for equipment.
   b. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating and Cooling Equipment: Minimum operating efficiencies, defined as COP and EER, as specified in ASHRAE 90.1.

B. Unit shall be rated (when matched with appropriate outdoor unit) per AHRI 210/240.

C. Units shall be certified by UL and CSA, and shall be UL or ETL listed and labeled.

D. Cooling performance rated in accordance with AHRI testing procedures.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Storage: Products shall be carefully stored in a manner that will prevent damage and in an area that is protected from the elements.

B. Protection of Equipment:

1. Box, crate, or otherwise protect from damage and moisture during shipment, handling, and storage.
2. Protect from exposure to corrosive fumes and keep thoroughly dry at all times.
3. Store motors, drives, electrical equipment, and other equipment with antifriction or sleeve bearings in weathertight and heated storage facilities prior to installation.
4. For extended storage periods, plastic equipment wrappers shall not be used to prevent accumulation of condensate in gears and bearings.

1.06 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following materials:

Item	Quantity
Filters	One complete set per unit.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics: Specified components of this section, including insulation, facings, mastics, and adhesives, shall have fire hazard rating not to exceed 25 for flame spread without evidence of continued progressive combustion, and 50 for smoke developed, as per test conducted in accordance with ASTM E84 and NFPA 255 methods.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.02 EQUIPMENT SCHEDULES

A. Refer to Supplements:

1. Ductless Split System DX Indoor Units Data Sheet.
2. Split System DX Outdoor Units Data Sheet.

2.03 SPLIT SYSTEM IN-CEILING CASSETTE AC UNIT, DUCTLESS

A. Manufacturers and Products:

1. Carrier; 45MBCAQ Series.
2. Or equal.

B. General:

1. Physical Characteristics: Indoor, direct-expansion, ceiling mounted fan coil unit complete with a cooling/heating coil, fan, fan motor, piping connectors, electrical controls, microprocessor control system, integral temperature sensing, condensate pump, and hanging brackets.
   a. Suitable for use with air conditioner or heat pump outdoor unit.
   b. Indoor unit shall be of the same manufacturer as the associated outdoor unit.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

C. Unit Cabinet:

1. Physical Characteristics:
   a. Constructed of zinc-coated steel.
   b. Fully insulated.
   c. Discharge and inlet grilles, high-impact polystyrene.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

D. Evaporator Fan:

1. Physical Characteristics:
   a. Centrifugal, direct-drive blower type with air intake in center of unit and discharge on perimeter.
   b. Air louvers shall be adjustable for 2-, 3-, or 4-way discharge.
   c. Motors:
      1) Open drip-proof, permanently lubricated with inherent protection.
      2) Seven-speed.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

E. DX Evaporator Coil:

1. Physical Characteristics:
   a. Copper tube with aluminum fins and galvanized steel tube sheets.
   b. Fins bonded to tubes by mechanical expansion.
   c. Condensate Drip Pan: Locate under coil with drain connection for hose attachment to remove condensate.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

F. Controls:

1. Physical Characteristics: None.
2. Functional Characteristics:
   a. Controls consist of a microprocessor-based control system which controls the space temperature, determines the optimum fan speed, and runs self-diagnostics.
   b. The fan speed control is user-selectable with three fan speed selections or microprocessor controlled automatic operation.
   c. Automatic restart after power failure at same operating conditions as at failure.
   d. Evaporator coil freeze protection.
3. Performance Characteristics: None.

G. Air Filters:

1. Physical Characteristics: Filter tracks and cleanable filters, accessible from below with 1/4-turn fastener.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

H. Accessories: Provide as scheduled in Ductless Split System DX Indoor Units Data Sheet.

2.04 SPLIT SYSTEM AC OUTDOOR UNITS

A. Manufacturers:

1. Carrier.
2. Or equal.

B. General:

1. Physical Characteristics:
   a. Factory assembled, single piece, air-cooled air conditioner outdoor unit.
   b. Contained within the unit enclosure shall be factory wiring, piping, controls, compressor, and holding charge of R-454B refrigerant.
   c. Outdoor unit shall be same manufacturer as associated indoor unit.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

C. Unit Cabinet:

1. Physical Characteristics:
   a. Constructed of galvanized steel, phosphatized and coated with a baked enamel finish.
   b. Removable access panels for access to internal components.
   c. Outdoor Compartment: Isolated, with acoustic lining to ensure quiet operation.
   d. Knockouts for unit electrical power.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

D. Condenser Fans:

1. Physical Characteristics:
   a. Direct-drive propeller type shall discharge air horizontally and shall draw air through outdoor coil.

b. Motors:
1) Totally enclosed, with Class E insulation and permanently lubricated bearings.
2) Thermal overload protection.
c. Shaft of galvanized or stainless steel construction.
d. Fan blades shall be corrosion-resistant and be statically and dynamically balanced.
e. Equip openings with PVC-coated protection grille over fan and coil.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

E. Compressor:

1. Physical Characteristics:
a. Fully hermetic reciprocating or scroll type.
b. Compressors shall be equipped with crankcase heaters to minimize liquid refrigerant accumulation in compressor during shutdown and to prevent refrigerant dilution of oil.
c. Installed on rubber vibration isolators and shall have internal spring isolation.

2. Functional Characteristics:
a. Equipped with oil system, operating oil charge, and motor.
b. Internal overloads shall protect compressor from overtemperature and overcurrent.
c. Motor: NEMA rated, Class E, suitable for operation in a refrigerant atmosphere.
d. Scroll compressors shall have high discharge gas temperature protection.

3. Performance Characteristics: None.

F. Condenser Coil:

1. Physical Characteristics: Constructed of aluminum fins mechanically bonded to internally enhanced seamless copper tubes that are cleaned, dehydrated, and sealed.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

G. Refrigeration Components:

1. Physical Characteristics:
a. Brass external liquid line service valve with service gauge port connections.
b. Suction line service valve with service gauge connection port.

c. Service gauge port connections on compressor suction and discharge lines with Schrader-type fittings with brass caps.
d. Suction Line: Accumulator.
e. Pressure relief.
f. Reversing Valve.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

H. Controls:

1. Physical Characteristics: Two-pole contactors.
2. Functional Characteristics:
   a. Factory selected, assembled, and tested.
   b. Refrigerant Metering:
      1) Reversing valve for heat pump units.
      2) Heating mode metering device for heat pump units.
   c. Automatic restart on power failure.
   d. Time delay control sequence shall be provided standard through control board on indoor units.
   e. High pressure and liquid line low pressure switches.
   f. Automatic outdoor fan motor protection.
   g. Start capacitor and relay (single-phase units without scroll compressors).
   h. Defrost board to provide defrost control.
   i. Safeties:
      1) Time delay restart to prevent compressor reverse rotation on single-phase scroll compressors.
      2) Safety lockout if an outdoor unit safety is open.
      3) High condensing temperature protection.
      4) System diagnostics.
      5) Compressor motor current and temperature overload protection.
      6) High pressure relief.
      7) Outdoor fan failure protection.
3. Performance Characteristics: None.

I. Accessories: Provide as scheduled in Split System DX Outdoor Units Data Sheet.

2.05 ELECTRICAL

A. General:

1. Physical Characteristics:
   a. Units shall include high and low voltage terminal block connections.

b. Control voltage to indoor unit fan shall be 0V dc to 15V dc.
c. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

B. Motors:

1. Physical Characteristics: None.
2. Functional Characteristics:
   a. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
   b. Unless otherwise stated, electric motors shall comply with the following:
      1) Voltage, Phase, Horsepower, Synchronous Speed: Refer to Supplements for motor driven equipment.
      2) Enclosure: ODP, unless specified otherwise.
      3) Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
      4) Winding Thermal Protection: Manufacturer’s standard.
      5) Space Heater: Manufacturer’s standard.
      6) Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer’s standard.
      7) Efficiency: Minimum efficiency per Section 26 20 00, Low-Voltage AC Induction Motors.
3. Performance Characteristics: None.

2.06 ACCESSORIES

A. Physical Characteristics:

1. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 3/8-inch high block type black enamel filled equipment identification number and letters indicated in this specification.
2. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, 1/2-inch minimum diameter, and as specified in Section 05 50 00, Metal Fabrications. Quantity as recommended by manufacturer.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.07 SOURCE QUALITY CONTROL

A. Factory Tests:

1. Direct expansion coils leak tested underwater with 200 psig air. Pressure tested to 450 psig.
2. Electric heating coils tested with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install equipment in accordance with manufacturer's recommendations, and these Specifications.
2. Set and install equipment so equipment is level and properly supported.
3. Ensure piping connections to equipment do not cause strain on equipment.
4. Ensure vibration isolation has been installed per manufacturer's instructions and isolation devices are performing satisfactorily.
5. Install safety devices as recommended by manufacturer and required by code.

B. Filters:

1. Install set of filters in each unit before operating and leave in place during startup and testing to keep equipment and ductwork clean.
2. Do not operate units until filters are installed. If operated without filters, completely clean ductwork, coils, and interior of units.

C. Lubricate unsealed bearings prior to startup.

3.02 FIELD QUALITY CONTROL

A. Initial equipment testing and startup shall be made by authorized representative of unit manufacturer.

B. Air-cooled outdoor unit shall not be started without complete prestart checkout of entire refrigerant piping system and charging of system with refrigerant as recommended by equipment manufacturer.

C. Field Testing: Manufacturer shall provide factory-trained representative employed by equipment manufacturer to perform the following services. Supervision only, of Contractor, will not be acceptable.

1. Leak test.
2. Refrigerant pressure test.

3. Evacuate (if required).
4. Dehydrate (if required).
5. Charge condensing unit with refrigerant and oil (if required).

3.03 MANUFACTURER'S SERVICES

A. Provide manufacturer's representative at Site in accordance with Section 01 91 14, Total System Commissioning, for the following:

1. Inspect installation including external interlock, power connections; supervise initial operation, calibration of operating and safety controls and supervise electrical testing including insulation resistance of motors and voltage balance between phases during starting and running.
2. Test Report:
   a. Submit test reports unit is in safe and proper operating condition.
   b. Contain pressure and control settings, meg readings, voltage readings per phase during START and RUN, suction temperature and pressure, liquid temperature and pressure.
   c. List minor discrepancies to be corrected which do not affect safe and reliable operation.
   d. One copy of report shall be left in unit control panel.
3. One copy of bound installation operation and maintenance service, and parts brochures, including applicable serial numbers, full unit description, parts ordering sources, shall be placed in unit control panel at time of starting.
4. Training of Contracting Officer's personnel for specified equipment.

3.04 ADJUSTING AND CLEANING

A. Install set of filters at time of final cleaning as defined in Section 01 77 00, Closeout Procedures.

3.05 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Ductless Split System DX Indoor Units Data Sheet.
2. Split System DX Outdoor Units Data Sheet.

END OF SECTION

DUCTLESS SPLIT SYSTEM DX INDOOR UNITS

SYMBOL				AC-01			
LOCATION				CANYON MECHANICAL BUILDING			
TYPE				IN CEILING			
FAN DATA (PERFORMANCE CHARACTERISTICS)	SUPPLY AIR		CFM	150			
	OUTSIDE AIR		CFM				
	EXTERNAL STATIC PRESS.		IN W.G.				
DX COOLING DATA (PERFORMANCE CHARACTERISTICS)	TOTAL		BTU/HR	12,000			
	SENS.		BTU/HR				
	ENTERING AIR TEMP.	DEG. F	DB				
		DEG. F	WB				
	COND. TEMP.		DEG. F				
DX HEATING DATA (PERFORMANCE CHARACTERISTICS)	TOTAL		BTU/HR	10,000			
	ENTERING AIR TEMP.	DEG. F	DB				
	COND. TEMP.		DEG. F	47			
ELECTRIC HEATING DATA (PERFORMANCE CHARACTERISTICS)	kW						
	STEPS						
	VOLT						
	PH						
FAN MOTOR DATA (PERFORMANCE CHARACTERISTICS)	FLA						
	VOLT						
	PH						
ELECTRICAL DATA (PERFORMANCE CHARACTERISTICS)	# CONN.						
	MCA			3			
	FUSE						
	VOLT			208			
	PH			1			
	FACTORY INSTALLED DISCONNECT?						
DIMENSIONS (PHYSICAL CHARACTERISTICS)	WIDTH		INCHES	22.44			
	DEPTH		INCHES	22.44			
	HEIGHT		INCHES	10.24			
	MAXIMUM WEIGHT		LBS	35.27			
MANUFACTURER				CARRIER			
MODEL NO.				45MBCAQ12--3			
APPLICABLE REMARKS:				OR EQUAL			

REMARKS:

A: ELECTRONIC PROGRAMMABLE THERMOSTAT
B: OUTSIDE AIR DUCT CONNECTION
C: WALL MOUNT THERMOSTAT MOUNTING KIT
D: INTERNAL CONDENSATE PUMP
E: SUPPLY AIR GRILLE GUARD

SPLIT SYSTEM DX OUTDOOR UNITS

SYMBOL			HP-01			
SERVING			CANYON MECHANICAL BUILDING			
DX COOLING DATA (PERFORMANCE CHARACTERISTICS)	CAPACITY	BTU/HR	9,000			
	AMBIENT TEMP.	DEG. F				
	SEER	@ AHRI	21.7			
DX HEATING DATA (PERFORMANCE CHARACTERISTICS)	CAPACITY	BTU/HR	10,000			
	COND. TEMP.	DEG. F				
	COP	@ AHRI	4			
OUTDOOR FAN DATA (PERFORMANCE CHARACTERISTICS)	NO.		1			
	H.P. (EA.)					
	VOLT		208			
	PH		1			
	CFM (TOTAL)		1236			
COMPRESSOR DATA (PERFORMANCE CHARACTERISTICS)	NO.		1			
	STEPS					
	RLA (EA.)		0.62			
	LRA (EA.)					
	VOLT		208			
	PH		1			
ELECTRICAL DATA (PERFORMANCE CHARACTERISTICS)	# CONN.					
	MCA		12			
	MOCP (FUSE)		15			
	VOLT		208			
	PH		1			
DIMENSIONS (PHYSICAL CHARACTERISTICS)	LENGTH	INCHES	11.93			
	WIDTH	INCHES	30.12			
	HEIGHT	INCHES	21.85			
	MAXIMUM WEIGHT	LBS	62.17			
MANUFACTURER			CARRIER			
MODEL NO.			37MARBQ09AA3			
APPLICABLE REMARKS:			OR EQUAL			

REMARKS:

A: CRANKCASE HEATER
B: CONDENSER HAIL GUARDS
C: 5-YEAR COMPRESSOR WARRANTY FOR EACH COMPRESSOR
D: DIP APPLIED ANTI-CORROSION COATING ON CONDENSER COIL (NOT SPRAY APPLIED)
E: COPPER CONDENSER COIL FINS
F: FACTORY INSTALLED UNLOADER ACCESSORY
G: HOT GAS BYPASS ON LEAD COMPRESSOR
H: HOT GAS BYPASS ON BOTH COMPRESSORS
I: FACTORY INSTALLED ACCUMULATOR
J: LOW-AMBIENT COOLING KIT
K: WALL-MOUNT KIT
L: COMPRESSOR START ASSIST
M: CABINET CORROSION PROTECTION
N: COMPRESSOR CYCLE DELAY
O: HOT-GAS REHEAT
P: LIQUID LINE FILTER DRIER
Q: LIQUID SOLENOID VALVE

SECTION 23 82 00
TERMINAL HEATING AND COOLING UNITS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Air Moving and Conditioning Association (AMCA): 300, Reverberant Room Method for Sound Testing of Fans
2. American Gas Association (AGA).
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE): 90.1 IP/SI, Energy Standard for Buildings, Except Low-Rise Residential Buildings.
4. ASTM International (ASTM):
   a. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   b. B117, Standard Practice for Operating Salt Spray (Fog) Apparatus.
5. Canadian Gas Association (CGA).
6. Electrical Test Laboratories (ETL).
7. National Electrical Manufacturer’s Association (NEMA).
8. National Fire Protection Association (NFPA):
   a. 54, National Fuel Gas Code.
   b. 70, National Electrical Code (NEC).
   c. 90A, Standard for the Installation of Air-Conditioning and Ventilating Systems.
9. Sheet Metal and Air Conditioning Contractors’ National Assoc., Inc. (SMACNA): Ducted Electric Heat Guide for Air Handling Systems.
10. UL: Product Directories.

1.02 DEFINITIONS

A. The following is a list of abbreviations which may be used in this section:

1. AC: Alternating Current.
2. CISD: Chemical Industry, Severe-Duty.
3. dB: Decibel.
4. DWDI: Double Width, Double Inlet.
5. FRP: Fiberglass Reinforced Plastic.
6. hp: Horsepower.
7. ODP: Open Drip Proof.
8. PSC: Permanent Split Capacitor.
9. SWSI: Single Width, Single Inlet.
10. TEFC: Totally Enclosed, Fan Cooled.

11. UV: Ultraviolet.
12. XP: Explosion Proof.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Anchorage and bracing drawings and data sheets, as required by Section 01 88 15, Anchorage and Bracing.
2. Complete specifications, descriptive drawings, catalog cuts, and descriptive literature which shall include make, model, dimensions, weight of equipment, and electrical schematics for products specified.
3. Manufacturer's standard finish color selection for cabinet finishes.
4. Performance data, including sound power level data (reference 10 to minus 12 power watts) at design operating point, shall be based on AMCA 300.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Detailed information on structural, mechanical, electrical, or other modifications necessary to adapt the arrangement or details shown to the equipment furnished.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data. Include as-built version of equipment schedules.

1.04 QUALITY ASSURANCE

A. Heating Equipment: Minimum operating efficiencies, specified in ASHRAE 90.1 IP.

PART 2 PRODUCTS

2.01 EQUIPMENT

A. Equipment Schedules: Refer to Article Supplement.

2.02 UNIT HEATER, ELECTRIC, SUSPENDED

A. Manufacturers and Products:

1. Qmark; Type MUH.
2. Or equal.

B. Physical Characteristics:

1. Factory assembled including casing, heater elements, fan wheel, drive assembly, motor, controls and accessories.
2. UL listed.
3. Meet requirements of National Electrical Code.
4. Three phase heaters shall have balanced phases.
5. Casing:
   a. Heavy gauge steel casing.
   b. Baked enamel finish.
   c. Individual adjustable discharge louvers.
   d. Protective air inlet louvers or fan guards.
6. Heating elements shall be one of the following types:
   a. Aluminum finned, copper clad, steel sheath.
   b. High mass, all steel tubular finned type, copper brazed, in fixed element banks.
   c. Nickel-chromium wire elements enclosed in powder filled aluminum coated steel tubes with permanently fused fins.
   d. Steel tubes with nickel chromium resistance wire embedded in a dielectric with steel fins crimped and brazed to the tube.
   e. Corrosion-resistant steel fins brazed to tubular heating elements.
7. Fan and Motor:
   a. Totally enclosed motor.
   b. Direct drive fan.
   c. Sealed bearings. Permanently lubricated.
8. Controls:
   a. Thermal overload protection with automatic reset.
   b. Controls, transformers, and contactors shall be factory assembled, except wall mounted thermostats when indicated.
9. Accessories and Features:
   a. Airflow discharge shall be horizontal.
   b. Electrical Disconnect: NEMA 4.
   c. Voltage: As scheduled.
   d. Wall mounting bracket.
   e. Fan delay feature that starts fan after element warmup and stops fan after element cool down.
10. Thermostat: Adjustable, unit mounted, low voltage with a minimum temperature range of 40 degrees F to 85 degrees F.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.03 ELECTRICAL

A. General:

1. Units shall include high and low voltage terminal block connections.
2. Control voltage to indoor unit fan shall be 24 volts.
3. Motor Starters/Contactors: Factory installed with unitary equipment, unless otherwise noted.
4. Disconnects: Factory installed nonfused disconnects or circuit breakers on each unit, unless otherwise noted.

B. Motors:

1. Physical Characteristics: None.
2. Functional Characteristics:
   a. Refer to Section 26 20 00, Low-Voltage AC Induction Motors, for general requirements.
   b. Unless otherwise stated, electric motors shall comply with the following:
      1) Voltage, Phase, Horsepower, Synchronous Speed: Refer to Equipment Schedule for motor driven equipment.
      2) Enclosure: ODP, unless specified otherwise.
      3) Torque Characteristics: Sufficient to accelerate driven loads satisfactorily.
      4) Winding Thermal Protection: Manufacturer’s standard.
      5) Space Heater: Manufacturer’s standard.
      6) Multispeed Motors, Synchronous Speed, Number of Windings: Manufacturer’s standard.
      7) Efficiency: Minimum efficiency per Section 26 20 00, Low-Voltage AC Induction Motors.
3. Performance Characteristics: None.

2.04 ACCESSORIES

A. Physical Characteristics:

1. Equipment Identification Plates: Furnish 16-gauge Type 316 stainless steel identification plate securely mounted on each separate equipment component and control panel in a readily visible location. Plate shall bear 1/4-inch high engraved block type black enamel filled equipment identification number and letters indicated in this specification and as shown.
2. Lifting Lugs: Furnish suitably attached for equipment assemblies and components weighing over 100 pounds.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.05 SOURCE QUALITY CONTROL

A. Functional Test:

1. Perform manufacturer's standard factory test on equipment.
2. Test equipment actually furnished.
3. Motor Test: See Section 26 20 00, Low-Voltage AC Induction Motors.
4. Equipment with Electric Resistance Heating Coils: Test with 2,000-volt dielectric test.

PART 3 EXECUTION

3.01 INSTALLATION

A. General: Install in strict compliance with manufacturer's instructions. Maintain clearances around unit as listed in manufacturer's recommendations.

B. Electric Unit Heaters, All Types:

1. Bottom of unit shall be a minimum of 7 feet above finish floor, unless indicated otherwise.
2. Heater shall be permanently mounted in position indicated with a fixed power supply.
3. Install so obstructions do not block heater air inlet or outlet.

3.02 SUPPLEMENT

A. The supplement listed below, following "End of Section," is a part of this specification:

1. Unit Heaters Schedule.

END OF SECTION

UNIT HEATERS

SYMBOL				UH-01			
LOCATION				CANYON MECHANICAL BUILDING			
TYPE				ELECTRIC, SUSPENDED			
AIR SIDE DATA (PERFORMANCE CHARACTERISTICS)	SUPPLY AIRFLOW	CFM		350			
	THROW	FEET		12			
	MOTOR	RPM		1600			
		POWER	kW	2.2			
		VOLT		208			
		PH		1			
	EAT	DEG F					
	LAT	DEG F					
ELECTRIC HEAT DATA (PERFORMANCE CHARACTERISTICS)	CAPACITY	kW		2.2			
	NUMBER OF STEPS						
	VOLT			208			
	PH			1			
HOT WATER HEATING COIL DATA (PERFORMANCE CHARACTERISTICS)	CAPACITY	MBH					
	FLOW	GPM					
	VALVE	CV					
		SIZE					
	EWT	DEG F					
	LWT	DEG F					
	DELTA P	FT H2O					
GAS TRAIN DATA (PERFORMANCE CHARACTERISTICS)	FUEL TYPE						
	GAS INPUT		MBH				
	GAS OUTPUT		MBH				
	SUPPLY PRESSURE	MIN	IN W.G.				
		MAX	IN W.G.				
UNIT ELECTRICAL DATA (PERFORMANCE CHARACTERISTICS)	MCA						
	MOCP						
	VOLT						
	PH						
MOUNTING HEIGHT	MINIMUM	FEET		7			
MAXIMUM DIMENSIONS (PHYSICAL CHARACTERISTICS)	LENGTH		INCHES	7.5"			
	WIDTH		INCHES	14"			
	HEIGHT		INCHES	16			
	WEIGHT		LBS	27			
MANUFACTURER				QMARK			
MODEL NO.				MUH03-21			
APPLICABLE REMARKS:				OR EQUAL			

ABBREVIATIONS:

NG: NATURAL GAS

PG: PROPANE GAS

NG/PG: DUAL FUEL, NATURAL AND PROPANE GAS

REMARKS:

A:
B:
C:
D:
E:
F:
G:
H:
I:
J:

©COPYRIGHT 2025 JACOBS

SECTION 26 05 02
BASIC ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. Requirements specified within this section apply to Division 26, Electrical. Work specified herein shall be performed as if specified in the individual sections.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Contractors Association (NECA): National Electrical Installation Standards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. Z535.4, Product Safety Signs and Labels.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.03 DESIGN REQUIREMENTS

A. Provide anchorage and bracing design drawings, calculations, and related information where required under Section 01 88 15, Anchorage and Bracing.

B. Provide seismic certification per requirements of Section 01 45 33, Special Inspection, Observation, and Testing, where required in that section for electrical equipment listed.

1.04 ELECTRIC SERVICE DIVISION OF RESPONSIBILITY

A. Incoming underground electrical service facilities provided by the serving utility as part of its normal obligation to customers is work provided outside this Contract. Under this Contract, provide customer required service provisions and electrical work including, but not limited to, metering components and associated conduit. Schedule and coordinate work of serving utility as required to provide electric service to the Work.

1.05 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' product data for the following:
   a. Electrical service components.
   b. Nameplates, signs, and labels.
2. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Anchorage and bracing calculations, as required by Section 01 88 15, Anchorage and Bracing.

1.06 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70. Where required by Authority Having Jurisdiction (AHJ), material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ, in order to provide a basis for approval under the NEC.

B. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark or label.

C. Provide materials and equipment acceptable to AHJ for Class, Division, and Group of hazardous area indicated.

1.07 ENVIRONMENTAL CONDITIONS

A. The following areas are classified hazardous Class I, Division 1, Group D, because of the potential for occurrence of hazardous concentrations of combustible gases, and for exposure to corrosive environment. Use materials and methods required for such areas.

1. Inside wet well containing wastewater. Refer to the Drawings for specific locations.

B. The following areas are classified hazardous, Class I, Division 2, Group D, because of the potential for accumulation of hazardous concentrations of combustible gases, and for exposure to corrosive environment. Use materials and methods required for such areas.

1. Enclosed, belowgrade valve and metering vaults with closed piping systems containing wastewater. Refer to the Drawings for specific locations.

C. The following areas are classified nonhazardous and wet. Use materials and methods required for such areas.

1. Outdoor abovegrade areas not covered above.
2. Belowgrade vaults.
3. Main Lift Station Pump Room.

D. The following areas are classified as indoor and dry:

1. Indoor, finished areas with environmental conditioning.

E. The following areas are not classified. Use dust-tight and oil-tight NEMA 12 materials and methods.

1. Canyon Mechanical Building.
2. Juniper Campground Comfort Stations Mechanical/Utility Rooms.
3. Juniper Campground Amphitheater Building.
4. Areas not covered above.

PART 2 PRODUCTS

2.01 GENERAL

A. Where two or more units of the same class of material or equipment are required, provide products of a single manufacturer. Component parts of materials or equipment need not be products of the same manufacturer.

B. Material and equipment installed in heated and ventilated areas shall be capable of continuous operation at their specified ratings within an ambient temperature range of 40 degrees F to 104 degrees F.

C. Materials and equipment installed outdoors shall be capable of continuous operation at their specified rating within the ambient temperature range of 0 degree F to 95 degrees F.

D. Electrical ratings of materials and equipment that are reduced by increased elevation shall be derated as required for maximum site elevation of 7,000 feet above mean sea level unless noted otherwise.

E. Equipment Finish: Manufacturer’s standard finish color, except where specific color is indicated.

2.02 NAMEPLATES

A. Physical Characteristics:

1. Material: Laminated plastic.
2. Color: White, engraved to a black core.

3. Letter Height, unless shown otherwise:
   a. Pushbuttons/Selector Switches: 1/8 inch.
   b. Other Electrical Equipment: 1/4 inch.

B. Functional Characteristics:

1. Means of Attachment:
   a. Screws: Stainless steel.
   b. Adhesive: Single-part, room temperature vulcanizing adhesive suitable for the environment and materials installed. Use adhesive on NEMA 4 or NEMA 4X enclosures only.

C. Performance Characteristics: None.

2.03 SIGNS AND LABELS

A. Physical Characteristics: Sign size, lettering, and color shall be in accordance with NEMA Z535.4.

B. Functional Characteristics: None.

C. Performance Characteristics: Signs and labels shall be suitable for use in the installation location and environment.

PART 3 EXECUTION

3.01 GENERAL

A. Electrical Drawings show general locations of equipment, devices, and raceway, unless specifically dimensioned. Contractor shall be responsible for actual location of equipment and devices and for proper routing and support of raceways, subject to approval of Contracting Officer.

B. Check approximate locations of light fixtures, switches, electrical outlets, equipment, and other electrical system components shown on the Drawings for conflicts with openings, structural members, and components of other systems and equipment having fixed locations. In the event of conflicts, notify Contracting Officer in writing.

C. Install work in accordance with NECA Standard of Installation, unless otherwise specified.

D. Keep openings in boxes and equipment closed during construction.

E. Lay out work carefully in advance. Do not cut or notch any structural member or building surface without specific approval of Contracting Officer. Carefully perform cutting, channeling, chasing, or drilling of floors, walls, partitions, ceilings, paving, or other surfaces required for the installation, support, or

anchorage of conduit, raceways, or other electrical materials and equipment. Following such work, restore surfaces to original condition.

3.02 ANCHORING, BRACING, AND MOUNTING

A. Equipment anchoring and mounting shall be in accordance with manufacturer's requirements to meet the requirements of Section 01 88 15, Anchorage and Bracing.

3.03 COMBINING CIRCUITS INTO COMMON RACEWAY

A. Homerun circuits shown on the Drawings indicate functional wiring requirements for power and control circuits. Circuits may be combined into common raceways in accordance with the following requirements:

1. Analog control circuits from devices in same general area to same destination.
   a. No power or ac discrete control circuits shall be combined in same conduit with analog circuits.
   b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, paging system circuits shall be combined with power or Class 1 circuits.
   c. Analog circuits shall be continuous from source to destination. Do not add TJB, splice, or combine into a multi-pair cable without authorization of Contracting Officer.
   d. Raceways shall be sized to not exceed 40 percent fill.
   e. Changes shall be documented on Record Drawings.
2. Discrete control circuits from devices in the same general area to the same destination.
   a. No power or analog control circuits shall be combined in same conduit with discrete circuits.
   b. No Class 2 or Class 3 circuits including, but not limited to, HVAC control circuits, fire alarm circuits, and paging system circuits shall be combined with power or Class 1 circuits.
   c. Raceways shall be sized to not exceed 40 percent fill.
   d. Changes shall be documented on Record Drawings.
3. Power circuits from loads in same general area to same source location (such as: panelboard, switchboard, low voltage motor control center).
   a. Lighting Circuits: Combine no more than three single-phase circuits to a single raceway. Contractor shall be responsible for increasing conduit and conductor size if derating is required by NEC.
   b. Receptacle Circuits, 120 Volt Only: Combine no more than three single-phase circuits to a single raceway. Provide a separate neutral conductor for each circuit. Contractor shall be responsible

for increasing conduit and conductor size if derating is required by NEC.

c. All Other Power Circuits: Do not combine power circuits without authorization of Contracting Officer.

3.04 NAMEPLATES, SIGNS, AND LABELS

A. Arc Flash Protection Warning Signs:

1. Field mark pad-mounted switchgear, panelboards, and motor starters to warn qualified persons of potential arc-flash hazards. Locate marking so to be clearly visible to persons before working on energized equipment.
2. Use arc flash hazard boundary, energy level, PPE level and description, shock hazard, bolted fault current, and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for warning signs.

B. Available Fault Current Signs:

1. Install label on service equipment to indicate the maximum available fault current at the equipment. Labels shall be of sufficient durability for the environment in which the equipment is installed. Labels shall include the following information:
   a. Equipment name or identification.
   b. Available fault current at the equipment.
   c. Date the fault current calculations were performed.
2. Use bolted fault current and equipment name from study required in Section 26 05 70, Electrical Systems Analysis, as basis for the label.
3. Where existing electrical systems are modified, completely remove existing fault current labels if present, and install new labels in accordance with the above requirements.

C. Equipment Nameplates:

1. Provide a nameplate to label electrical equipment including pad-mounted switchgear, panelboards, motor starters, transformers, disconnect switches, and control stations.
2. Switchgear, transformer, and terminal junction box nameplates shall include equipment designation.
3. Disconnect switch, starter, and control station nameplates shall include name and number of equipment powered or controlled by that device.
4. Switchboard and panelboard nameplates shall include equipment designation, service voltage, and phases.

3.05 LOAD BALANCE

A. The Drawings and Specifications indicate circuiting to electrical loads and distribution equipment.

B. Balance electrical load between phases as nearly as possible on switchboards, panelboards, motor control centers, and other equipment where balancing is required.

C. When loads must be reconnected to different circuits to balance phase loads, maintain accurate record of changes made, and provide circuit directory that lists final circuit arrangement.

3.06 CLEANING AND TOUCHUP PAINTING

A. Cleaning: Throughout the Work, clean interior and exterior of devices and equipment by removing debris and vacuuming.

B. Touchup Paint:

1. Touchup scratches, scrapes and chips on exterior and interior surfaces of devices and equipment with finish matching type, color, and consistency and type of surface of original finish.
2. If extensive damage is done to equipment paint surfaces, refinish entire equipment in a manner that provides a finish equal to or better than factory finish, that meets requirements of the Specifications, and is acceptable to Contracting Officer.

3.07 PROTECTION FOLLOWING INSTALLATION

A. Protect materials and equipment from corrosion, physical damage, and effects of moisture on insulation and contact surfaces.

B. When equipment intended for indoor installation is installed at Contractor’s convenience in areas where subject to dampness, moisture, dirt or other adverse atmosphere until completion of construction, ensure adequate protection from these atmospheres is provided and acceptable to Contracting Officer.

END OF SECTION

SECTION 26 05 04
BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A1011/A1011M, Standard Specification for Steel, Sheet, and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low Alloy and High-Strength Low Alloy Formability.
   b. E662, Standard Testing Method for Specific Optical Density of Smoke Generated by Solid Materials.
   c. E814, Method of Fire Tests of Through-Penetration Fire Stops.
2. Canadian Standards Association (CSA).
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE): 18, Standard for Shunt Power Capacitors.
4. International Society of Automation (ISA): RP12.06.01, Wiring Practices for Hazardous (Classified) Locations Instrumentation–Part 1: Intrinsic Safety.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C12.1, Code for Electricity Metering.
   c. C12.6, Phase-Shifting Devices Used in Metering, Marking and Arrangement of Terminals.
   d. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.
   e. ICS 5, Industrial Control and Systems: Control Circuit and Pilot Devices.
   f. KS 1, Enclosed and Miscellaneous Distribution Switches (600 Volts Maximum).
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 94, Standard for Safety for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 248, Standard for Low Voltage Fuses.
   d. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   e. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.

f. 508, Standard for Industrial Control Equipment.
g. 810, Standard for Capacitors.
h. 943, Standard for Ground-Fault Circuit-Interrupters.
i. 1059, Standard for Terminal Blocks.
j. 1479, Fire Tests of Through-Penetration Fire Stops.

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' product data for the following:
   a. Control devices.
   b. Control relays.
   c. Circuit breakers.
   d. Fused switches.
   e. Nonfused switches.
   f. Fuses.
   g. Magnetic contactors.
   h. Intrinsic safety barriers.
   i. Enclosures: Include enclosure data for products having enclosures.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

1. Fuses, 0 Volt to 600 Volts: Six of each type and each current rating installed.

PART 2 PRODUCTS

2.01 MOLDED CASE CIRCUIT BREAKER THERMAL MAGNETIC, LOW VOLTAGE

A. Physical Characteristics:

1. Type: Molded case.
2. Suitable for mounting and operating in any position.
3. Accessories: Shunt trip, auxiliary switches, handle lock ON devices, mechanical interlocks, key interlocks, unit mounting bases, double lugs

as shown or otherwise required. Shunt trip operators shall be continuous duty rated or have coil-clearing contacts.

4. Connections:
   a. Supply (line side) at either end.
      1) Mechanical wire lugs.
      2) Lugs removable/replaceable for breaker frames greater than 100 amperes.
      3) Suitable for 75 degrees C rated conductors without derating breaker or conductor ampacity.
      4) Use bolted bus connections, except where bolt-on is not compatible with existing breaker provisions.
5. Enclosures for Independent Mounting: See Article Enclosures.
6. Operating Mechanism:
   a. Overcenter, trip-free, toggle type handle.
   b. Quick-make, quick-break action.
   c. Locking provisions for padlocking breaker in OPEN position.
   d. ON/OFF and TRIPPED indicating positions of operating handle.
   e. Operating handle to assume a CENTER position when tripped.
7. Trip Mechanism:
   a. Individual permanent thermal and magnetic trip elements in each pole.
   b. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
   c. Two and three pole, common trip.
   d. Automatically opens all poles when overcurrent occurs on one pole.
   e. Test button on cover.
   f. Do not provide single-pole circuit breakers with handle ties where multi-pole circuit breakers are shown.

B. Functional Characteristics:

1. UL 489.
2. Trip Ratings: 15 amps to 800 amps.
3. Voltage Ratings: 120, 240, 277, 480, and 600V ac.
4. Service Entrance Use: UL Labeled for service entrance where shown or required by Code.
5. Circuit Breakers with 400A Frame or Greater: Provide solid state trip unit with adjustable settings for long-time delay, short-time trip and delay, instantaneous trip and ground fault trip and delay, or as shown on the Drawings.
6. Short Circuit Interrupting Ratings:
   a. Equal to, or greater than, available fault current or interrupting rating shown.
   b. Equal to rating of existing equipment.

c. Series Connected Ratings: Do not apply series connected short circuit ratings.

7. Interlock: Enclosure and switch shall interlock to prevent opening cover with switch in the ON position. Provide bypass feature for use by qualified personnel.
8. GFCI and EGFI breakers shall have push-to-test button.

C. Performance Characteristics:

1. Trip mechanisms calibrated for 40 degrees C ambient.
2. Ground Fault Circuit Interrupter (GFCI): Where indicated, equip breaker as specified above with ground fault sensor and rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel). Ground fault sensor shall be rated same as circuit breaker.
3. Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker specified above with ground fault sensor and rated to trip on 30-mA ground fault (UL-listed for equipment ground fault protection).
4. Magnetic Only Type Breakers: Where shown; instantaneous trip adjustment which simultaneously sets magnetic trip level of each individual pole continuously through a 3X to 10X trip range.

2.02 FUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. Physical Characteristics:

1. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
2. Connections:
   a. Mechanical lugs, except crimp compression lugs where shown.
   b. Lugs removable/replaceable.
   c. Suitable for 75 degrees C rated conductors at NEC 75 degrees C ampacity.
3. Fuse Provisions:
   a. 30-amp to 600-amp rated shall incorporate rejection feature to reject all fuses except Class R.
   b. 601-amp rated and greater shall accept Class L fuses, unless otherwise shown.
4. Enclosures: See Article Enclosures.

B. Functional Characteristics:

1. UL 98 listed for use and location of installation.
2. NEMA KS 1.
3. Short Circuit Rating: 200,000 amps rms symmetrical with Class R, Class J, or Class L fuses installed.

4. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

C. Performance Characteristics: None.

2.03 NONFUSED SWITCH, INDIVIDUAL, LOW VOLTAGE

A. Physical Characteristics:

1. Quick-make, quick-break, motor rated, load-break, heavy-duty (HD) type with external markings clearly indicating ON/OFF positions.
2. Enclosures: See Article Enclosures.

B. Functional Characteristics:

1. NEMA KS 1.
2. Lugs: Suitable for use with 75 degrees C wire at NEC 75 degrees C ampacity.
3. Interlock: Enclosure and switch to prevent opening cover with switch in ON position. Provide bypass feature for use by qualified personnel.

C. Performance Characteristics: None.

2.04 FUSE, 250-VOLT AND 600-VOLT

A. Power Distribution, General:

1. Physical Characteristics: Provide to fit mountings specified with switches.
2. Functional Characteristics:
   a. Current-limiting, with 200,000 ampere rms interrupting rating.
   b. UL 248.
3. Performance Characteristics: None.

B. Power Distribution, Ampere Ratings 1 Amp to 600 Amps:

1. Physical Characteristics: Dual element, with time delay.
2. Functional Characteristics: None.
3. Performance Characteristics: RK-1 Class.

C. Power Distribution, Ampere Ratings 601 Amps to 6,000 Amps:

1. Physical Characteristics: Double O-rings and silver links.
2. Functional Characteristics: None.
3. Performance Characteristics: L Class.

D. Cable Limiters:

1. Physical Characteristics:
   a. Crimp connection to copper conductors.
   b. Bolt connection to bus and terminal pads.
2. Functional Characteristics: 600V.
3. Performance Characteristics: None.

E. Ferrule:

1. Physical Characteristics:
   a. Dual-element time-delay, time-delay, or nontime-delay as required.
   b. Provide with blocks or holders as indicated and suitable for location and use.
2. Functional Characteristics:
   a. 600V or less, rated for applied voltage, small dimension.
   b. Ampere Ratings: 1/10 amp to 30 amps.
3. Performance Characteristics: None.

2.05 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Physical Characteristics:

1. Selector Switch Operating Lever: Standard.
2. Indicating Light:
   a. Push-to-Test LED, full voltage.
   b. Colors:
      1) OFF: Green.
      2) ON or RUNNING: Red.
      3) ALARM, FAIL, SHUTDOWN, etc.: Amber or Yellow.
      4) POWER ON: White.
3. Pushbutton:
   a. Pushbutton and selector switch lockable in OFF position where indicated.
   b. Colors:
      1) ON or START: Black.
      2) OFF or STOP: Red.
4. Legend Plate:
   a. Material: Aluminum.
   b. Engraving: Enamel filled in high contrasting color.
   c. Text Arrangement: 11-character/spaces on one line, 14-character/spaces on each of two lines, as required, indicating specific function.
   d. Letter Height: 7/64 inch.

B. Functional Characteristics:

1. Contact Rating: 7,200VA make, 720VA break, at 600V, NEMA ICS 5 Designation A600.

C. Performance Characteristics: None.

2.06 TERMINAL BLOCK, 600 VOLTS

A. Physical Characteristics:

1. Size components to allow insertion of necessary wire sizes.
2. Capable of termination of control circuits entering or leaving equipment, panels, or boxes.
3. Screw clamp compression, dead front barrier type, with current bar providing direct contact with wire between compression screw and yoke.
4. Yoke, current bar, and clamping screw of high strength and high conductivity metal.
5. Yoke shall guide all strands of wire into terminal.
6. Current bar shall ensure vibration-proof connection.
7. Terminals:
   a. Capable of wire connections without special preparation other than stripping.
   b. Capable of jumper installation with no loss of terminal or rail space.
   c. Individual, rail mounted.
8. Marking system, allowing use of preprinted or field-marked tags.

B. Functional Characteristics: UL 486E and UL 1059.

C. Performance Characteristics: None.

2.07 MAGNETIC CONTROL RELAY

A. Physical Characteristics:

1. Latching Attachment: Mechanical latch, having unlatching coil and coil clearing contacts.

B. Functional Characteristics:

1. NEMA ICS 2, Designation: A600 (600 volts).
2. Industrial control with field convertible contacts rated 10 amps continuous, 7,200VA make, 720VA break.

C. Performance Characteristics: None.

2.08 SUPPORT AND FRAMING CHANNELS

A. Carbon Steel Framing Channel:

1. Physical Characteristics:
   a. Material: Rolled, mild strip steel, 12-gauge minimum.
   b. Finish: Hot-dip galvanized after fabrication.
2. Functional Characteristics: ASTM A1011/A1011M, Grade 33
3. Performance Characteristics: None.

B. Stainless Steel Framing Channel:

1. Physical Characteristics: Rolled, Type 316 stainless steel, 12-gauge minimum.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.09 INTRINSIC SAFETY BARRIER

A. Physical Characteristics: Mounting: Rail or surface.

B. Functional Characteristics:

1. Rating: Power source shall be rated 24V dc, nominal, with not more than 250 volts available under fault conditions.
2. Contact Rating: 5 amps, 250V ac.

C. Performance Characteristics: Provides a safe energy level for exposed wiring in a Class I, Division 1 or Division 2 hazardous area when circuit is connected to power source in nonhazardous area.

2.10 ENCLOSURES

A. Physical Characteristics:

1. Finish: Sheet metal structural and enclosure parts shall be completely painted using an electrodeposition process so interior and exterior surfaces as well as bolted structural joints have a complete finish coat on and between them.
2. Color: Manufacturer’s standard color (gray) baked-on enamel, unless otherwise shown.
3. Barriers: Provide metal barriers within enclosures to separate wiring of different systems and voltage.

B. Functional Characteristics:

1. Enclosure Selections:

a. Except as shown otherwise, provide electrical enclosures according to the following table:

Enclosures			
Location	**Finish**	**Environment**	**NEMA 250 Type**
Indoor	Finished	Dry	1
Indoor	Unfinished	Dry	1
Indoor	Unfinished	Industrial Use	12
Indoor and Outdoor	Any	Wet	4
Indoor and Outdoor	Any	Denoted “WP”	3R
Indoor and Outdoor	Any	Wet and Corrosive	4X 316 Stainless Steel
Indoor and Outdoor	Any	Wet, Dust or Oil	13
Indoor and Outdoor	Any	Hazardous Gas	7
Indoor and Outdoor	Any	Hazardous Dust	9

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

A. Install equipment in accordance with manufacturer’s recommendations.

3.02 PUSHBUTTON, INDICATING LIGHT, AND SELECTOR SWITCH

A. Install heavy-duty, oil-tight type in nonhazardous, indoor, dry locations, including motor control centers, control panels, and individual stations, unless otherwise shown.

B. Install heavy-duty, watertight and corrosion-resistant type in nonhazardous, outdoor, or normally wet areas, unless otherwise shown.

3.03 SUPPORT AND FRAMING CHANNEL

A. Install where required for mounting and supporting electrical equipment, raceway, and cable tray systems.

B. Channel Type:

1. Interior, Wet or Dry (Noncorrosive) Locations: Carbon steel.
2. Interior, Corrosive (Wet or Dry) Locations: Stainless steel.
3. Outdoor, Noncorrosive Locations: Carbon steel or stainless steel.
4. Outdoor Corrosive Locations: Stainless steel.

C. Paint carbon steel channel cut ends prior to installation with zinc-rich primer.

3.04 INTRINSIC SAFETY BARRIERS

A. Install in compliance with ISA RP12.06.01.

B. Arrange conductors such that wiring from hazardous areas cannot short to wiring from nonhazardous area.

C. Stencil “INTRINSICALLY SAFE CIRCUIT” on all boxes enclosing barriers.

END OF SECTION

SECTION 26 05 05
CONDUCTORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Association of Edison Illuminating Companies (AEIC): CS 8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 kV through 46 kV.
2. ASTM International (ASTM):
   a. B3, Standard Specification for Soft or Annealed Copper Wire.
   b. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   c. B496, Standard Specification for Compact Round Concentric-Lay-Stranded Copper Conductors.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV Through 500 kV.
   b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500000 V.
4. Insulated Cable Engineer’s Association, Inc. (ICEA):
   a. S-58-679, Standard for Control Cable Conductor Identification.
   b. S-73-532, Standard for Control Thermocouple Extensions and Instrumentation Cables.
   c. T-29-520, Conducting Vertical Cable Tray Flame Tests with Theoretical Heat Input of 210,000 Btu/hour.
5. National Electrical Manufacturers’ Association (NEMA):
   a. CC 1, Electric Power Connectors for Substations.
   b. WC 57, Standard for Control, Thermocouple Extension, and Instrumentation Cables.
   c. WC 70, Standard for Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   d. WC 71, Standard for Nonshielded Cables Rated 2001-5000 Volts for Use in the Distribution of Electric Energy.
   e. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.

6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
7. Telecommunications Industry Association (TIA): TIA-568-C, Commercial Building Telecommunications Cabling Standard.
8. UL:
   a. 13, Standard for Safety for Power-Limited Circuit Cables.
   b. 44, Standard for Safety for Thermoset-Insulated Wires and Cables.
   c. 62, Standard for Safety for Flexible Cord and Cables.
   d. 486A-486B, Standard for Safety for Wire Connectors.
   e. 486C, Standard for Safety for Splicing Wire Connectors.
   f. 510, Standard for Safety for Polyvinyl Chloride, Polyethylene, and Rubber Insulating Tape.
   g. 854, Standard for Safety for Service-Entrance Cables.
   h. 1072, Standard for Safety for Medium-Voltage Power Cables.
   i. 1277, Standard for Safety for Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
   j. 1569, Standard for Safety for Metal-Clad Cables.
   k. 1581, Standard for Safety for Reference Standard for Electrical Wires, Cables, and Flexible Cords.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' Product Data:
   a. Wire and cable.
   b. Wire and cable accessories.
2. Cable Pulling Calculations:
   a. Ensure submitted and reviewed before cable installation.
   b. Provide for the following cable installations:
      1) Medium voltage cable runs that cannot be hand pulled.
      2) Multiconductor 600-volt cable sizes larger than 2 AWG that cannot be hand pulled.

B. Informational Submittals: Journeyman lineman or electrician splicing credentials.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70. Where required by the AHJ, material and equipment shall be labeled or listed by a nationally

recognized testing laboratory or other organization acceptable to the AHJ in order to provide a basis for approval under NEC.

2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

B. Terminations and Splices for Conductors above 600 Volts: Work shall be done by journeyman lineman with splicing credentials or electrician certified to use materials approved for cable splices and terminations.

PART 2 PRODUCTS

2.01 CONDUCTORS 600 VOLTS AND BELOW

A. General Requirements:

1. Physical Characteristics:
   a. Conductor Type:
      1) 120-Volt and 277-Volt Lighting, 10 AWG and Smaller: Solid copper.
      2) 120-Volt Receptacle Circuits, 10 AWG and Smaller: Solid copper.
      3) All Other Circuits: Stranded copper.
   b. Insulation:
      1) Power Conductors: Type THHN/THWN-2.
      2) Control Conductors: Type THHN/THWN-2.
2. Functional Characteristics: Conform to applicable requirements of NEMA WC 70.
3. Performance Characteristics: None.

B. Flexible Cords and Cables:

1. Physical Characteristics: Type SOOW with ethylene propylene rubber insulation.
2. Functional Characteristics: In accordance with UL 62.
3. Performance Characteristics: Suitable for extra-hard industrial uses.

2.02 600-VOLT RATED CABLE

A. General Requirements:

1. Physical Characteristics:
   a. Type TC.
   b. Overall Outer Jacket: PVC, flame-retardant, sunlight-resistant and oil-resistant.

c. Permanently and legibly marked with manufacturer's name, maximum working voltage for which cable was tested, type of cable, and UL listing mark.

2. Functional Characteristics:
   a. Meet requirements of UL 1277, including Vertical Tray Flame Test at 70,000 Btu per hour, and NFPA 70, Article 340, or UL 13 meeting requirements of NFPA 70, Article 725.
   b. Minimum Temperature Rating: 90 degrees C dry locations, 75 degrees C wet locations.
3. Performance Characteristics: Suitable for installation in open air, in cable trays, or conduit.

B. Type 1:

1. Physical Characteristics:
   a. Multiconductor Control Cable.
   b. Conductors:
      1) 14 AWG, seven-strand copper.
      2) Insulation: 15-mil PVC with 4-mil nylon.
      3) Conductor group bound with spiral wrap of barrier tape.
      4) Color Code: In accordance with ICEA S-58-679, Method 1, Table 2.
   c. Cable Sizes:

No. of Conductors	**Max. Outside Diameter (Inches)**	**Jacket Thickness (Mils)**
3	0.41	45
5	0.48	45
7	0.52	45
12	0.72	60
19	0.83	60
25	1.00	60
37	1.15	80

2. Functional Characteristics: UL 1581 listed as Type THHN/THWN rated VW-1.
3. Performance Characteristics:
   a. Cable: Passes the ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.

C. Type 2:

1. Physical Characteristics:
   a. Multiconductor Power Cable.
   b. Conductors:
      1) Class B stranded, coated copper.
      2) Insulation: Chemically cross-linked ethylene-propylene or cross-linked polyethylene.
      3) Color Code:
         a) Conductors, size 8 AWG and smaller, colored conductors, ICEA S-58-679, Method 1, Table 1.
         b) Conductors, size 6 AWG and larger, ICEA S-73-532, Method 4.
   c. Overall Jacket: PVC.
   d. Cable Sizes:

Conductor Size	**Minimum Ground Wire Size**	**No. of Current Carrying Conductors**	**Max. Outside Diameter (Inches)**	**Nominal Jacket Thickness (Mils)**
12	12	2 3 4	0.42 0.45 0.49	45
10	10	2 3 4	0.54 0.58 0.63	60
8	10	3 4	0.66 0.75	60
6	8	3 4	0.74 0.88	60
4	6	3 4	0.88 1.04	60 80
2	6	3 4	1.01 1.16	80
1	6	3 4	1.10 1.25	80
1/0	6	3 4	1.22 1.35	80
2/0	4	3 4	1.32 1.53	80

Conductor Size	Minimum Ground Wire Size	No. of Current Carrying Conductors	Max. Outside Diameter (Inches)	Nominal Jacket Thickness (Mils)
3/0	4	3 4	1.40 1.60	80
4/0	4	3 4	1.56 1.78	80 110

2. Functional Characteristics:
   a. UL rated VW-1 or listed Type XHHW-2.
   b. Meet or exceed UL 1581 for cable tray use.
   c. Meet or exceed UL 1277 for direct burial and sunlight-resistance.
3. Performance Characteristics: Cable shall pass ICEA T-29-520, 210,000 Btu per hour Vertical Tray Flame Test.

D. Type 3:

1. Physical Characteristics:
   a. Twisted, shielded pair instrumentation cable.
   b. Signal Conductors:
      1) 16 AWG, bare soft annealed copper, Class B, seven-strand concentric.
      2) Insulation: 15-mil nominal PVC.
      3) Color Code: Pair conductors, black and red.
      4) Jacket: 4-mil nominal nylon.
   c. Drain Conductor: 20 AWG, seven-strand tinned copper.
   d. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer overlapped to provide 100 percent coverage.
   e. Outer Jacket: 45-mil nominal thickness.
   f. Dimension: 0.31-inch nominal OD.
2. Functional Characteristics:
   a. Signal conductors in accordance with ASTM B8.
   b. Overall cable meeting requirements of NEMA WC 57.
3. Performance Characteristics: Designed for noise rejection for process control, computer, or data log applications.

E. Type 4:

1. Physical Characteristics:
   a. Single twisted, shielded triad instrumentation cable.
   b. Signal conductors:
      1) 16 AWG, bare soft annealed copper, Class B, seven-strand concentric.
      2) Insulation: 15-mil nominal PVC.

3) Jacket: 4-mil nylon.
4) Color Code: Triad conductors black, red, and blue.

c. Drain Conductor: 20 AWG, seven-strand, tinned copper.
d. Individual Pair Shield: 1.35-mil, double-faced aluminum/synthetic polymer, overlapped to provide 100 percent coverage.
e. Outer Jacket: 45-mil nominal.
f. Dimension: 0.32-inch nominal OD.

2. Functional Characteristics:
   a. Signal conductors in accordance with ASTM B8.
   b. Overall cable meeting NEMA WC 57 requirements.
3. Performance Characteristics: Designed for noise rejection for process control, computer, or data log applications.

2.03 SPECIAL CABLES

A. Type 30, Unshielded Twisted Pair (UTP) Telephone and Data Cable, 300V:

1. Physical Characteristics:
   a. Four pair, individually twisted, 23 AWG conductors, with FEP insulation and blue PVC jacket.
   b. Cable shall withstand a bend radius of 1-inch minimum at a temperature of minus 20 degrees C maximum without jacket or insulation cracking.
2. Functional Characteristics:
   a. Category 6 UTP, UL listed, and
   b. Indoor application: NFPA 70 Plenum (CMP) rated; comply with flammability plenum requirements of NFPA 70 and NFPA 262.
   c. Outdoor application: NFPA 70 Riser (CMR) & Outdoor (CMX) rated.
3. Performance Characteristics:
   a. Third party verified to comply with TIA/EIA 568-C Category 6 requirements.
   b. Suitable for high-speed network applications including gigabit ethernet and video.
   c. Cable shall be interoperable with other standards compliant products and shall be backward compatible with Category 5 and Category 5e.

2.04 GROUNDING CONDUCTORS

A. Equipment Grounding Conductors:

1. Physical Characteristics:
   a. Stranded copper with green insulation.
   b. Insulation: Type THHN/THWN or USE/RHH/RHW-XLPE.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

B. Direct Buried:

1. Physical Characteristics: Bare stranded copper.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.05 ACCESSORIES FOR CONDUCTORS 600 VOLTS AND BELOW

A. Tape:

1. General Purpose:
   a. Physical Characteristics:
      1) Flame retardant, 7-mil, vinyl plastic.
      2) Rated for 90 degrees C minimum.
   b. Functional Characteristics: Meet requirements of UL 510.
   c. Performance Characteristics: None.
2. Flame Retardant:
   a. Physical Characteristics: Cold and weather resistant: 8.5-mil, vinyl plastic.
   b. Functional Characteristics: None.
   c. Performance Characteristics: None.

B. Identification Devices:

1. Sleeve:
   a. Physical Characteristics: Permanent, PVC, yellow or white, with legible machine-printed black markings.
   b. Functional Characteristics: None.
   c. Performance Characteristics: None.
2. Heat Bond Marker:
   a. Physical Characteristics:
      1) Transparent thermoplastic heat bonding film with acrylic pressure sensitive adhesive.
      2) Self-laminating protective shield over text.
      3) Machine printed black text.
   b. Functional Characteristics: None.
   c. Performance Characteristics: None.
3. Marker Plate:
   a. Physical Characteristics: Nylon, with legible designations permanently hot stamped on plate.
   b. Functional Characteristics: None.
   c. Performance Characteristics: None.

4. Tie-On Cable Marker Tags:
    a. Physical Characteristics:
        1) Chemical-resistant white tag.
        2) Size: 1/2 inch by 2 inch.
    b. Functional Characteristics: None.
    c. Performance Characteristics: None.
5. Grounding Conductor Marker:
    a. Physical Characteristics: Permanent green heat-shrink sleeve, 2-inch minimum.
    b. Functional Characteristics: None.
    c. Performance Characteristics: None.

C. Connectors and Terminations:

1. Nylon, Self-Insulated Crimp Connectors:
    a. Physical Characteristics:
        1) Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
        2) Seamless.
    b. Functional Characteristics: UL listed.
    c. Performance Characteristics: None.
2. Self-Insulated, Freespring Wire Connector (Wire Nuts):
    a. Physical Characteristics:
        1) UL 486C.
        2) Plated steel, square wire springs.
    b. Functional Characteristics: UL listed.
    c. Performance Characteristics: None.
3. Self-Insulated, Set Screw Wire Connector:
    a. Physical Characteristics:
        1) Two piece compression type with set screw in brass barrel.
        2) Insulated by insulator cap screwed over brass barrel.
    b. Functional Characteristics: UL listed.
    c. Performance Characteristics: None.

D. Cable Lugs:

1. Physical Characteristics:
    a. Made from same material as conductor.
    b. Uninsulated Crimp Connectors and Terminators.
    c. Uninsulated, Bolted, Two-Way Connectors and Terminators.
2. Functional Characteristics:
    a. In accordance with NEMA CC 1.
    b. Rated 600 volts.
    c. UL listed.
3. Performance Characteristics: Suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.

E. Cable Ties:

1. Physical Characteristics: Nylon.
2. Functional Characteristics: Adjustable, self-locking, and reusable.
3. Performance Characteristics: None.

F. Heat Shrinkable Insulation:

1. Physical Characteristics:
   a. Thermally stabilized cross-linked polyolefin.
   b. Single wall for insulation and strain relief.
   c. Dual Wall, adhesive sealant lined, for sealing and corrosion resistance.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.06 CONDUCTORS ABOVE 600 VOLTS

A. EPR Insulated Cable:

1. Physical Characteristics:
   a. Type: 15 kV, nonshielded.
   b. Conductors:
      1) Phase: Soft-annealed copper, concentric lay Class B stranded.
      2) Concentric Neutral: 1/3 soft-annealed solid copper.
   c. Conductor shield: Extruded, semi-conducting cross-linked copolymer.
   d. Insulation:
      1) Extruded, 133 percent insulation level, ethylene-propylene rubber (NL-EPR) containing no polyethylene or lead.
      2) Insulation Thickness: 220-mil nominal.
   e. Insulation Shield: Extruded, semiconducting cross-linked copolymer, extruded directly over insulation.
   f. Neutral Separator: Mylar tape.
   g. Overall Jacket: Extruded polyvinyl chloride (PVC) compound.
2. Functional Characteristics:
   a. UL 1072, Type MV-105.
   b. Conductor screen and insulation in accordance with NEMA WC 71, and AEIC CS 8.
   c. Conductors in accordance with ASTM B3, ASTM B8, and ASTM B496.
   d. Overall jacket in accordance with NEMA WC 71 or NEMA WC 74.

3. Performance Characteristics:
    a. Operating Temperature: 105 degrees C continuous normal operations, 130 degrees C emergency operating conditions, and 250 degrees C short-circuit conditions.

2.07 ACCESSORIES FOR CONDUCTORS ABOVE 600 VOLTS

A. Molded Splice Kits:

1. Physical Characteristics:
    a. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
    b. Capable of making splices with a current rating equal to, or greater than cable ampacity.
    c. Class 15 kV, with compression connector, EPDM molded semiconductive insert, peroxide-cured EPDM insulation, and EPDM molded semiconductive outer shield.
    d. Premolded splice shall be rejacketed with a heat shrinkable adhesive-lined sleeve to provide a waterproof seal.
2. Functional Characteristics: Conforming to IEEE 404.
3. Performance Characteristics: None.

B. Heat Shrinkable Splice Kits:

1. Physical Characteristics:
    a. Components necessary to provide insulation, metallic shielding and grounding systems, and overall jacket.
    b. Capable of making splices with a current rating equal to, or greater than, cable ampacity.
    c. Class 15 kV, with compression connector, splice insulating and conducting sleeves, stress-relief materials, shielding braid and mesh, and abrasion-resistant heat shrinkable adhesive-lined rejacketing sleeve to provide a waterproof seal.
2. Functional Characteristics: Conforming to IEEE 404.
3. Performance Characteristics: None.

C. Termination Kits:

1. Physical Characteristics:
    a. Capable of terminating 15 kV, single-conductor, polymeric-insulated cables with concentric neutral.
    b. Capable of producing a termination with a current rating equal to, or greater than, cable ampacity.
    c. Capable of accommodating cable shielding or construction without need for special adapters or accessories.
2. Functional Characteristics: Meet Class 1 requirements of IEEE 48.
3. Performance Characteristics: None.

D. Bus Connection Insulation:

1. Physical Characteristics:
   a. Heat shrinkable tubing, tape, and sheets of flexible cross-linked polymeric material formulated for high dielectric strength.
   b. Tape and sheet products to have coating to prevent adhesion to metal surfaces.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

E. Elbow Connector Systems:

1. Physical Characteristics:
   a. Molded, peroxide-cured, EPDM-insulated, Class 15 kV, 95 kV BIL, 200A, 10,000A rms load-break elbows having copper current-carrying parts in accordance with IEEE 386.
   b. Protective Caps: Class 15 kV, 95 kV BIL, 200 amperes, with molded EPDM insulated body.
   c. Insulated Standoff Bushings: Class 15 kV, 95 kV BIL, 200 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
   d. Bushing Inserts: Class 15 kV, 95 kV BIL, 200A, load-break with EPDM rubber body and all-copper, current-carrying parts.
   e. Junctions: Class 15 kV, 95 kV three- and four-way as shown, 200A, load-break, having EPDM rubber body mounted on adjustable bracket.
   f. Mounting Plates: ASTM A167 stainless steel, complete with universal mounting brackets, grounding lugs and two parking stands.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

F. Cable Lugs:

1. Physical Characteristics:
   a. Rated 15 kV of same material as conductor metal.
   b. Uninsulated Compression Connectors and Terminators.
   c. Uninsulated, Bolted, Two-Way Connectors and Terminators.
2. Functional Characteristics: In accordance with NEMA CC1.
3. Performance Characteristics: None.

2.08 PULLING COMPOUND

A. Physical Characteristics: Nontoxic, noncorrosive, noncombustible, nonflammable, water-based lubricant.

B. Functional Characteristics:

1. UL Listed.
2. Approved for intended use by cable manufacturer.

C. Performance Characteristics:

1. Suitable for rubber, neoprene, PVC, polyethylene, hypalon, CPE, and lead-covered wire and cable.
2. Suitable for zinc-coated steel, aluminum, PVC, bituminized fiber, and fiberglass raceways.

2.09 WARNING TAPE

A. As specified in Section 26 05 33, Raceway and Boxes.

2.10 SOURCE QUALITY CONTROL

A. Conductors 600 Volts and Below: Test in accordance with UL 44 and UL 854.

B. Conductors Above 600 Volts: Test in accordance with NEMA WC 71 and AEIC CS 8 partial discharge level test for EPR insulated cable.

PART 3 EXECUTION

3.01 GENERAL

A. Conductor installation shall be in accordance with manufacturer's recommendations.

B. Conductor and cable sizing shown is based on copper conductors, unless noted otherwise.

C. Do not exceed cable manufacturer's recommendations for maximum pulling tensions and minimum bending radii.

D. Terminate conductors and cables, unless otherwise indicated.

E. Tighten screws and terminal bolts in accordance with UL 486A-486B for copper conductors and aluminum conductors.

F. Cable Lugs: Provide with correct number of holes, bolt size, and center-to-center spacing as required by equipment terminals.

G. Bundling: Where single conductors and cables in manholes, handholes, vaults, cable trays, and other indicated locations are not wrapped together by some other means, bundle conductors from each conduit throughout their exposed length with cable ties placed at intervals not exceeding 12 inches on center.

H. Ream, remove burrs, and clear interior of installed conduit before pulling wires or cables.

I. Concrete-Encased Raceway Installation: Prior to installation of conductors, pull through each raceway a mandrel approximately 1/4 inch smaller than raceway inside diameter.

3.02 POWER CONDUCTOR COLOR CODING

A. Conductors 600 Volts and Below:

1. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
2. 8 AWG and Smaller: Provide colored conductors.
3. Colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts, Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts, Three-Phase, Four-Wire, Delta, Center Tap, Ground on Single-Phase	Grounded Neutral Phase A High (wild) Leg Phase C	White Black Orange Blue
480Y/277 Volts, Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Brown Orange Yellow
Note: Phase A, B, C implies direction of positive phase rotation.		

4. Tracer: Outer covering of white with identifiable colored strip, other than green, in accordance with NFPA 70.

B. Conductors Above 600 Volts:

1. Apply general purpose, flame retardant tape at each end, and at accessible locations wrapped at least six full overlapping turns, covering area 1-1/2 inches to 2 inches wide.
2. Colors:
   a. Phase A: Brown.
   b. Phase B: Orange.
   c. Phase C: Yellow.

3.03 CIRCUIT IDENTIFICATION

A. Identify power, instrumentation, and control conductor circuits at each termination, and in accessible locations such as manholes, handholes, panels, switchboards, motor control centers, pull boxes, and terminal boxes.

1. Assign circuit name based on device or equipment at load end of circuit.
2. Where this would result in same name being assigned to more than one circuit, add number or letter to each otherwise identical circuit name to make it unique.

B. Method:

1. Conductors 3 AWG and Smaller: Identify with sleeves or heat bond markers.
2. Cables and Conductors 2 AWG and Larger:
   a. Identify with marker plates or tie-on cable marker tags.
   b. Attach with nylon tie cord.
3. Taped-on markers or tags relying on adhesives not permitted.

3.04 CONDUCTORS 600 VOLTS AND BELOW

A. Install 10 AWG or 12 AWG conductors for branch circuit power wiring in lighting and receptacle circuits.

B. Do not splice incoming service conductors and branch power distribution conductors 6 AWG and larger, unless specifically indicated or approved by Contracting Officer.

C. Connections and Terminations:

1. Install nylon self-insulated crimp connectors and terminators for instrumentation and control, circuit conductors.
2. Install self-insulated, set screw wire connectors for two-way connection of power circuit conductors 12 AWG and smaller.

3. Install uninsulated crimp connectors and terminators for instrumentation, control, and power circuit conductors 4 AWG through 2/0 AWG.
4. Install uninsulated, bolted, two-way connectors and terminators for power circuit conductors 3/0 AWG and larger.
5. Install uninsulated terminators bolted together on motor circuit conductors 10 AWG and larger.
6. Place no more than one conductor in any single-barrel pressure connection.
7. Install crimp connectors with tools approved by connector manufacturer.
8. Install terminals and connectors acceptable for type of material used.
9. Compression Lugs:
    a. Attach with a tool specifically designed for purpose. Tool shall provide complete, controlled crimp and shall not release until crimp is complete.
    b. Do not use plier type crimpers.

D. Do not use soldered mechanical joints.

E. Termination Insulation:

1. Insulate uninsulated connections.
2. Indoors: Use general purpose, flame retardant tape or single wall heat shrink.
3. Outdoors, Dry Locations: Use flame retardant, cold- and weather-resistant tape or single wall heat shrink.
4. Below Grade and Wet or Damp Locations: Use dual wall heat shrink.

F. Cap spare conductors with UL listed end caps.

G. Cabinets, Panels, and Motor Controls:

1. Remove surplus wire, bridle and secure.
2. Where conductors pass through openings or over edges in sheet metal, remove burrs, chamfer edges, and install bushings and protective strips of insulating material to protect the conductors.

H. Control and Instrumentation Wiring:

1. Where terminals provided will accept such lugs, terminate control and instrumentation wiring, except solid thermocouple leads, with insulated, locking-fork compression lugs.
2. Terminate with methods consistent with terminals provided, and in accordance with terminal manufacturer’s instructions.
3. Locate splices in readily accessible cabinets or junction boxes using terminal strips.

4. Where connections of cables installed under this section are to be made under Section 40 90 00, Instrumentation and Control for Process Systems, leave pigtails of adequate length for bundled connections.
5. Cable Protection:
   a. Install individual wires, pairs, or triads in flex conduit under floor or grouped into bundles at least 1/2 inch in diameter.
   b. Maintain integrity of shielding of instrumentation cables.
   c. Ensure grounds do not occur because of damage to jacket over shield.

I. Extra Conductor Length: For conductors to be connected by others, install minimum 6 feet of extra conductor in freestanding panels and minimum 2 feet in other assemblies.

3.05 CONDUCTORS ABOVE 600 VOLTS

A. Do not splice unless specifically indicated or approved by Contracting Officer.

B. Make joints and terminations with splice and termination kits, in accordance with kit manufacturer’s instructions.

C. Install splices or terminations as continuous operation in accessible locations under clean, dry conditions.

D. Single Conductor Cable Terminations: Provide heat shrinkable stress control and outer nontracking insulation tubings, high relative permittivity stress relief mastic for insulation shield cutback treatment, and a heat-activated sealant for environmental sealing, plus concentric neutral braid and clamp.

E. Install terminals or connectors acceptable for type of conductor material used.

F. Provide outdoor rain skirts for outdoor switchgear terminations.

G. Provide shield termination and grounding for terminations.

H. Provide necessary mounting hardware, covers, and connectors.

I. Where elbow connectors are specified, install in accordance with manufacturer’s instructions.

J. Connections and Terminations:

1. Install uninsulated crimp connectors and terminators for power circuit conductors 4 AWG and larger.
2. Install uninsulated, bolted, two-way connectors for motor circuit conductors No. 12 and larger.

3. Insulate bus connections with heat shrinking tubing, tape, and sheets.
4. Make bus connections removable and reusable in accordance with manufacturer's instructions.

K. Give 2 working days' notice to Contracting Officer prior to making splices or terminations.

END OF SECTION

SECTION 26 05 26
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Institute of Electrical and Electronics Engineers (IEEE): C2, National Electrical Safety Code (NESC).
2. National Fire Protection Association (NFPA): 70, National Electrical Code. (NEC).

1.02 SUBMITTALS

A. Action Submittals:

1. Provide manufacturers' product data for the following:
   a. Mechanical connectors.
   b. Compression connectors.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
2. Materials and equipment manufactured within the scope of standards published by UL:
   a. Confirm conformance with UL standards.
   b. Supply with an applied UL listing mark.

PART 2 PRODUCTS

2.01 GROUND ROD

A. Physical Characteristics:

1. Material: Copper-clad.
2. Diameter: Minimum 3/4 inch.
3. Length: 10 feet.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.02 GROUND CONDUCTORS

A. As specified in Section 26 05 05, Conductors.

2.03 CONNECTORS

A. Compression Type:

1. Physical Characteristics:
   a. Compress-deforming type; wrought copper extrusion material.
   b. Single indentation for conductors 6 AWG and smaller.
   c. Double indentation with extended barrel for conductors 4 AWG and larger.
   d. Barrels prefilled with oxide-inhibiting and antiseizing compound and sealed.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

B. Mechanical Type:

1. Physical Characteristics: Split-bolt, saddle, or cone screw type; copper alloy material.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.04 GROUNDING WELLS

A. Physical Characteristics: Ground rod box complete with cast-iron riser ring and cover.

B. Functional Characteristics: Traffic rated cover marked “GROUND ROD”.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

A. Grounding: In compliance with NFPA 70 and IEEE C2.

B. Ground electrical service neutral at service entrance equipment with grounding electrode conductor to grounding electrode system.

C. Ground each separately derived system neutral with common grounding electrode conductor to grounding electrode system.

D. Bond together all grounding electrodes that are present at each building or structure served to form one common grounding electrode system.

E. Bond together system neutrals, service equipment enclosures, exposed noncurrent-carrying metal parts of electrical equipment, metal raceways, ground conductor in raceways and cables, receptacle ground connections, and metal piping systems.

F. Shielded Power Cables: Ground shields at each splice or termination in accordance with recommendations of splice or termination manufacturer.

G. Shielded Instrumentation Cables:

1. Ground shield to ground bus at power supply for analog signal.
2. Expose shield minimum 1 inch at termination to field instrument and apply heat shrink tube.
3. Do not ground instrumentation cable shield at more than one point.

3.02 WIRE CONNECTIONS

A. Ground Conductors: Install in conduit containing power conductors and control circuits above 50 volts.

B. Nonmetallic Raceways and Flexible Tubing: Install equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Connect ground conductors to raceway grounding bushings.

D. Extend and connect ground conductors to ground bus in all equipment containing a ground bus.

E. Connect enclosure of equipment containing ground bus to that bus.

F. Bolt connections to equipment ground bus.

G. Bond grounding conductors to metallic enclosures at each end, and to intermediate metallic enclosures.

H. Junction Boxes: Furnish materials and connect to equipment grounding system with grounding clips mounted directly on box, or with 3/8-inch machine screws.

I. Metallic Equipment Enclosures: Use furnished ground lug; if none furnished, tap equipment housing and install solderless terminal connected to box with

machine screw. For circuits greater than 20 amps use minimum 5/16-inch diameter bolt.

3.03 MOTOR GROUNDING

A. Extend equipment ground bus via grounding conductor installed in motor feeder raceway; connect to motor frame.

B. Nonmetallic Raceways and Flexible Tubing: Install an equipment grounding conductor connected at both ends to noncurrent-carrying grounding bus.

C. Motors Less Than 10 hp: Use furnished ground lug in motor connection box. If none furnished, provide compression, spade-type terminal connected to conduit box mounting screw.

D. Motors 10 hp and Above: Use furnished ground lug in motor connection box. If none furnished, tap motor frame or equipment housing; furnish compression, one-hole, lug type terminal connected with minimum 5/16-inch brass threaded stud with bolt and washer.

3.04 GROUND RODS

A. Install full length with conductor connection at upper end.

B. Install with connection point below finished grade, unless otherwise shown.

C. Space multiple ground rods by one rod length.

D. Install to 8 feet below local frost depth.

3.05 GROUNDING WELLS

A. Install for ground rods located inside buildings, asphalt and paved areas, and where shown on the Drawings.

B. Install riser ring and cover flush with surface.

C. Place 6 inches of crushed rock in bottom of each well.

3.06 CONNECTIONS

A. General:

1. Abovegrade Connections: Install mechanical or compression-type connectors; or brazing.
2. Belowgrade Connections: Install compression type connectors.

3. Remove paint, dirt, or other surface coverings at connection points to allow good metal-to-metal contact.
4. Notify Contracting Officer prior to backfilling ground connections.

B. Compression Type:

1. Install in accordance with connector manufacturer's recommendations.
2. Install connectors of proper size for grounding conductors and ground rods specified.
3. Install using connector manufacturer's compression tool having proper sized dies and operate per manufacturer's instructions.

C. Mechanical Type:

1. Apply homogeneous blend of colloidal copper and rust and corrosion inhibitor before making connection.
2. Install in accordance with connector manufacturer's recommendations.
3. Do not conceal mechanical connections.

3.07 METAL STRUCTURE GROUNDING

A. Bond metal sheathing and exposed metal vertical structural elements to grounding system.

B. Bond electrical equipment supported by metal platforms to the platforms.

C. Provide electrical contact between metal frames and railings supporting pushbutton stations, receptacles, and instrument cabinets, and raceways carrying circuits to these devices.

3.08 MANHOLE AND HANDHOLE GROUNDING

A. Install one ground rod inside each manhole and handhole larger than 24-inch by 24-inch inside dimensions.

B. Ground Rod Floor Protrusion: 4 inches to 6 inches above floor.

C. Make connections of grounding conductors fully visible and accessible.

D. Connect all noncurrent-carrying metal parts and any metallic raceway grounding bushings to ground rod with 6 AWG copper conductor.

3.09 TRANSFORMER GROUNDING

A. Bond neutrals of transformers within buildings to system ground network and to any additional indicated grounding electrodes.

B. Bond neutrals of pad-mounted transformers to locally driven ground rod(s) and system ground network.

3.10 MEDIUM VOLTAGE CONDUCTORS

A. Bond concentric neutral conductors and cable shields to local ground system at terminations, connections, and splices.

3.11 LIGHTNING PROTECTION SYSTEMS

A. Bond lightning protection system, where provided, ground terminals to building or structure grounding electrode system.

3.12 SURGE PROTECTION EQUIPMENT GROUNDING

A. Connect surge arrestor ground terminals to equipment ground bus.

END OF SECTION

SECTION 26 05 33
RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
   a. A123/123M, Standard Specification for Zinc (Hot-Dipped Galvanized) Coatings on Iron and Steel Products.
   b. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   c. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   d. C857, Standard Practice for Minimum Structural Design Loading for Underground Precast Concrete Utility Structures.
   e. D149, Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
   f. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
   g. E662, Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials.
3. Telecommunications Industry Association (TIA): 569B, Commercial Building Standard for Telecommunications Pathways and Spaces.
4. National Electrical Contractor’s Association, Inc. (NECA): Installation standards.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. C80.1, Electrical Rigid Steel Conduit (ERSC).
   c. C80.3, Steel Electrical Metallic Tubing (EMT).
   d. C80.5, Electrical Rigid Aluminum Conduit (ERAC).
   e. C80.6, Electrical Intermediate Metal Conduit (EIMC).
   f. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
   g. TC 2, Electrical Polyvinyl Chloride (PVC) Conduit.
   h. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

i. TC 6, Polyvinyl Chloride (PVC) Plastic Utilities Duct for Underground Installation.
j. TC 7, Solid-Wall Coilable and Straight Electrical Polyethylene Conduit.
k. TC 14, Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
l. VE 1, Metallic Cable Tray Systems.

6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 1, Standard for Safety for Flexible Metal Conduit.
   b. 5, Standard for Safety for Surface Metal Raceways and Fittings.
   c. 6, Standard for Safety for Electrical Rigid Metal Conduit – Steel.
   d. 6A, Standard for Safety for Electrical Rigid Metal Conduit – Aluminum, Red Brass and Stainless.
   e. 94, Standard for Safety for Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
   f. 360, Standard for Safety for Liquid-Tight Flexible Steel Conduit.
   g. 514B, Standard for Safety for Conduit, Tubing, and Cable Fittings.
   h. 651, Standard for Safety for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
   i. 651A, Standard for Safety for Type EB and A Rigid PVC Conduit and HDPE Conduit.
   j. 797, Standard for Safety for Electrical Metallic Tubing – Steel.
   k. 870, Standard for Safety for Wireways, Auxiliary Gutters, and Associated Fittings.
   l. 1242, Standard for Safety for Electrical Intermediate Metal Conduit – Steel.
   m. 1660, Standard for Safety for Liquid-Tight Flexible Nonmetallic Conduit.
   n. 2024, Standard for Safety for Optical Fiber and Communication Cable Raceway.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s Product Data:
   a. Rigid galvanized steel conduit.
   b. PVC Schedule 40 conduit.
   c. HDPE conduit.
   d. Flexible metal, liquid-tight conduit.
   e. Flexible metal, nonliquid-tight conduit.
   f. Conduit fittings.

g. Wireways.
h. Innerduct.

2. Precast Manholes, Handholes, and frames/covers:
   a. Dimensional drawings and descriptive literature.
   b. Traffic loading calculations.
   c. Accessory information.
3. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals: Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.

1.03 QUALITY ASSURANCE

A. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Contracting Officer, material and equipment shall be labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the Contracting Officer in order to provide a basis for approval under NEC.

B. Materials and equipment manufactured within scope of standards published by Underwriters Laboratories, Inc. shall conform to those standards and shall have an applied UL listing mark.

PART 2 PRODUCTS

2.01 CONDUIT AND TUBING

A. Rigid Galvanized Steel Conduit (RGS):

1. Physical Characteristics: Hot-dip galvanized steel with chromated protective layer.
2. Functional Characteristics: Meet requirements of NEMA C80.1 and UL 6.
3. Performance Characteristics: None.

B. PVC Schedule 40 Conduit:

1. Physical Characteristics: UV sunlight resistant PVC.
2. Functional Characteristics:
   a. Meet requirements of NEMA TC 2 and UL 651.
   b. UL listed for concrete encasement, underground direct burial, concealed or direct sunlight exposure, and 90 degrees C insulated conductors.
3. Performance Characteristics: None.

C. High Density Polyethylene (HDPE) Conduit:

1. Physical Characteristics:
   a. UV sunlight resistant HDPE.
   b. Smooth-wall, straight or coiled continuous-length.
2. Functional Characteristics:
   a. Meet requirements of UL 651A, NEMA TC 7, and ASTM D3350.
   b. Listed for concrete encasement, underground direct burial, and 90 degrees C insulated conductors.
3. Performance Characteristics: None.

D. Flexible Metal, Liquid-Tight Conduit:

1. Physical Characteristics:
   a. Spiral-wound, interlocked, galvanized steel strip.
   b. UV sunlight and oil resistant PVC jacket.
2. Functional Characteristics: UL 360 listed for 105 degrees C insulated conductors.
3. Performance Characteristics: None.

E. Flexible Metal, Nonliquid-Tight Conduit:

1. Physical Characteristics:
   a. Helically formed, continuously interlocked, hot-dipped galvanized steel strip.
   b. Smooth interior.
2. Functional Characteristics: Meet requirements of UL 1.
3. Performance Characteristics: None.

F. Innerduct:

1. Manufacturers:
   a. Maxcell.
   b. Or equal.
2. Physical Characteristics:
   a. Flexible, fabric innerduct for use in underground installations.
   b. Single and multiple cells as shown on Drawings.
   c. Conduit sealing and termination: Reusable, laminated foil, inflatable bag for installation around cables and innerduct.
3. Functional Characteristics: Resistant to spread of fire, per requirements of UL 2024.
4. Performance Characteristics: Suitable for conduit installation with existing cables with manufacturer-recommended tools and equipment.

2.02 FITTINGS

A. Rigid Galvanized Steel Conduit:

1. Physical Characteristics:
   a. Threaded, galvanized. Set screw and threadless compression fittings not permitted.
   b. Bushings: Malleable iron with integral insulated throat. Solderless lugs for grounding type bushing.
   c. Conduit Hub: Malleable iron with insulated throat with bonding screw.
   d. Couplings: As supplied by conduit manufacturer.
   e. Unions: Concrete-tight, hot-dip galvanized malleable iron.
   f. Cable Sealing Fitting: Neoprene busing at connector entry for conductors with OD of 1/2 inch or less.
2. Functional Characteristics:
   a. Meet requirements of UL 514B.
   b. Bushings: Rated for 150 degrees C.
   c. Conduit Hub: UL listed for use in wet locations.
   d. Conduit Bodies: Sized as required by NFPA 70.
   e. Cable Sealing Fitting: Forms watertight nonslip cord or cable connection to conduit.
3. Performance Characteristics: None.

B. PVC Conduit:

1. Physical Characteristics:
   a. Type: PVC, slip-on.
2. Functional Characteristics: Meet requirements of NEMA TC 3.
3. Performance Characteristics: None.

C. HDPE Conduit:

1. Physical Characteristics:
   a. Designed for use with smooth wall conduit.
   b. Compression, press fit, screw fit, clamshell, or fusion type as suitable for installation.
2. Functional Characteristics: Listed for use with HDPE conduit.
3. Performance Characteristics: None.

D. Flexible Metal, Liquid-Tight Conduit:

1. Physical Characteristics:
   a. Metal insulated throat connectors with integral nylon or plastic bushing.
   b. Insulated throat and sealing O-rings.

2. Functional Characteristics: Rated for 105 degrees C.
3. Performance Characteristics: None.

E. Flexible Metal, Nonliquid-Tight Conduit:

1. Physical Characteristics:
   a. Body: Galvanized steel or malleable iron.
   b. Throat: Nylon insulated.
   c. 1-1/4-Inch Conduit and Smaller: One screw body.
   d. 1-1/2-Inch Conduit and Larger: Two screw body.
2. Functional Characteristics: Meet requirements of UL 514B.
3. Performance Characteristics: None.

F. Watertight Entrance Seal Device:

1. Physical Characteristics:
   a. New Construction: Oversized sleeve, malleable iron body with sealing ring, pressure ring, grommet seal, and pressure clamp.
   b. Cored-Hole Application: Assembled dual pressure disks, neoprene sealing ring, and membrane clamp.
2. Functional Characteristics: Suitable for installation location.
3. Performance Characteristics: Provides water-tight seal between structure and conduit or cables.

2.03 OUTLET AND DEVICE BOXES

A. Cast Metal:

1. Physical Characteristics:
   a. Box: Malleable iron.
   b. Cover: Gasketed, weatherproof, malleable iron, with stainless steel screws.
   c. Hubs: Threaded.
   d. Lugs: Cast Mounting.
2. Functional Characteristics: Suitable for use with threaded conduit and fittings.
3. Performance Characteristics: None.

2.04 JUNCTION AND PULL BOXES

A. Outlet Box Used as Junction or Pull Box: As specified under Article Outlet and Device Boxes.

B. Conduit Bodies Used as Junction Boxes: As specified under Article Fittings.

C. Sheet Steel Box:

1. Physical Characteristics:
   a. Box: Code-gauge, galvanized steel.
   b. Cover: Full access, screw type.
   c. Machine Screws: Corrosion-resistant.
2. Functional Characteristics: NEMA 250, Type 1.
3. Performance Characteristics: None.

D. Cast Metal Box:

1. Physical Characteristics:
   a. Box: Cast malleable iron, with drilled and tapped conduit entrances and exterior mounting lugs.
   b. Cover: Hinged with clamps.
   c. Gasket: Neoprene.
   d. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
2. Functional Characteristics: NEMA 250, Type 4.
3. Performance Characteristics: None.

E. Stainless Steel Box:

1. Physical Characteristics:
   a. Box: 14-gauge, ASTM A240/A240M, Type 304 stainless steel.
   b. Cover: Hinged with clamps.
   c. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
2. Functional Characteristics: NEMA 250 Type 4X.
3. Performance Characteristics: None.

F. Steel Box:

1. Physical Characteristics:
   a. Box: 14-gauge minimum steel, with white enamel painted interior and gray primed exterior, over phosphated surfaces. Provide tan finish as approved by Contracting Officer.
   b. Cover: Nonhinged with screws.
   c. Hardware and Machine Screws: ASTM A167, Type 316 stainless steel.
2. Functional Characteristics: NEMA 250 Type 3R or 12.
3. Performance Characteristics: None.

G. Concrete Box, Nontraffic Areas:

1. Physical Characteristics:
   a. Box: Reinforced, cast concrete with extension.
   b. Cover: Steel diamond plate with locking bolts.
   c. Cover Marking: ELECTRICAL, TELEPHONE, or as shown.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.05 METAL WIREWAYS

A. Physical Characteristics:

1. Type: Steel-enclosed, lay-in type.
2. Cover: Removable, screw type.
3. Finish: Rust inhibiting phosphatizing primer and gray baked enamel.
4. Hardware: Plated to prevent corrosion; screws installed toward the inside protected by spring nuts or otherwise guarded to prevent wire insulation damage.
5. Knockouts: Without knockouts, unless otherwise indicated.

B. Functional Characteristics:

1. Meet requirements of UL 870.
2. Rating:
   a. Wet, Damp, and Outdoor Locations: Outdoor raintight.
   b. Dry, Indoor Locations: Indoor.

C. Performance Characteristics: None.

2.06 PRECAST MANHOLES AND HANDHOLES

A. Physical Characteristics:

1. Access: Provide cast concrete 6-inch or 12-inch risers and access hole adapters between top of manhole or handhole and finished grade at required elevations.
2. Drainage:
   a. Slope floors toward drain points, leaving no pockets or other nondraining areas.
   b. Provide drainage outlet or sump at low point of floor.
3. Raceway Entrances:
   a. Provide on all four sides.
   b. Provide knockout panels or precast individual raceway openings.
   c. At entrances where raceways are to be installed by others, provide minimum 12-inch-high by 24-inch-wide knockout panels for future raceway installation.

4. Embedded Pulling Iron:
    a. Material: 3/4-inch-diameter stock, fastened to overall steel reinforcement before concrete is placed.
    b. Location:
        1) Wall: Opposite each raceway entrance and knockout panel for future raceway entrance.
        2) Floor: Centered below manhole or handhole cover.
5. Frames and Covers:
    a. Material: Machined cast iron.
    b. Diameter:36-1/2 inch.
    c. Cover Type: Indented, solid top design, with two drop handles each.
    d. Cover Designation: Cast, on upper side, in integral letters, minimum 2 inches in height, appropriate titles:
        1) Above 600 Volts: ELECTRIC HV.
        2) 600 Volts and Below: ELECTRIC LV.
        3) COMMUNICATIONS.
6. Hardware: Steel, hot-dip galvanized.
7. Furnish knockout for ground rod in each handhole and manhole.

B. Functional Characteristics:

1. Manhole and Handhole Loading: AASHTO, H-20 in accordance with ASTM C857.
2. Cover Loading: AASHTO H-20.

C. Performance Characteristics: Concrete Strength: Minimum, 3,000 psi compressive, in 28 days.

2.07 ACCESSORIES

A. Duct Bank Spacers:

1. Physical Characteristics: Nonmetallic, interlocking, for multiple conduit sizes.
2. Functional Characteristics: Suitable for all types of conduit.
3. Performance Characteristics: None.

B. Warning Tape:

1. Physical Characteristics:
    a. Material: Polyethylene, 4-mil gauge with detectable strip.
    b. Color: Red.
    c. Width: Minimum 3 inches.

d. Designation: Warning on tape that electric circuit is located below tape.
e. Identifying Letters: Minimum 1-inch-high permanent black lettering imprinted continuously over entire length.

2. Functional Characteristics: Detectable.
3. Performance Characteristics: None.

C. Heat Shrinkable Tubing:

1. Physical Characteristics:
a. Material: Heat-shrinkable, cross-linked polyolefin.
b. Semi-flexible with meltable adhesive inner liner.
c. Color: Black.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

D. Wraparound Duct Band:

1. Physical Characteristics:
a. Material: Heat-shrinkable, cross-linked polyolefin, precoated with hot-melt adhesive.
b. Width: 50 mm minimum.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

A. Conduit and tubing sizes shown are based on use of copper conductors. Reference Section 26 05 05, Conductors, concerning conduit sizing for aluminum conductors.

B. Comply with NECA Installation Standards.

C. Crushed or deformed raceways not permitted.

D. Maintain raceway entirely free of obstructions and moisture.

E. Immediately after installation, plug or cap raceway ends with watertight and dust-tight seals until time for pulling in conductors.

F. Sealing Fittings: Provide drain seal in vertical raceways where condensate may collect above sealing fitting.

G. Avoid moisture traps where possible. When unavoidable in exposed conduit runs, provide junction box and drain fitting at conduit low point.

H. Group raceways installed in same area.

I. Proximity to Heated Piping: Install raceways minimum 12 inches from parallel runs.

J. Follow structural surface contours when installing exposed raceways. Avoid obstruction of passageways.

K. Run exposed raceways parallel or perpendicular to walls, structural members, or intersections of vertical planes.

L. Block Walls: Do not install raceways in same horizontal course or vertical cell with reinforcing steel.

M. Install watertight fittings in outdoor, underground, or wet locations.

N. Paint threads and cut ends, before assembly of fittings, galvanized conduit, installed in exposed or damp locations with zinc-rich paint or liquid galvanizing compound.

O. Metal conduit shall be reamed, burrs removed, and cleaned before installation of conductors, wires, or cables.

P. Do not install raceways in concrete non-electrical equipment pads, foundations, or beams without Contracting Officer approval.

Q. Horizontal raceways installed under floor slabs shall lie completely under slab, with no part embedded within slab.

R. Install concealed, embedded, and buried raceways so that they emerge at right angles to surface and have no curved portion exposed.

S. Install conduits for fiber optic cables, telephone cables, and Category 6 data cables in strict conformance with the requirements of TIA 569B.

3.02 REUSE OF EXISTING CONDUITS

A. Where Drawings indicate existing conduits may be reused, they may be reused only where they meet the following criteria:

1. Conduit is in useable condition with no deformation, corrosion, or damage to exterior surface.
2. Conduit is sized per the NEC.
3. Conduit is of the type specified in Contract Documents.
4. Conduit is supported as specified in Contract Documents.

B. Conduit shall be reamed with wire brush, then with a mandrel approximately 1/4 inch smaller than raceway inside diameter then cleaned prior to pulling new conductors.

3.03 INSTALLATION IN CAST-IN-PLACE STRUCTURAL CONCRETE

A. Minimum Cover: 2 inches, including fittings.

B. Conduit placement shall not require changes in reinforcing steel location or configuration.

C. Provide nonmetallic support during placement of concrete to ensure raceways remain in position.

D. Conduit larger than 1 inch shall not be embedded in concrete slabs, walls, foundations, columns, or beams unless approved by Contracting Officer.

E. Slabs and Walls (Requires Contracting Officer Approval):

1. Trade size of conduit not to exceed one-fourth of slab or wall thickness.
2. Install within middle two-fourths of slab or wall.
3. Separate conduit less than 2-inch trade size by a minimum ten times conduit trade size, center-to-center, unless otherwise shown.
4. Separate conduit 2-inch and greater trade size by a minimum eight times conduit trade size, center-to-center, unless otherwise shown.
5. Cross conduit at an angle greater than 45 degrees, with minimum separation of 1 inch.
6. Separate conduit by a minimum six times the outside dimension of expansion/deflection fittings at expansion joints.
7. Conduit shall not be installed below the maximum water surface elevation in walls of water holding structures.

F. Columns and Beams (Requires Contracting Officer Approval):

1. Trade size of conduit not to exceed one-fourth of beam thickness.
2. Conduit cross-sectional area not to exceed 4 percent of beam or column cross section.

3.04 CONDUIT APPLICATION

A. Diameter:

1. Interior and exterior above grade, minimum 3/4 inch.
2. Exterior below grade and below slab, minimum 1 inch.

B. Exterior, Exposed: Rigid galvanized steel.

C. Interior, Exposed: Rigid galvanized steel.

D. Interior, Concealed (Not Embedded in Concrete): Rigid galvanized steel.

E. Aboveground, Embedded in Concrete Walls, Ceilings, or Floors:

1. Rigid galvanized steel.
2. PVC Schedule 40.

F. Direct Earth Burial:

1. HDPE.
2. PVC Schedule 40.

G. Concrete-Encased Ductbank:

1. HDPE.
2. PVC Schedule 40.

H. Under Slabs-On-Grade:

1. PVC Schedule 40.
2. HDPE.

I. Transition from Underground or Concrete Embedded to Exposed: Rigid galvanized steel conduit.

J. Under Electrical Equipment Mounting Pads:

1. Rigid galvanized steel.
2. PVC Schedule 40 conduit.

3.05 FLEXIBLE CONNECTIONS

A. For motors, wall or ceiling mounted fans and unit heaters, dry type transformers, electrically operated valves, instrumentation, and other locations approved by Contracting Officer where flexible connection is required to minimize vibration:

1. Conduit Size 4 Inches or Less: Flexible, metallic liquid-tight conduit.
2. Conduit Size Over 4 Inches: Nonflexible.
3. Wet or Corrosive Areas: Flexible, metallic liquid-tight.
4. Dry Areas: Flexible, metallic liquid-tight.

B. Suspended Lighting Fixtures in Dry Areas: Flexible steel, nonliquid-tight conduit.

C. Outdoor Areas, Process Areas Exposed to Moisture, and Areas Required to be Oiltight and Dust-Tight: Flexible metal, liquid-tight conduit.

D. Flexible Conduit Length: 18 inches minimum, 60 inches maximum; sufficient to allow movement or adjustment of equipment.

3.06 PENETRATIONS

A. Make at right angles, unless otherwise shown.

B. Notching or penetration of structural members, including footings and beams, not permitted.

C. Apply heat shrinkable tubing or single layer of wraparound duct band to metallic conduit protruding through concrete floor slabs to a point 2 inches above and 2 inches below concrete surface.

D. Concrete Walls, Floors, or Ceilings (Aboveground): Provide nonshrink grout dry-pack, or use watertight seal device.

E. Entering Structures:

1. General: Seal raceway at first box or outlet with oakum or expandable plastic compound to prevent entrance of gases or liquids from one area to another.
2. Concrete Roof or Membrane Waterproofed Wall or Floor:
   a. Provide a watertight seal.
   b. Without Concrete Encasement: Install watertight entrance seal device on each side.
   c. With Concrete Encasement: Install watertight entrance seal device on accessible side.
   d. Securely anchor malleable iron body of watertight entrance seal device into construction with one or more integral flanges.
   e. Secure membrane waterproofing to watertight entrance seal device in a permanent, watertight manner.
3. Heating, Ventilating, and Air Conditioning Equipment:
   a. Penetrate equipment in area established by manufacturer.
   b. Terminate conduit with flexible metallic liquid-tight conduit at junction box or condulet attached to exterior surface of equipment prior to penetrating equipment.
   c. Seal penetration with one-part flexible polyurethane, immersible sealant.
4. Existing or Precast Wall (Underground): Core drill wall and install watertight entrance seal device.
5. Nonwaterproofed Wall or Floor (Underground, without Concrete Encasement):
   a. Provide Schedule 40 galvanized pipe sleeve, or watertight entrance seal device.
   b. Fill space between raceway and sleeve with expandable plastic compound or oakum and lead joint, on each side.

6. Manholes and Handholes:
    a. Metallic Raceways: Provide insulated grounding bushings.
    b. Nonmetallic Raceways: Provide bell ends flush with wall.
    c. Install such that raceways enter as near as possible to one end of wall, unless otherwise shown.

3.07 SUPPORT

A. Support from structural members only, at intervals not exceeding NFPA 70 requirements. Do not exceed 10 feet in any application. Do not support from piping, pipe supports, or other raceways.

B. Application/Type of Conduit Strap:

1. Rigid Steel Conduit: Zinc coated steel, pregalvanized steel or malleable iron.

C. Provide and attach wall brackets, strap hangers, or ceiling trapeze as follows:

1. Wood: Wood screws.
2. Hollow Masonry Units: Toggle bolts.
3. Concrete or Brick: Expansion shields, or threaded studs driven in by powder charge, with lock washers and nuts.
4. Steelwork: Machine screws.
5. Location/Type of Hardware:
    a. Dry, Noncorrosive Areas: Galvanized.
    b. Wet, Noncorrosive Areas: Stainless steel.

D. Nails or wooden plugs inserted in concrete or masonry for attaching raceway not permitted. Do not weld raceways or pipe straps to steel structures. Do not use wire in lieu of straps or hangers.

3.08 BENDS

A. Install concealed raceways with a minimum of bends in the shortest practical distance.

B. Make bends and offsets of longest practical radius. Bends in conduits and ducts being installed for fiber optic cables shall be not less than 20 times cable diameter, 15 inches minimum.

C. Install with symmetrical bends or cast metal fittings.

D. Avoid field-made bends and offsets, but where necessary, make with acceptable hickey or bending machine. Do not heat metal raceways to facilitate bending.

E. Make bends in parallel or banked runs from same center or centerline with same radius so that bends are parallel.

F. Factory elbows may be installed in parallel or banked raceways if there is change in plane of run, and raceways are same size.

G. PVC Conduit:

1. Bends 30 Degrees and Larger: Provide factory-made elbows.
2. Use manufacturer's recommended method for forming smaller bends.

H. Flexible Conduit: Do not make bends that exceed allowable conductor bending radius of cable to be installed or that significantly restricts conduit flexibility.

3.09 EXPANSION/DEFLECTION FITTINGS

A. Provide on raceways at structural expansion joints and in long tangential runs.

B. Provide expansion/deflection joints for 25 degrees F maximum temperature variation.

C. Install in accordance with manufacturer's instructions.

3.10 PVC CONDUIT

A. Solvent Welding:

1. Apply manufacturer recommended solvent to joints.
2. Install in order that joint is watertight.

B. Adapters:

1. PVC to Metallic Fittings: PVC terminal type.
2. PVC to Rigid Metal Conduit: PVC female adapter.

C. Belled-End Conduit: Bevel unbelled end of joint prior to joining.

3.11 WIREWAYS

A. Install in accordance with manufacturer's instructions.

B. Locate with cover on accessible vertical face of wireway, unless otherwise shown.

C. Applications:

1. Metal wireway in indoor dry locations.
2. Nonmetallic wireway in indoor wet, outdoor, and corrosive locations.

3.12 TERMINATION AT ENCLOSURES

A. Cast Metal Enclosure: Install manufacturer's premolded insulating sleeve inside metallic conduit terminating in threaded hubs.

B. Nonmetallic, Cabinets, and Enclosures:

1. Terminate conduit in threaded conduit hubs, maintaining enclosure integrity.
2. Metallic Conduit: Provide ground terminal for connection to maintain continuity of ground system.

C. Metal Boxes, Cabinets, and Enclosures:

1. General:
   a. Install insulated bushing on ends of conduit where grounding is not required.
   b. Provide insulated throat when conduit terminates in sheet metal boxes having threaded hubs.
   c. Utilize sealing locknuts or threaded hubs on sides and bottom of NEMA 3R and NEMA 12 enclosures.
   d. Terminate conduits at threaded hubs at the tops of NEMA 3R and NEMA 12 boxes and enclosures.
   e. Terminate conduits at threaded conduit hubs at NEMA 4 and NEMA 4X boxes and enclosures.
2. Rigid Galvanized Conduit:
   a. Provide one lock nut each on inside and outside of enclosure.
   b. Install grounding bushing at source enclosure.
   c. Provide bonding jumper from grounding bushing to equipment ground bus or ground pad.
3. Flexible Metal Conduit: Provide two screw type, insulated, malleable iron connectors.
4. PVC Schedule 40 Conduit: Provide PVC terminal adapter with lock nut, except where threaded hubs required above.

D. Free-Standing Enclosures:

1. Terminate metal conduit entering bottom with grounding bushing; provide grounding jumper extending to equipment ground bus or grounding pad.
2. Terminate PVC conduit entering bottom with bell end fittings.

3.13 UNDERGROUND RACEWAYS

A. Grade: Maintain minimum grade of 4 inches in 100 feet, either from one manhole, handhole, or pull box to the next, or from a high point between them, depending on surface contour.

B. Cover: Maintain minimum 2-foot cover above conduit and concrete encasement, unless otherwise shown.

C. Make routing changes as necessary to avoid obstructions or conflicts.

D. Couplings: In multiple conduit runs, stagger so couplings in adjacent runs are not in same transverse line.

E. Union type fittings not permitted.

F. Spacers:

1. Provide preformed, nonmetallic spacers designed for such purpose, to secure and separate parallel conduit runs in a trench or concrete encasement.
2. Install at intervals not greater than that specified in NFPA 70 for support of the type conduit used, but in no case greater than 10 feet.

G. Support conduit so as to prevent bending or displacement during backfilling or concrete placement.

H. Installation with Other Piping Systems:

1. Crossings: Maintain minimum 12-inch vertical separation.
2. Parallel Runs: Maintain minimum 12-inch separation.
3. Installation over valves or couplings not permitted.

I. Metallic Raceway Coating: Apply wraparound duct band with one-half tape width overlap to obtain two complete layers.

J. Provide expansion fittings that allow minimum of 4 inches of movement in vertical conduit runs from underground where exposed conduit will be fastened to or will enter building or structure.

K. Concrete Encasement:

1. As specified in Section 03 30 00, Cast-in-Place Concrete.
2. Concrete Color: Red.

L. Backfill:

1. As specified in Section 31 23 23.15, Trench Backfill.
2. Do not backfill until inspected by Contracting Officer.

3.14 UNDER SLAB RACEWAYS

A. Make routing changes as necessary to avoid obstructions or conflicts.

B. Support raceways so as to prevent bending or displacement during backfilling or concrete placement.

C. Install raceways with no part embedded within slab and with no interference with slab on grade construction.

D. Raceway spacing, in a single layer or multiple layers:

1. 3 inches clear between adjacent 2-inch or larger raceway.
2. 2 inches clear between adjacent 1-1/2-inch or smaller raceway.

E. Multiple Layers of Raceways: Install under slab on grade in trench below backfill zone, as specified in Section 31 23 23.15, Trench Backfill.

F. Individual Raceways and Single Layer Multiple Raceways: Install at lowest elevation of backfill zone with spacing as specified herein. Where conduits cross at perpendicular orientation, installation of conduits shall not interfere with placement of under slab fill that meets compaction and void limitations of earthwork specifications.

G. Under slab raceways that emerge from below slab to top of slab as exposed, shall be located to avoid conflicts with structural slab rebar. Coordinate raceway stub ups with location of structural rebar.

H. Fittings:

1. Union type fittings are not permitted.
2. Provide expansion/deflection fittings in raceway runs that exit building or structure below slab. Locate fittings 18 inches, maximum, beyond exterior wall. Raceway type between building exterior wall to fitting shall be PVC-coated rigid steel.
3. Couplings: In multiple raceway runs, stagger so couplings in adjacent runs are not in same traverse line.

3.15 OUTLET AND DEVICE BOXES

A. General:

1. Install plumb and level.
2. Install suitable for conditions encountered at each outlet or device in wiring or raceway system, sized to meet NFPA 70 requirements.
3. Open no more knockouts in sheet steel device boxes than are required; seal unused openings.
4. Install galvanized mounting hardware in industrial areas.

B. Size:

1. Depth: Minimum 2 inches, unless otherwise required by structural conditions. Box extensions not permitted.
   a. Hollow Masonry Construction: Install with sufficient depth such that conduit knockouts or hubs are in masonry void space.
2. Ceiling Outlet: Minimum 4-inch octagonal device box, unless otherwise required for installed fixture.
3. Switch and Receptacle: Minimum 2-inch by 4-inch device box.

C. Locations:

1. Drawing locations are approximate.
2. To avoid interference with mechanical equipment or structural features, relocate outlets as directed by Contracting Officer.
3. Light Fixture: Install in symmetrical pattern according to room layout, unless otherwise shown.

D. Mounting Height:

1. General:
   a. Dimensions given to centerline of box.
   b. Where specified heights do not suit building construction or finish, adjust up or down to avoid interference.
   c. Do not straddle CMU block or other construction joints.
   d. Dimensions shown are typical unless otherwise indicated on the Drawings.
2. Light Switch:
   a. 48 inches maximum above floor.
   b. When located next to door, install on lock side of door.
3. Thermostat: 48 inches maximum above floor.
4. Convenience Receptacle:
   a. General Interior Areas: 15 inches above floor.
   b. Industrial Areas, Workshops: 48 inches above floor.
   c. Outdoor Areas: 24 inches above finished grade.
5. Switch, Motor Starting: 48 inches above floor.

E. Flush Mounted:

1. Install with concealed conduit.
2. Install proper type extension rings or plaster covers to make edges of boxes flush with finished surface.
3. Holes in surrounding surface shall be no larger than required to receive box.

F. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Provide plaster rings where necessary.
5. Boxes embedded in concrete or masonry need not be additionally supported.

G. Install separate junction boxes for flush or recessed lighting fixtures where required by fixture terminal temperature.

H. Boxes Supporting Fixtures: Provide means of attachment with adequate strength to support fixture.

3.16 JUNCTION AND PULL BOXES

A. General:

1. Install plumb and level.
2. Installed boxes shall be accessible.
3. Do not install on finished surfaces.
4. Use outlet boxes as junction and pull boxes wherever possible and allowed by applicable codes.
5. Use conduit bodies as junction and pull boxes where no splices are required and allowed by applicable codes.
6. Install pull boxes where necessary in raceway system to facilitate conductor installation.
7. Install where shown and where necessary to terminate, tap-off, or redirect multiple conduit runs.
8. Install in conduit runs at least every 150 feet or after the equivalent of three right-angle bends.

B. Flush Mounted:

1. Install with concealed conduit.
2. Holes in surrounding surface shall be no larger than required to receive box.
3. Make edges of boxes flush with final surface.

C. Mounting Hardware:

1. Noncorrosive Dry Areas: Galvanized.
2. Noncorrosive Wet Areas: Stainless steel.
3. Corrosive Areas: Stainless steel.

D. Supports:

1. Support boxes independently of conduit by attachment to building structure or structural member.
2. Install bar hangers in frame construction or fasten boxes directly as follows:
   a. Wood: Wood screws.
   b. Concrete or Brick: Bolts and expansion shields.
   c. Hollow Masonry Units: Toggle bolts.
   d. Steelwork: Machine screws.
3. Threaded studs driven in by powder charge and provided with lock washers and nuts are acceptable in lieu of expansion shields.
4. Boxes embedded in concrete or masonry need not be additionally supported.

E. At or Below Grade:

1. Install boxes for below grade conduit flush with finished grade in locations outside of paved areas, roadways, or walkways.
2. If adjacent structure is available, box may be mounted on structure surface just above finished grade in accessible but unobtrusive location.
3. Obtain Contracting Officer's written acceptance prior to installation in paved areas, roadways, or walkways.
4. Use boxes and covers suitable to support anticipated weights.

F. Install Drain/breather fittings in NEMA 250 Type 4 and Type 4X enclosures.

3.17 MANHOLES AND HANDHOLES

A. Excavate, shore, brace, backfill, and final grade in accordance with Section 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

B. Do not install until final raceway grading has been determined.

C. Install such that raceway enters at nearly right angle and as near as possible to end of wall, unless otherwise shown.

D. Grounding: As specified in Section 26 05 26, Grounding and Bonding for Electrical Systems.

E. Identification: Field stamp covers with manhole or handhole number as shown. Stamped numbers to be 1-inch minimum height.

3.18 EMPTY RACEWAYS

A. Provide permanent, removable cap over each end.

B. Provide PVC plug with pull tab for underground raceways with end bells.

C. Provide nylon pull cord.

D. Identify, as specified in Article Identification Devices, with waterproof tags attached to pull cord at each end, and at intermediate pull point.

3.19 IDENTIFICATION DEVICES

A. Install approximately 12 inches above underground or concrete-encased raceways. Align parallel to, and within 12 inches of, centerline of run.

3.20 PROTECTION OF INSTALLED WORK

A. Protect products from effects of moisture, corrosion, and physical damage during construction.

B. Provide and maintain manufactured watertight and dust-tight seals over conduit openings during construction.

C. Touch up painted conduit threads after assembly to cover nicks or scars.

END OF SECTION

SECTION 26 05 70
ELECTRICAL SYSTEMS ANALYSIS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   b. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems.
   c. 399, Recommended Practice for Industrial and Commercial Power System Analysis.
   d. 1584, Guide for Performing Arc Flash Hazard Calculations, 2018 edition.
3. National Electrical Manufacturers Association (NEMA): Z535.4, Product Safety Signs and Labels.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70E, Standard for Electrical Safety in the Workplace.
5. Occupational Safety and Health Standards (OSHA): 29 CFR, Part 1910 Subpart S, Electrical.

1.02 SUBMITTALS

A. Action Submittals:

1. Initial Short Circuit Study.
2. Final Short Circuit Study.
3. Initial Protective Device Coordination Study.
4. Final Protective Device Coordination Study.
5. Arc Flash Study.
6. Arc flash warning labels.
7. Electronic files of final studies including all engineering software input files, output reports, and libraries.

1.03 QUALITY ASSURANCE

A. Short circuit and protective device coordination and arc flash studies shall be prepared by a professional electrical engineer registered in the State of New Mexico.

1.04 SEQUENCING AND SCHEDULING

A. Initial complete short circuit study shall be submitted and reviewed before switchgear and incoming service submittals.

B. Initial complete protective device coordination and arc flash studies shall be submitted within 90 days after approval of initial short circuit study.

C. Initial complete arc flash study shall be submitted and accepted prior to energization of the electrical equipment.

D. Revised short circuit, protective device coordination, and arc flash studies, and arc flash labels shall be submitted 10 days before energizing electrical equipment.

E. Final short circuit, protective device coordination, and arc flash studies shall be completed prior to Project Substantial Completion. Final version of study shall include as-installed equipment, materials, and parameter data or settings entered into equipment based on study.

F. Submit final arc flash labels described herein and in compliance with NEMA Z535.4 prior to Project Substantial Completion.

1.05 GENERAL STUDY REQUIREMENTS

A. Equipment and component titles used in the studies shall be identical to equipment and component titles shown on the Drawings.

B. Perform studies using one of the following electrical engineering software packages:

1. SKM Power Tools for Windows.
2. ETAP.
3. Easy Power.

C. Utilize proposed load data for study obtained from Contract Documents.

D. Existing System and Equipment:

1. Extent of existing system to be included in study is limited to system elements that are refed from new system and equipment.
2. Include fault contribution of existing motors and equipment in study.
3. Include impedance elements that affect new system and equipment.
4. Include protective devices in series with new equipment.

E. Device coordination time-current curves for medium voltage distribution system; include individual protective device time-current characteristics.

1.06 SHORT CIRCUIT STUDY

A. General:

1. Prepare in accordance with IEEE 399.
2. Use cable impedances based on copper conductors, except where aluminum conductors are specified or shown.
3. Use bus impedances based on copper bus bars, except where aluminum bus bars are specified or shown.
4. Use cable and bus resistances calculated at 25 degrees C.
5. Use medium-voltage cable reactances based on use of typical dimensions of shielded cables with 133 percent insulation levels.
6. Use 600-volt cable reactances based on use of typical dimensions of THHN/THWN conductors.
7. Obtain and utilize Utility fault contribution current data for primary service point.
8. Use transformer impedances 92.5 percent of “nominal” impedance based on tolerances specified in IEEE C57.12.00.

B. Provide:

1. Calculation methods and assumptions.
2. Typical calculation.
3. Tabulations of calculated quantities.
4. Results, conclusions, and recommendations.
5. Selected base per unit quantities.
6. One-line diagrams.
7. Source impedance data, including electric utility system and motor fault contribution characteristics.

C. Calculate short circuit interrupting and momentary (when applicable) duties for an assumed three-phase bolted fault at each:

1. Electric utility’s supply termination point.
2. Medium voltage pad-mounted switchgear and sectionalizing equipment.
3. Transformer primary and secondary terminals.
4. Low-voltage service equipment.
5. Safety disconnect switches, three-phase or fed from 480V source.
6. Low-voltage branch circuit panelboards.
7. Future load contributions as shown on one-line diagram.

D. Provide bolted line-to-ground fault current study for areas as defined for three-phase bolted fault short circuit study.

E. Provide bolted line-to-line fault current study for areas as defined for three-phase bolted fault short circuit study.

F. Verify:

1. Equipment and protective devices are applied within their ratings.
2. Adequacy of switchgear bus bars to withstand short circuit stresses.
3. Adequacy of transformer windings to withstand short circuit stresses.
4. Cable sizes for ability to withstand short circuit heating, in addition to normal load currents.

G. Tabulations:

1. General Data:
   a. Short circuit reactances of rotating machines.
   b. Cable and conduit material data.
   c. Bus data.
   d. Transformer data.
   e. Circuit resistance and reactance values.
2. Short Circuit Data:
   a. Fault impedances.
   b. X to R ratios.
   c. Asymmetry factors.
   d. Motor contributions.
   e. Short circuit kVA.
   f. Symmetrical and asymmetrical fault currents.
3. Equipment Evaluation:
   a. Equipment bus bracing, equipment short circuit rating, transformer, cable, busway.
   b. Maximum fault current available.

H. Written Summary:

1. Scope of studies performed.
2. Explanation of bus and branch numbering system.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of short circuit study.
6. Comments or suggestions.

I. Suggest changes and additions to equipment rating and/or characteristics.

J. Notify Contracting Officer in writing of existing circuit protective devices improperly rated for new fault conditions.

K. Revise data for “as-installed” condition.

1.07 PROTECTIVE DEVICE COORDINATION STUDY

A. General:

1. Prepare in accordance with IEEE 242.
2. Proposed protective device coordination time-current curves for distribution system, graphically displayed on conventional log-log curve sheets.
   a. Provide separate curve sheets for phase and ground fault coordination for each scenario.
   b. Each curve sheet to have title and one-line diagram that applies to specific portion of system associated with time-current curves on that sheet. Limit number of devices shown to four to six.
   c. Identify device associated with each curve by manufacturer type, function, and, if applicable, recommended tap, time delay, instantaneous and other settings recommended.
   d. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which device is exposed.
   e. Apply motor protection methods that comply with NFPA 70.

B. Plot Characteristics on Curve Sheets:

1. Electric utility's fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
2. Medium-voltage equipment relays.
3. Medium-voltage and low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
4. Low-voltage equipment circuit breaker trip devices, including manufacturers tolerance bands.
5. Transformer magnetizing inrush currents.
6. Transformer damage curves; appropriate for system operation and location.
7. Significant symmetrical and asymmetrical fault currents.
8. Ground fault protective device settings.
9. Other system load protective devices for largest branch circuit and feeder circuit breaker in each motor control center.

C. Primary Protective Device Settings for Delta-Wye Connected Transformer:

1. Secondary Line-to-Ground Fault Protection: Primary protective device operating band within transformer's characteristics curve, including a point equal to 58 percent of IEEE C57.12.00 withstand point.
2. Secondary Line-to-Line Faults: 16 percent current margin between primary protective device and associated secondary device characteristic curves.

D. Tabulate Recommended Protective Device Settings:

1. Relays:
   a. Current tap.
   b. Time dial.
   c. Instantaneous pickup.
   d. Electronic settings data file.
2. Circuit Breakers:
   a. Adjustable pickups.
   b. Adjustable time-current characteristics.
   c. Adjustable time delays.
   d. Adjustable instantaneous pickups.
   e. I^2t In/Out.
   f. Zone interlocking.
   g. Electronic settings data file.

E. Written Summary:

1. Scope of studies performed.
2. Summary of protective device coordination methodology.
3. Prevailing conditions.
4. Selected equipment deficiencies.
5. Results of coordination study.
6. Appendix of complete relay and circuit breaker electronic setting files.
7. Comments or suggestions.

1.08 ARC FLASH STUDY

A. Perform arc flash study in accordance with NFPA 70E, OSHA 29 CFR, Part 1910 Subpart S, and IEEE 1584.

B. Base Calculation:

1. For each major part of electrical power system, determine the following:
   a. Flash hazard protection boundary.
   b. Limited approach boundary.
   c. Restricted approach boundary.
   d. Incident energy level.
   e. Glove class required.

C. Produce arc flash warning labels that list items in Paragraph Base Calculation and the following additional items.

1. Bus name.
2. Bus voltage.

D. Produce bus detail sheets that list items in Paragraph Base Calculation and the following additional items:

1. Bus name.
2. Upstream protective device name, type, and settings.
3. Bus line-to-line voltage.

E. Produce arc flash evaluation summary sheet listing the following additional items:

1. Bus name.
2. Upstream protective device name, type, settings.
3. Bus line-to-line voltage.
4. Bus bolted fault.
5. Protective device bolted fault current.
6. Arcing fault current.
7. Protective device trip/delay time.
8. Breaker opening time.
9. Equipment type.
10. Gap.
11. Arc flash boundary.
12. Working distance.
13. Incident energy.

F. Analyze short circuit, protective device coordination, and arc flash calculations and highlight equipment that is determined to be underrated or causes incident energy values greater than 40 cal/cm^2. Propose approaches to reduce energy levels.

G. Prepare report summarizing arc flash study with conclusions and recommendations which may affect integrity of electric power distribution system. As a minimum, include the following:

1. Equipment manufacturer’s information used to prepare study.
2. Assumptions made during study.
3. Reduced copy of one-line drawing; 11 inches by 17 inches maximum.
4. Arc flash evaluations summary spreadsheet.
5. Bus detail sheets.
6. Arc flash warning labels printed in color on thermally bonded adhesive backed UV and weather-resistant labels.

PART 2 PRODUCTS

2.01 ARC FLASH WARNING LABELS

A. Physical Characteristics:

1. Arc flash warning labels printed in color on thermally bonded adhesive backed labels.
2. Arc flash warning labels for incident energy levels less than 40 cal/cm^2 shall be similar to Supplement Figure 1.
3. Arc flash warning labels for incident energy equal or greater than 40 cal/cm^2 shall be similar to Supplement Figure 2.

B. Functional Characteristics: UV and weather resistant.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

A. Adjust relay and protective device settings according to values established by coordination study.

B. Make minor modifications to equipment as required to accomplish conformance with short circuit and protective device coordination studies.

C. Notify Contracting Officer in writing of required major equipment modifications.

D. Provide arc flash warning labels on the following equipment:

1. Utility service and metering equipment.
2. Low-voltage service and metering equipment.
3. Switchgear.
4. Transfer switches.
5. Panelboards.
6. Safety disconnect switches fed by three-phase or 480V source.
7. Equipment requiring servicing, adjustment, or inspection while energized.

3.02 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. Figure 1: Example Arc Flash Label – Warning.
2. Figure 2: Example Arc Flash Label – Danger.

END OF SECTION

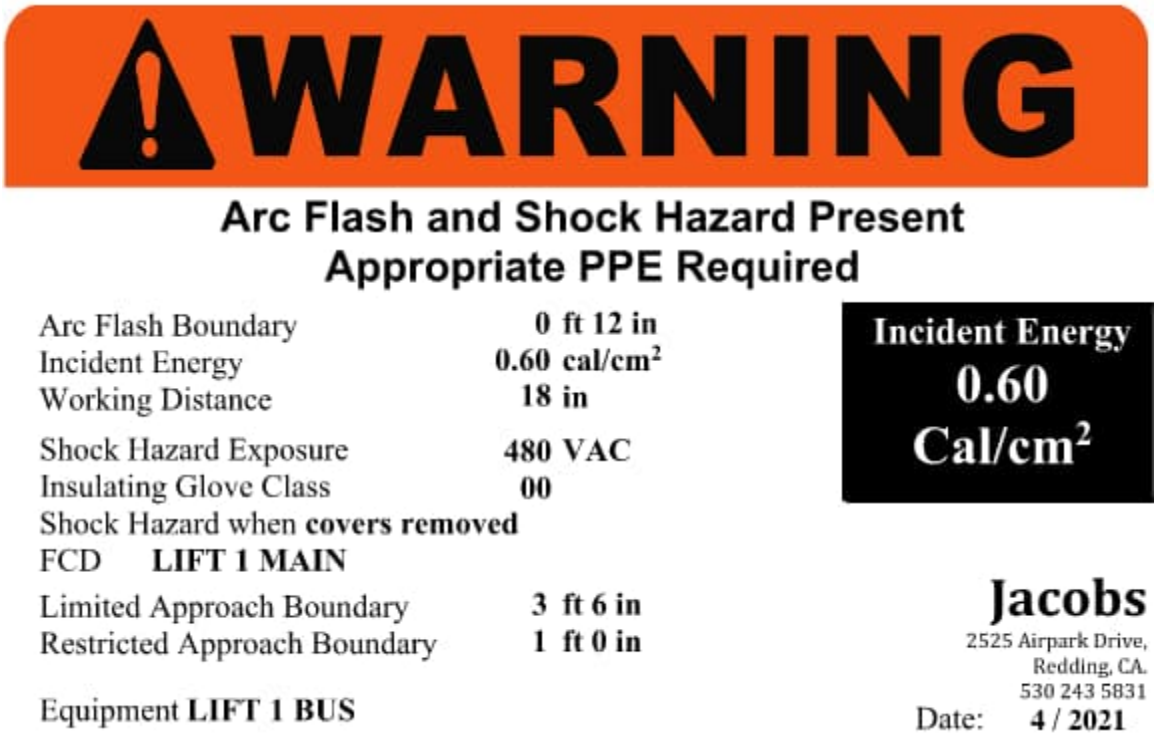


Figure 1
Example Arc Flash Label – Warning

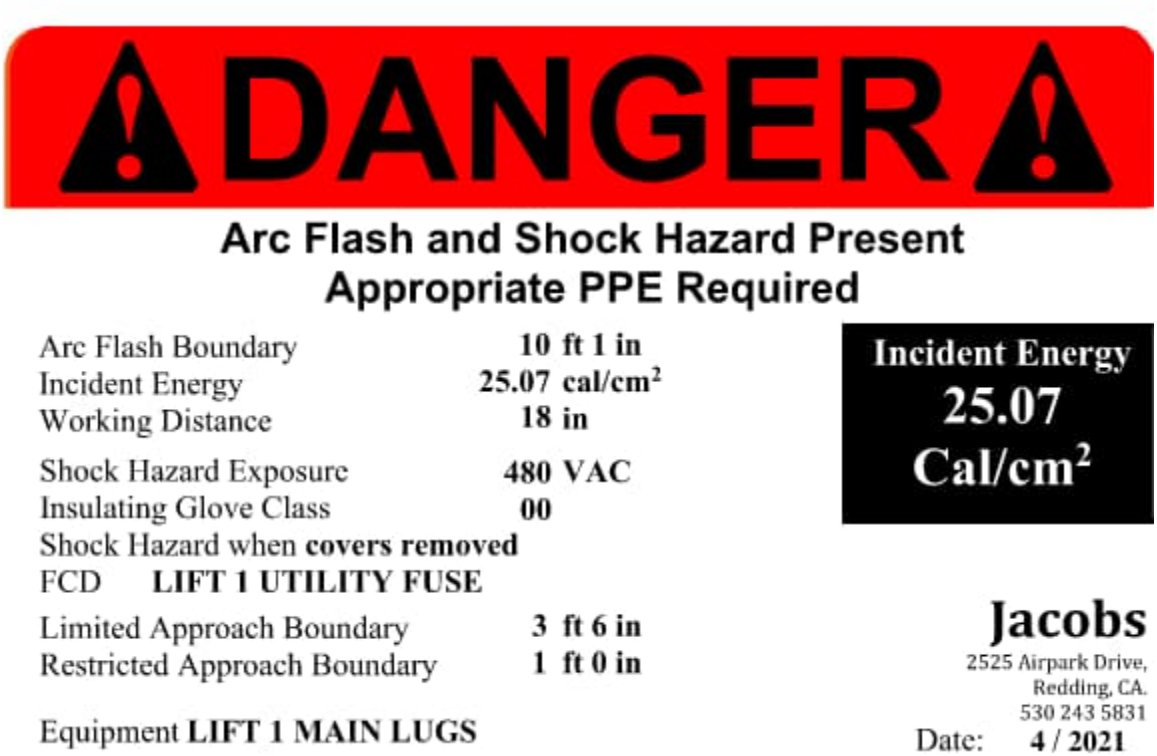


Figure 2
Example Arc Flash Label – Danger

SECTION 26 08 00
COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D877/D877M, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes.
   b. D923, Standard Practices for Sampling Electrical Insulating Liquids.
   c. D924, Standard Test Method for Dissipation Factor (or Power Factor) and Relative Permittivity (Dielectric Constant) of Electrical Insulating Liquids.
   d. D971, Standard Test Method for Interfacial Tension of Oil Against Water by the Ring Method.
   e. D974, Standard Test Method for Acid and Base Number by Color-Indicator Titration.
   f. D1298, Standard Test Method for Density, Relative Density, or API Gravity of Crude Petroleum and Liquid Petroleum Products by Hydrometer Method.
   g. D1500, Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale).
   h. D1524, Standard Test Method for Visual Examination of Used Electrical Insulating Liquids in the Field.
   i. D1533, Standard Test Method for Water in Insulating Liquids by Coulometric Karl Fischer Titration.
   j. D1816, Standard Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using VDE Electrodes.
2. Institute of Electrical and Electronics Engineers (IEEE):
   a. 43, Recommended Practice for Testing Insulation Resistance of Electric Machinery.
   b. 48, Standard Test Procedures and Requirements for Alternating-Current Cable Terminators Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV.
   c. 81, Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
   d. 95, Recommended Practice for Insulation Testing of AC Electric Machinery (2300V and Above) with High Direct Voltage.
   e. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.

f. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
g. 450, Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications.
h. C2, National Electrical Safety Code.
i. C37.20.1, Standard for Metal-Enclosed Low-Voltage (1000 Vac and below, 3200 Vdc and below) Power Circuit Breaker Switchgear.
j. C37.20.2, Standard for Metal-Clad Switchgear.
k. C37.20.3, Standard for Metal-Enclosed Interrupter Switchgear.
l. C37.23, Standard for Metal-Enclosed Bus.
m. C62.33, Standard Test Methods and Performance Values for Metal-Oxide Varistor Surge Protective Components.

3. Insulated Cable Engineers Association (ICEA):
   a. S-93-639, 5-46 kV Shielded Power Cables for Use in the Transmission and Distribution of Electric Energy.
   b. S-94-649, Concentric Neutral Cables Rated 5 through 46 kV.
   c. S-97-682, Standard for Utility Shielded Power Cables Rated 5 through 46 kV.
4. National Electrical Manufacturers Association (NEMA):
   a. AB 4, Guidelines for Inspection and Preventive Maintenance of Molded Case Circuit Breakers Used in Commercial and Industrial Applications.
   b. PB 2, Deadfront Distribution Switchboards.
   c. WC 74, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
5. InterNational Electrical Testing Association (NETA): ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).
   b. 70B, Recommended Practice for Electrical Equipment Maintenance.
   c. 70E, Standard for Electrical Safety in the Workplace.
   d. 101, Life Safety Code.
7. National Institute for Certification in Engineering Technologies (NICET).
8. Occupational Safety and Health Administration (OSHA): CFR 29, Part 1910, Occupational Safety and Health Standards.

1.02 SUBMITTALS

A. Informational Submittals:

1. Submit 30 days prior to performing inspections or tests:
   a. Testing firm qualifications.
   b. Schedule for performing inspection and tests.
   c. List of references to be used for each test.
   d. Sample copy of equipment and materials inspection form(s).
   e. Sample copy of individual device test form.
   f. Sample copy of individual system test form.
2. Energization Plan:
   a. Prior to initial energization of electrical distribution equipment; include the following:
      1) Owner's representative sign-off form for complete and accurate arc flash labeling and proper protective device settings for equipment to be energized.
      2) Staged sequence of initial energization of electrical equipment.
      3) Lock-Out-Tag-Out plan for each stage of the progressive energization.
      4) Barricading, signage, and communication plan notifying personnel of newly energized equipment.
3. Submit test or inspection reports and certificates for each electrical item tested within 30 days after completion of test:
4. Operation and Maintenance Data:
   a. In accordance with Section 01 78 23, Operation and Maintenance Data.
   b. After test or inspection reports and certificates have been reviewed and returned, insert a copy of each in Operation and Maintenance Manual.
5. Programmable Settings:
   a. Prior to substantial completion, submit final hardcopy printout and electronic files of as-left setpoints, programs, and device configuration files for:
      1) Protective relays.
      2) Intelligent overload relays.
      3) Adjustable frequency drives.
      4) Power metering devices.

1.03 QUALITY ASSURANCE

A. Testing Firm Qualifications:

1. Independent testing organization functioning as an unbiased testing authority.
2. Employer of engineers and technicians regularly engaged in testing and inspecting of electrical equipment, installations, and systems.
3. Supervising engineer accredited as Certified Electrical Test Technologist by NICET or NETA and having a minimum of 5 years' testing experience on similar projects.
4. Technicians certified by NICET or NETA.
5. Assistants and apprentices assigned to Project at ratio not to exceed two certified to one noncertified assistant or apprentice.
6. Registered Professional Engineer to provide comprehensive Project report outlining services performed, results of such services, recommendations, actions taken, and opinions.
7. In compliance with OSHA CFR 29, Part 1910.7 criteria for accreditation of testing laboratories or a full member company of NETA.

B. Test equipment shall have an operating accuracy equal to or greater than requirements established by NETA ATS.

C. Test Instrument Calibration: In accordance with NETA ATS.

1.04 SEQUENCING AND SCHEDULING

A. Perform inspection and electrical tests after equipment listed herein has been installed.

B. Perform tests with apparatus de-energized whenever feasible.

1. Scheduled with Contracting Officer prior to de-energization.
2. Minimized to avoid extended period of interruption to the operating plant equipment.

C. Notify Contracting Officer at least 24 hours prior to performing tests on energized electrical equipment.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Perform tests in accordance with requirements of Section 01 91 14, Equipment Testing and Facility Startup.

B. Tests and inspections shall establish:

1. Electrical equipment is operational within industry and manufacturer's tolerances and standards.
2. Installation operates properly.
3. Equipment is suitable for energization.
4. Installation conforms to requirements of Contract Documents and NFPA 70, NFPA 70E, NFPA 101, and IEEE C2.

C. Perform inspection and testing in accordance with NETA ATS, industry standards, and manufacturer's recommendations.

D. Set, test, and calibrate protective relays, circuit breakers, fuses, power monitoring meters, and other applicable devices in accordance with values established by studies as specified in Section 26 05 70, Electrical Systems Analysis.

E. Adjust mechanisms and moving parts of equipment for free mechanical movement.

F. Adjust and set electromechanical electronic relays and sensors to correspond to operating conditions, or as recommended by manufacturer.

G. Verify nameplate data for conformance to Contract Documents and approved Submittals.

H. Realign equipment not properly aligned and correct unlevelness.

I. Properly anchor electrical equipment found to be inadequately anchored.

J. Tighten accessible bolted connections, including wiring connections, with calibrated torque wrench/screw driver to manufacturer's recommendations, or as otherwise specified in NETA ATS.

K. Clean contaminated surfaces with cleaning solvents as recommended by manufacturer.

L. Provide proper lubrication of applicable moving parts.

M. Inform Contracting Officer of working clearances not in accordance with NFPA 70.

N. Investigate and repair or replace:

1. Electrical items that fail tests.
2. Active components not operating in accordance with manufacturer's instructions.
3. Damaged electrical equipment.

O. Electrical Enclosures:

1. Remove foreign material and moisture from enclosure interior.
2. Vacuum and wipe clean enclosure interior.
3. Remove corrosion found on metal surfaces.
4. Repair or replace, as determined by Contracting Officer, door and panel sections having dented surfaces.
5. Repair or replace, as determined by Contracting officer, poor fitting doors and panel sections.
6. Repair or replace improperly operating latching, locking, or interlocking devices.
7. Replace missing or damaged hardware.
8. Finish:
   a. Provide matching paint and touch up scratches and mars.
   b. If required because of extensive damage, as determined by Contracting Officer refinish entire assembly.

P. Replace fuses and circuit breakers that do not conform to size and type required by the Contract Documents or approved Submittals.

3.02 CHECKOUT AND STARTUP

A. Voltage Field Test:

1. Check voltage at point of termination of power company supply system to Project when installation is essentially complete and is in operation.
2. Check voltage amplitude and balance between phases for loaded and unloaded conditions.
3. Record supply voltage (all three phases simultaneously on same graph) for 24 hours during normal working day.
4. Unbalance Corrections:
   a. Make written request to power company to correct condition if balance (as defined by NEMA) exceeds 1 percent, or if voltage varies throughout the day and from loaded to unloaded condition more than plus or minus 4 percent of nominal.

b. Obtain written certification from responsible power company official that voltage variations and unbalance are within their normal standards if corrections are not made.

B. Equipment Line Current Tests:

1. Check line current in each phase for each piece of equipment.
2. Make line current check after power company has made final adjustments to supply voltage magnitude or balance.
3. If phase current for a piece of equipment is above rated nameplate current, prepare Equipment Line Phase Current Report that identifies cause of problem and corrective action taken.

3.03 SWITCHGEAR ASSEMBLIES

A. Visual and Mechanical Inspection:

1. Insulator damage and contaminated surfaces.
2. Proper barrier and shutter installation and operation.
3. Proper operation of indicating devices.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check key interlocking systems for:
   a. Key captivity when device is in CLOSED position.
   b. Key removal when device is in CLOSED position.
   c. Closure attempt of device when key has been removed.
   d. Correct number of keys in relationship to number of lock cylinders.
   e. Existence of Other Keys Capable of Operating Lock Cylinders: Destroy duplicate sets of keys.
8. Check nameplates for proper identification of: Equipment title and tag number with latest one-line diagram.
9. Verify fuse and circuit breaker ratings, sizes, and types conform to those specified.
10. Check bolted electrical connections for high resistance by low resistance ohmmeter and calibrated torque wrench applied to bolted joints.
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
11. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
12. Verify performance of each control device and feature.

13. Control Wiring:
    a. Compare wiring to local and remote control and protective devices with elementary diagrams.
    b. Proper conductor lacing and bundling.
    c. Proper conductor identification.
    d. Proper conductor lugs and connections.
14. Exercise active components.
15. Perform phasing check on double-ended equipment to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. With switches open.
    e. With switches closed.
    f. Control wiring except that connected to solid state components.
    g. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Overpotential Tests:
    a. Applied ac or dc voltage and test procedure in accordance with C37.20.3. Alternatively use NETA ATS, Table 100.2.
    b. Each phase of each bus section.
    c. Phase-to-phase and phase-to-ground for 1 minute.
    d. Test results evaluated on a pass/fail basis.
3. Current Injection Tests:
    a. For entire current circuit in each section.
    b. Secondary injection for current flow of 1 ampere.
    c. Test current at each device.
4. Control Wiring:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal boards and each device terminal.
5. Operational Test:
    a. Initiate control devices.
    b. Check proper operation of control system in each section.

3.04 PANELBOARDS

A. Visual and Mechanical Inspection: Include the following inspections and related work:

1. Inspect for defects and physical damage, labeling, and nameplate compliance with requirements of up-to-date drawings and panelboard schedules.
2. Exercise and perform operational tests of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
3. Check panelboard mounting, area clearances, and alignment and fit of components.
4. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
5. Perform visual and mechanical inspection for overcurrent protective devices.

B. Electrical Tests:

1. Include the following items performed in accordance with manufacturer's instruction:
   a. Insulation Resistance Tests:
      1) Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
      2) Each phase of each bus section.
      3) Phase-to-phase and phase-to-ground for 1 minute.
      4) With breakers open.
      5) With breakers closed.
      6) Control wiring except that connected to solid state components.
      7) Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   b. Ground continuity test ground bus to system ground.

3.05 DRY TYPE TRANSFORMERS

A. Dry-type transformer tests may be performed by installer in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.

5. Removal of shipping brackets, fixtures, or bracing.
6. Free and properly installed resilient mounts.
7. Cleanliness and improper blockage of ventilation passages.
8. Verify tap-changer is set at correct ratio for rated output voltage under normal operating conditions.
9. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.

3.06 LIQUID FILLED TRANSFORMERS

A. Visual and Mechanical Inspection:

1. Physical and insulator damage.
2. Proper winding connections.
3. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
4. Defective wiring.
5. Proper operation of fans, indicators, and auxiliary devices.
6. Effective core and equipment grounding.
7. Removal of shipping brackets, fixtures, or bracing.
8. Tank leaks and proper liquid level.
9. Integrity and contamination of bus insulation system.
10. Verify tap-changer is set at correct ratio for rated voltage under normal operating conditions.
11. Verify proper secondary voltage phase-to-phase and phase-to-ground after energization and prior to loading.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.5 for each:
      1) Winding-to-winding.
      2) Winding-to-ground.
   b. Test Duration: 10 minutes with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
   c. Results temperature corrected in accordance with NETA ATS, Table 100.14.
   d. Temperature corrected insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
   e. Insulation resistance test results to compare within 1 percent of adjacent windings.
2. Sample insulating oil in accordance with ASTM D923 and have laboratory test for:
   a. Dielectric breakdown voltage in accordance with ASTM D877/D877M or ASTM D1816.
   b. Acid neutralization number in accordance with ASTM D974.
   c. Interfacial tension in accordance with ASTM D971.
   d. Color in accordance with ASTM D1500.
   e. Visual condition in accordance with ASTM D1524.
   f. Specific gravity in accordance with ASTM D1298.
   g. Water content, in parts per million, in accordance with ASTM D1533.
   h. Dielectric fluid test results in accordance with NETA ATS, Table 100.4.
   i. Power factor at 25 degrees C and at 100 degrees, in accordance with ASTM D924.
   j. Maximum power factor, corrected to 20 degrees C, in accordance with manufacturer's specifications.

3.07 LOW VOLTAGE CABLES, 600 VOLTS MAXIMUM

A. Low-voltage cable tests may be performed by installer in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Inspect each individual exposed power cable No. 4 and larger for:
   a. Physical damage.
   b. Proper connections in accordance with single-line diagram.
   c. Cable bends not in conformance with manufacturer's minimum allowable bending radius where applicable.

d. Color coding conformance with specification.
e. Proper circuit identification.

2. Mechanical Connections for:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
3. Shielded Instrumentation Cables for:
   a. Proper shield grounding.
   b. Proper terminations.
   c. Proper circuit identification.
4. Control Cables for:
   a. Proper termination.
   b. Proper circuit identification.
5. Cables Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

C. Electrical Tests for Conductors No. 4 and Larger:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 600-volt insulated conductors.
   b. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   c. Evaluate ohmic values by comparison with conductors of same length and type.
   d. Investigate values less than 50 megohms.
2. Continuity test by ohmmeter method to ensure proper cable connections.

3.08 MEDIUM-VOLTAGE CABLES, 15 KV MAXIMUM

A. Visual and Mechanical Inspection:

1. Inspect each individual exposed cable for:
   a. Physical damage plus jacket and insulation condition.
   b. Proper connections in accordance with single-line diagram or approved Submittals.
   c. Proper shield grounding.
   d. Proper cable support.
   e. Proper cable termination.
   f. Cable bends not in conformance with manufacturer’s minimum allowable bending radius.
   g. Proper arc and fireproofing in common cable areas.
   h. Proper circuit and phase identification.

2. Mechanical Connections:
   a. Proper lug type for conductor material.
   b. Proper lug installation.
   c. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturers.
3. Conductors Terminated Through Window Type CTs: Verify neutrals and grounds are terminated for correct operation of protective devices.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 5,000-volt megohmmeter for 8 kV and 15 kV conductors.
   b. Test each cable individually with remaining cables and shields grounded.
   c. Test each conductor with respect to ground and to adjacent conductors for 1 minute.
   d. Evaluate ohmic values by comparison with conductors of same length and type.
   e. Investigate values less than 50 megohms.
2. Shield Continuity Tests:
   a. By ohmmeter method on each section of conductor.
   b. Investigate values in excess of 10 ohms per 1,000 feet of conductors.
3. Acceptance Tests:
   a. In accordance with IEEE 400, ICEA S-93-639, NEMA WC 74, ICEA S-94-649, and ICEA S-97-682 for insulated conductors.
   b. Each conductor section tested with:
      1) Splices and terminations in place but disconnected from equipment.
      2) Remaining conductors and shields grounded in accordance with IEEE 400.
   c. Apply maximum test voltage per NETA ATS, Table 100.6, based on method (DC, AC, PD, or VLF) used.
   d. Measure only leakage current associated with conductor.
   e. Utilize guard ring or field reduction sphere to suppress corona at disconnected terminations.
   f. Maximum test voltage shall not exceed limits for terminators specified in IEEE 48, IEEE 386, or manufacturer’s specifications.
   g. Apply test voltage in a minimum of five equal increments until maximum acceptable test voltage is reached.
      1) Increments not to exceed ac voltage rating of conductor.
      2) Record dc leakage current at each step after a constant stabilization time consistent with system charging current.
   h. Raise conductor to specified maximum test voltage and hold for 15 minutes or as specified by conductor manufacturer. Record

leakage current at 30 seconds and 1 minute, and at 1-minute intervals, thereafter.

i. Immediately following test, ground conductor for adequate time period to drain insulation stored charge.

j. Test results evaluated on a pass/fail basis.

3.09 SAFETY SWITCHES, 600 VOLTS MAXIMUM

A. Safety switch tests may be performed by installer in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Proper blade pressure and alignment.
2. Proper operation of switch operating handle.
3. Adequate mechanical support for each fuse.
4. Proper contact-to-contact tightness between fuse clip and fuse.
5. Cable connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Proper phase barrier material and installation.
7. Verify fuse sizes and types correspond to one-line diagram or approved Submittals.
8. Perform mechanical operational test and verify interlocking system operation and sequencing.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate deviation of 50 percent or more from adjacent poles or similar switches.

3.10 MEDIUM-VOLTAGE METAL-ENCLOSED AIR SWITCHES

A. Visual and Mechanical Inspection:

1. Proper blade pressure, alignment, and arch interrupter operation.
2. Proper operation of operating mechanism.
3. Proper contact condition.
4. Adequate mechanical support for each fuse.

5. Proper contact-to-contact tightness between fuse clip and fuse.
6. Bus and cable connection tightness.
7. Proper phase barrier material and installation.
8. Proper operation of indicating devices.
9. Installation of expulsion limiting devices on expulsion type element holders.
10. Verify fuse links and types correspond to one-line diagram or approved Submittals.
11. Perform mechanical operational test to verify interlocking system operation and sequencing.
12. Perform phasing check on double-ended air switch arrangements to ensure proper bus phasing from each source.

B. Electrical Tests:

1. Insulation Resistance Tests:
   a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
   b. Phase-to-phase and phase-to-ground for 1 minute on each pole.
   c. Insulation resistance values equal to, or greater than, ohmic values established by manufacturer.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each switch blade and fuse holder.
   b. Investigate values exceeding 500 microhms or deviation of 50 percent or more from adjacent poles or similar switches.
3. Overpotential Tests:
   a. Applied ac or dc voltage in accordance with NETA ATS, Table 100.19.
   b. Phase-to-phase and phase-to-ground for 1 minute.
   c. Test results evaluated on pass/fail basis.

3.11 MOLDED AND INSULATED CASE CIRCUIT BREAKERS

A. General: Inspection and testing limited to circuit breakers rated 70 amperes and larger and to motor circuit protector breakers rated 50 amperes and larger.

B. Visual and Mechanical Inspection:

1. Proper mounting.
2. Proper conductor size.
3. Feeder designation according to nameplate and one-line diagram.
4. Cracked casings.
5. Connection bolt torque level in accordance with NETA ATS, Table 100.12.
6. Operate breaker to verify smooth operation.

7. Compare frame size and trip setting with circuit breaker schedules or one-line diagram.
8. Verify that terminals are suitable for 75 degrees C rated insulated conductors.

C. Electrical Tests:

1. Insulation Resistance Tests:
   a. Utilize 1,000-volt dc megohmmeter for 480-volt and 600-volt circuit breakers and 500-volt dc megohmmeter for 240-volt circuit breakers.
   b. Pole-to-pole and pole-to-ground with breaker contacts opened for 1 minute.
   c. Pole-to-pole and pole-to-ground with breaker contacts closed for 1 minute.
   d. Test values to comply with NETA ATS, Table 100.1.
2. Contact Resistance Tests:
   a. Contact resistance in microhms across each pole.
   b. Investigate deviation of 50 percent or more from adjacent poles and similar breakers.
3. Primary Current Injection Test to Verify:
   a. Long-time minimum pickup and delay.
   b. Short-time pickup and delay.
   c. Ground fault pickup and delay.
   d. Instantaneous pickup by run-up or pulse method.
   e. Trip characteristics of adjustable trip breakers shall be within manufacturer's published time-current characteristic tolerance band, including adjustment factors.
   f. Trip times shall be within limits established by NEMA AB 4, Table 5-3. Alternatively, use NETA ATS, Table 100.7.
   g. Instantaneous pickup value shall be within values established by NEMA AB 4, Table 5-4. Alternatively, use NETA ATS, Table 100.8.

3.12 INSTRUMENT TRANSFORMERS

A. Instrument transformer tests may be performed by installer in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Visually check current, potential, and control transformers for:
   a. Cracked insulation.
   b. Broken leads or defective wiring.

c. Proper connections.
d. Adequate clearances between primary and secondary circuit wiring.

2. Verify Mechanically:
a. Grounding and shorting connections have good contact.
b. Withdrawal mechanism and grounding operation, when applicable, operate properly.

3. Verify proper primary and secondary fuse sizes for potential transformers.

C. Electrical Tests:

1. Current Transformer Tests:
a. Insulation resistance test of transformer and wiring-to-ground at 1,000 volts dc for 30 seconds.
b. Polarity test.
c. Ratio and accuracy test.

2. Potential Transformer Tests:
a. Insulation resistance test at test voltages in accordance with NETA ATS, Table 100.9, for 1 minute on:
1) Winding-to-winding.
2) Winding-to-ground.
b. Polarity test to verify polarity marks or H1-X1 relationship as applicable.
c. Ratio and accuracy test.

3. Insulation resistance measurement on instrument transformer shall not be less than that shown in NETA ATS, Table 100.5.

3.13 METERING

A. Metering tests may be performed by installer in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Verify meter connections in accordance with appropriate diagrams.
2. Verify meter multipliers.
3. Verify meter types and scales conform to Contract Documents.
4. Check calibration of meters at cardinal points.
5. Check calibration of electrical transducers.

3.14 GROUNDING SYSTEMS

A. Visual and Mechanical Inspection:

1. Equipment and circuit grounds in panelboard and switchgear assemblies for proper connection and tightness.
2. Ground bus connections in panelboard and switchgear assemblies for proper termination and tightness.
3. Effective transformer core and equipment grounding.
4. Accessible connections to grounding electrodes for proper fit and tightness.
5. Accessible exothermic-weld grounding connections to verify that molds were fully filled and proper bonding was obtained.

B. Electrical Tests:

1. Fall-of-Potential Test:
   a. In accordance with IEEE 81, Section 8.2.1.5 for measurement of main ground system's resistance.
   b. Main ground electrode system resistance to ground to be no greater than 3 ohm(s).
2. Two-Point Direct Method Test:
   a. In accordance with IEEE 81, Section 8.2.1.1 for measurement of ground resistance between main ground system, equipment frames, and system neutral and derived neutral points.
   b. Equipment ground resistance shall not exceed main ground system resistance by 0.50 ohm.
3. Neutral Bus Isolation:
   a. Test neutral bus individually with neutral bonding jumper removed at service entrance or separately derived system.
   b. Evaluate ohmic values by measuring resistance between ground bus and neutral bus.
   c. Investigate values less than 50 megohms.

3.15 AC INDUCTION MOTORS

A. Motor tests may be performed by installer in lieu of independent testing firm.

B. General: Inspection and testing limited to motors rated 1 horsepower and larger.

C. Visual and Mechanical Inspection:

1. Proper electrical and grounding connections.
2. Shaft alignment.
3. Blockage of ventilating air passageways.

4. Operate motor and check for:
    a. Excessive mechanical and electrical noise.
    b. Overheating.
    c. Correct rotation.
    d. Check vibration detectors, resistance temperature detectors, or motor inherent protectors for functionability and proper operation.
    e. Excessive vibration, in excess of values in NETA ATS, Table 100.10.
5. Check operation of space heaters.

D. Electrical Tests:

1. Insulation Resistance Tests:
    a. In accordance with IEEE 43 at test voltages established by NETA ATS, Table 100.1 for:
        1) Motors above 200 horsepower for 10-minute duration with resistances tabulated at 30 seconds, 1 minute, and 10 minutes.
        2) Motors 200 horsepower and less for 1-minute duration with resistances tabulated at 30 seconds and 60 seconds.
    b. Insulation resistance values equal to, or greater than, ohmic values established by manufacturers.
2. Insulation resistance test on insulated bearings in accordance with manufacturer's instructions.
3. Measure running current and voltage, and evaluate relative to load conditions and nameplate full-load amperes.

3.16 LOW-VOLTAGE MOTOR CONTROL

A. Low-voltage motor control tests may be performed by installer in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Proper barrier and shutter installation and operation.
2. Proper operation of indicating and monitoring devices.
3. Proper overload protection for each motor.
4. Improper blockage of air-cooling passages.
5. Proper operation of drawout elements.
6. Integrity and contamination of bus insulation system.
7. Check door and device interlocking system by:
    a. Closure attempt of device when door is in OPEN position.
    b. Opening attempt of door when device is in CLOSED position.
8. Check nameplates for proper identification of:
    a. Equipment title and tag number with latest one-line diagram.

9. Verify fuse and circuit breaker sizes and types conform to Contract Documents.
10. Verify current and potential transformer ratios conform to Contract Documents.
11. Check bus connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to bolted joints:
    a. Ohmic value to be zero.
    b. Bolt torque level in accordance with NETA ATS, Table 100.12, unless otherwise specified by manufacturer.
12. Check operation and sequencing of electrical and mechanical interlock systems by:
    a. Closure attempt for locked open devices.
    b. Opening attempt for locked closed devices.
    c. Key exchange to operate devices in OFF-NORMAL positions.
13. Verify performance of each control device and feature furnished as part of motor control center.
14. Control Wiring:
    a. Compare wiring to local and remote control, and protective devices with elementary diagrams.
    b. Check for proper conductor lacing and bundling.
    c. Check for proper conductor identification.
    d. Check for proper conductor lugs and connections.
15. Exercise active components.
16. Inspect contactors for:
    a. Correct mechanical operations.
    b. Correct contact gap, wipe, alignment, and pressure.
    c. Correct torque of connections.
17. Compare overload heater rating with full-load current for proper size.
18. Compare motor protector and circuit breaker with motor characteristics for proper size.
19. Perform phasing check on double-ended motor control centers to ensure proper bus phasing from each source.

C. Electrical Tests:

1. Insulation Resistance Tests:
    a. Applied megohmmeter dc voltage in accordance with NETA ATS, Table 100.1.
    b. Bus section phase-to-phase and phase-to-ground for 1 minute on each phase.
    c. Contactor phase-to-ground and across open contacts for 1 minute on each phase.
    d. Starter section phase-to-phase and phase-to-ground on each phase with starter contacts closed and protective devices open.
    e. Test values to comply with NETA ATS, Table 100.1.

2. Current Injection through Overload Unit at 300 Percent of Motor Full-Load Current and Monitor Trip Time:
    a. Trip time in accordance with manufacturer's published data.
    b. Investigate values in excess of 120 seconds.
3. Control Wiring Tests:
    a. Apply secondary voltage to control power and potential circuits.
    b. Check voltage levels at each point on terminal board and each device terminal.
    c. Insulation resistance test at 1,000 volts dc on control wiring, except that connected to solid state components; 1 megohm minimum insulation resistance.
4. Operational test by initiating control devices to affect proper operation.

3.17 AUTOMATIC TRANSFER SWITCHES

A. Automatic transfer switch tests may be performed by electrical contractor in lieu of independent testing firm. Inspections and tests are to be done on an existing transfer switch to verify functionality with the new standby generator.

B. Visual and Mechanical Inspection:

1. Check doors and panels for proper interlocking.
2. Check connections for high resistance by low-resistance ohmmeter and calibrated torque wrench applied to accessible bolted joints.
3. Check positive mechanical and electrical interlock between normal and alternate sources.
4. Check for proper operation:
    a. Manual transfer function switch.
    b. Generator under load and nonload conditions.
    c. Auto-exerciser of generator under load and no-load conditions.
5. Verify settings and operation of control devices.

C. Electrical Tests:

1. Set and calibrate in accordance with the Specifications, manufacturer's recommendations, and Coordination Study.
    a. Voltage and frequency sensing relays.
    b. Time delay relays.
    c. Engine start and shutdown relays.
2. Perform automatic transfer tests by:
    a. Simulating loss of normal power.
    b. Return to normal power.
    c. Simulating loss of alternate power.
    d. Simulating single-phase conditions for normal and alternate sources.

3. Monitor and verify operation and timing of:
    a. Normal and alternate voltage sensing relays.
    b. Engine-start sequence.
    c. Timing delay upon transfer and retransfer.
    d. Engine cool down and shutdown.
    e. Interlocks and limit switch functions.
    f. Engine cool down and shutdown feature.

3.18 LOW VOLTAGE SURGE ARRESTORS

A. Low voltage surge arrestor inspection and tests may be performed by installer in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Adequate clearances between arrestors and enclosures.
2. Ground connections to ground bus.

C. Electrical Tests: None.

3.19 MEDIUM-VOLTAGE SURGE ARRESTORS

A. Visual Inspection:

1. Ground connections to ground bus.
2. Shortest practical jumper connections to line.

B. Electrical Tests: None.

3.20 STANDBY GENERATOR SYSTEMS

A. Standby generator inspections and tests may be performed by installer or manufacturer representative in lieu of independent testing firm.

B. Visual and Mechanical Inspection:

1. Proper grounding.
2. Blockage of ventilating passageways.
3. Proper operation of jack water heaters.
4. Integrity of engine cooling and fuel supply systems.
5. Excessive mechanical and electrical noise.
6. Overheating of engine or generator.
7. Proper installation of vibration isolators.
8. Proper cooling liquid type and level.
9. Operate engine-generator and check for:
    a. Excessive mechanical and electrical noise.
    b. Overheating.

c. Correct rotation.
d. Check resistance temperature detectors or generator inherent thermal protectors for functionability and proper operation.
e. Excessive vibration.

10. Verify voltage regulator and governor operation will cause unit speed and output voltage to stabilize at proper values within reasonable length of time.
11. Proper operation of meters and instruments.
12. Compare generator nameplate rating and connection with one-line diagram or approved Submittal.

C. Electrical and Mechanical Tests:

1. Cold start test by interrupting normal power source with test load consisting of connected building load to verify:
   a. Transfer switch operation.
   b. Automatic starting operation.
   c. Operating ability of engine-generator.
   d. Overcurrent devices capability to withstand inrush currents.
2. Phase rotation tests.
3. Test engine protective shutdown features for:
   a. Low oil pressure.
   b. Overtemperature.
   c. Overspeed.
4. Load bank test with resistors for each load step. Record voltage, frequency, load current, oil pressure, and engine coolant temperature at 15-minute intervals:
   a. 25 percent applied load for 30 minutes.
   b. 50 percent applied load for 30 minutes.
   c. 75 percent applied load for 30 minutes.
   d. 100 percent applied load for 3 hours.
   e. Load test results to demonstrate ability of unit to deliver rated load for test period.
5. One-Step Rated kW Load Pickup Test:
   a. Perform test immediately after performing load bank test.
   b. Apply rated load, minus largest rated hp motor, to generator.
   c. Start largest rated horsepower motor and record voltage drop for 20 cycles minimum with high-speed chart recorder or digital storage oscilloscope.
   d. Compare voltage drop with maximum allowable voltage dip for specified starting situation.

END OF SECTION

SECTION 26 12 02
OIL-FILLED PAD MOUNTED TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): D3487, Standard Specification for Mineral Insulating Oil Used in Electrical Apparatus.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
   b. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
   c. C57.12.22, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers with High-Voltage Bushings, 2,500 kVA and Smaller.
   d. C57.12.26, Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High Voltage Connectors.
   e. C57.12.28, Switchgear and Transformers—Pad-Mounted Equipment, Enclosure Integrity.
   f. C57.12.90, Standard Test Code for Liquid Immersed Distribution, Power, and Regulating Transformers.
   g. C57.106, Guide for Acceptance and Maintenance of Insulating Oil in Equipment.
   h. C62.11, Metal-Oxide Surge Arresters for Alternating-Current Power Circuits (>1 kV).
3. National Electrical Manufacturers Association (NEMA):
   a. TR 1, Transformers, Regulators, Reactors.
   b. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL.
6. United States Department of Energy: Code of Federal Regulations, Final Rule 10 CPR Part 431 DOE 2016 efficiency.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers Product Data:
   a. Descriptive information.
   b. Dimensional drawings.
   c. Transformer nameplate data, including efficiency.
2. Seismic anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Seismic anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.03 QUALITY ASSURANCE

A. Design, test, and assemble in accordance with applicable standards of NEMA TR 1, IEEE C57.12.00, IEEE C57.12.22, IEEE C57.12.26, and IEEE C57.12.90.

1.04 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following materials:

1. One quart of paint to match color and quality of equipment final shop finish.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics:

1. Integral, compartmental type unit consisting of transformer, oil-filled tank, and high and low voltage terminating compartments, assembled on a common structural base.
2. Anchor Bolts: Type 316 stainless steel, sized by equipment manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.02 TRANSFORMER

A. Physical Characteristics:

1. Dielectric Coolant: Fully biodegradable, nontoxic, and nonbio-accumulating fluid, qualifying as “less flammable” per NEC 450.23; Factory Mutual Approved or UL Classified.
2. Primary Taps:
   a. Full capacity, two 2-1/2 percent below and two 2-1/2 percent above, rated voltage.
   b. Externally operated no-load tap changer.
   c. Provisions for locking handle in any position.
3. Coil Conductors: Copper windings.
4. Wye-wye transformers wound on five-legged or triplex cores.

B. Functional Characteristics:

1. kVA Rating: As shown.
2. Three-Phase Units:
   a. Primary Voltage: 13.2 kV line-to-line, three-phase, four-wire, 60-Hz.
   b. Secondary Voltage: 208/120 and 480/277 volts as shown, three-phase, four-wire, 60-Hz.
3. Single-Phase Units:
   a. Primary Voltage:7.6 kV line-to-neutral, single-phase, two-wire, 60-Hz.
   b. Secondary Voltage: 120/240 volts as shown, single-phase, three-wire, 60-Hz.
4. BIL Rating:
   a. 95 kV BIL for 15 kV insulation class transformers.
   b. 30 kV BIL for secondary.
5. Temperature Rise: 55/65 degrees C above 30 degrees average ambient with maximum ambient not to exceed 40 degrees C.
6. Impedance:
   a. 1.35 percent minimum for transformers rated 150 kVA and less.
   b. 3.0 percent minimum for transformers rated 225 kVA to 500 kVA.
   c. 5.75 percent minimum for transformers rated 750 kVA and above.

C. Performance Characteristics:

1. Efficiency: Meet or exceed DOE 2016 efficiency requirements.
2. Sound Level: In accordance with manufacturer’s standards.

2.03 ENCLOSURE

A. Physical Characteristics:

1. Welded carbon steel transformer tank, with cooling panels when required, and lifting eyes.
2. 12-gauge sheet steel terminal compartment enclosure having no exposed screws, bolts, or other fasteners that are externally removable.
3. Color: Provide Tan finish as approved by Contracting Officer.

B. Functional Characteristics: In accordance with IEEE C57.12.28 requirements.

C. Performance Characteristics: In accordance with IEEE C57.12.28 requirements.

2.04 TERMINAL COMPARTMENTS

A. Physical Characteristics:

1. IEEE C57.12.28, enclosed high and low voltage compartments side by side, separated by steel barrier, bolted to transformer tank.
2. Doors:
   a. Individual, full-height, air-filled.
   b. Low voltage door with three-point latching mechanism, vault type handle, and single padlocking provision.
   c. High voltage door fastenings inaccessible until low voltage door has been opened.
   d. Door Bolts: Hex-head type.
   e. Lift-off, stainless steel hinges and door stops.
   f. Removable front sill to facilitate rolling or skidding over conduit stubs.
   g. Recessed lock pocket, with steel door release bolt adjacent to secondary compartment door handle.
3. Stainless steel equipment nameplate.
4. Liquid level gauge.
5. 1-inch upper filter press and filling plug.
6. Drain valve with sampling device.
7. Dial type thermometer.
8. Pressure relief valve.

B. Functional Characteristics:

1. High Voltage Compartment:
   a. Deadfront in accordance with IEEE C57.12.26 type construction.
   b. Protective fuses.
   c. High voltage bushings.
   d. Transformer grounding pad.

2. Low Voltage Compartment:
   a. Livefront in accordance with IEEE C57.12.26 type construction.
   b. Low voltage bushings.
   c. Grounding pad.

C. Performance Characteristics: None.

2.05 BUSHINGS

A. High Voltage, Deadfront Termination:

1. Physical Characteristics:
   a. Bushings externally clamped and front removable.
   b. Standoff brackets located adjacent to bushings.
2. Functional Characteristics:
   a. Integrated bushing rated at 8.3 kV phase-to-ground/14.4 kV phase-to-phase in accordance with IEEE 386.
   b. Rated for 200 amperes continuous, 95 kV BIL.
   c. Insulated Standoff Bushings: Class 15 kV BIL, 200 amperes, complete with EPDM rubber body, stainless steel eyebolt with brass pressure foot, and stainless steel base bracket.
3. Performance Characteristics: None.

B. Low Voltage:

1. Physical Characteristics:
   a. Molded epoxy bushing clamped to tank with hole spade type terminals.
   b. Internally connected neutral extending to neutral bushing.
2. Functional Characteristics: Rated 150 percent of continuous full-load current, 30 kV BIL, 600 volts.
3. Performance Characteristics: None.

2.06 HIGH VOLTAGE SWITCHING

A. Physical Characteristics: Internal, oil-immersed, gang-operated load-break, manually operated switches.

B. Functional Characteristics: Hot stick operated handle located in high voltage compartment.

C. Performance Characteristics:

1. Capable of operating at full-load current.
2. Feed Switch: Four-position, indexing plate, loop.

2.07 HIGH VOLTAGE PROTECTION

A. Bayonet-Type, Oil-Immersed Expulsion Fuses:

1. Physical Characteristics: Accessible through primary compartment.
2. Functional Characteristics: Externally replaceable with hot stick.
3. Performance Characteristics: Fault sensing with interrupting capacity of 1,800 amperes rms asymmetrical.

2.08 SURGE ARRESTERS

A. Metal-Oxide, Varistor Type:

1. Physical Characteristics:
   a. Insulated body, elbow type.
   b. Installed in high voltage compartment.
   c. Connected to transformer high voltage terminals.
2. Functional Characteristics: 3 duty-cycle kV rating in accordance with IEEE C62.11.
3. Performance Characteristics: None.

2.09 TANK GROUNDING PADS

A. High and Low Voltage Compartments:

1. Physical Characteristics:
   a. Connected together with bare No. 2/0 stranded copper conductors.
   b. Wye-wye high and low voltage neutrals internally connected with link and brought out to insulated low voltage bushing externally grounded to tank.
   c. Low voltage neutral connected to externally mounted insulating bushing in low voltage compartment and grounded to tank with removable strap.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.10 TAP CHANGER WARNING SIGN

A. Physical Characteristics:

1. Red laminated plastic, engraved to white core.
2. Engrave to Read: DO NOT OPERATE WHEN TRANSFORMER ENERGIZED.

B. Functional Characteristics: Mount above tap changer handle.

C. Performance Characteristics: None.

2.11 EQUIMENT FOUNDATION

A. Physical Characteristics:

1. Fiberglass reinforced polymer ground sleeve for in-ground installation.
2. Minimum Height: 24 inches.
3. Tapered or straight sides. External support ribs where required to support equipment.
4. Flanged base.
5. Inserts for lifting eyebolts.
6. Internal bracing as recommended by manufacturer.
7. Exterior gel-coated surface, manufacturer's standard color.

B. Functional Characteristics:

1. Provides rigid mounting surface for mounting and anchoring outdoor electrical equipment.
2. UV, fire, corrosion, and tamper resistant.
3. Reinforced stress areas.
4. Sized for provided equipment.

C. Performance Characteristics: Meet Los Alamos County Department of Public Utilities requirements.

2.12 FACTORY TESTS

A. Production tests in accordance with IEEE C57.12.90 and IEEE C57.12.00, Section 8 and Table 16.

B. Dielectric test in accordance with IEEE C57.12.26.

PART 3 EXECUTION

3.01 GENERAL

A. Secure to mounting pads or ground sleeve with anchor bolts.

B. Install plumb and longitudinally in alignment with pad or ground sleeve.

C. Ground neutrals and enclosures in accordance with applicable codes.

3.02 ADJUSTMENTS

A. Adjust voltage taps to obtain rated output voltage under normal operating load conditions.

END OF SECTION

SECTION 26 13.16.02
PAD-MOUNTED SWITCHGEAR

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. B117, Standard Practice for Operating for Salt Spray (Fog) Apparatus.
   b. B187, Standard Specification for Copper Bar, Bus Bar, Rod, and Shapes.
   c. B236, Standard Specification for Aluminum Bars for Electrical Purposes (Bus Bars).
   d. D523, Standard Test Method for Specular Gloss.
   e. D543, Standard Practice for Evaluating for Resistance of Plastics to Chemical Reagents.
   f. D570, Standard Test Method for Water Absorption of Plastics.
   g. D635, Standard Test Method for Rate of Burning and/or Extent and Time of Burning of Plastics in a Horizontal Position.
   h. D714, Standard Test Method for Evaluating Degree of Blistering of Paints.
   i. D756, Standard Practice for Determination of Weight and Shape Changes of Plastics under Accelerated Service Conditions.
   j. D790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastic and Electrical Insulating Materials.
   k. D1654, Standard Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.
   l. D2247, Standard Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
   m. D2794, Standard Test Method for Resistance or Organic Coatings to the Effects of Rapid Deformation.
   n. D3359, Standard Test Methods for Measuring Adhesion by Tape Test.
   o. D4060, Standard Test Method for Abrasion Resistance to Organic Coatings by the Taber Abraser.
   p. D4214, Test Method for Evaluating Degree of Chalking of Exterior Paint Films.
   q. G154, Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.

2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems above 600V.
   b. C37.20.3, Metal Enclosed Interrupter Switchgear.
   c. C37.46, Specifications for Power Fuses and Fused Disconnecting Switches.
   d. C37.57, Metal Enclosed Interrupter Switchgear Assemblies—Conformance Testing.
   e. C37.58, Indoor AC Medium-Voltage Switches for Use in Metal-Enclosed Switchgear—Conformance Test Procedures.
   f. C37.91, Guide for Protective Relay Applications to Power Transformers.
   g. C57.12.28, Switchgear and Transformers, Pad-Mounted Equipment, Enclosure Integrity.
   h. C62.11, Metal-Oxide Surge Arrestors for Alternating-Current Power Circuits (>1 KV).
3. National Electrical Manufacturers Association (NEMA):
   a. C2, National Electrical Safety Code.
   b. C29.9, Wet-Process Porcelain Insulators - Apparatus Post-Type.
   c. C29.10, Wet Process Porcelain Insulators - Indoor Apparatus Type.
   d. LA 1, Surge Arrestors.
   e. SG 2, High Voltage Fuses.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s Product Data:
   a. Descriptive product information.
   b. Dimensional drawings.
   c. Itemized bill of material.
   d. Operational description.
   e. Installation instructions.
   f. Switchgear configurations.
   g. Interrupter switch data.
   h. Bus data.
   i. Fuse data and time-current characteristics on transparencies.
2. Equipment foundation pedestals.
3. Anchoring details.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
3. Factory test reports.
4. Manufacturer's installation instructions.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Provide pad-mounted switchgear that is the product of a single manufacturer. Assembled units with component parts of several manufacturers will not be acceptable with the exception that minor items such as, terminal blocks, test switch, foundations, ground sleeves, and wiring, may be manufactured by others.

2.02 GENERAL

A. Physical Characteristics:

1. Pad-mounted switchgear complete with self-supporting enclosure for elbow-connected encased components.
2. Interrupter switch configuration as shown on one-line diagram.
3. Anchor Bolts: Type 316 stainless steel, 5/8-inch diameter, length sized by manufacturer, and as specified in Section 05 50 00, Metal Fabrications.

B. Functional Characteristics:

1. Equipment suitable for 13,200 volts, three-phase, four-wire solid grounded-wye electrical system having an available short-circuit current at line terminals as shown.
2. Switchgear shall be manually operated.
3. Integrated switchgear assembly ratings at 60-Hz.
   a. Voltage: 14.4 kV nominal, 17 kV maximum.
   b. Insulation Level: 95 kV BIL.
   c. Bus Current: 200 amperes continuous.
   d. Three-Pole Interrupter Switches:
      1) Current: 200 continuous amperes, 200 load dropping amperes.

2) Two-Time Duty-Cycle Fault Closing: 22,400 amperes rms asymmetrical.

e. Fuses with Integral Load Interrupter:

1) Current: 200 maximum amperes, 200 load dropping amperes.

2) Two-Time Duty-Cycle Fault Closing: 13,000 amperes rms asymmetrical.

f. Short-Circuit Rating: 14,000 amperes rms symmetrical, 350 mVa three-phase symmetrical at rated nominal voltage.

4. Fault-closing ratings to equal, or exceed, the short-circuit ratings of the pad mounted switchgear with:

a. Momentary and two-time duty-cycle rating of switches.

b. Momentary rating of bus.

c. Interrupting ratings of fuses.

d. One-time duty-cycle capabilities of fuses with integral load interrupters.

C. Performance Characteristics:

1. Design, test, and assemble in accordance to IEEE C37.20.3, IEEE C37.57, and IEEE C57.12.28.

2. Operating Conditions:

a. Ambient Temperature: Maximum 40 degrees C.

b. Provide equipment fully rated without derating for these operating conditions.

2.03 ENCLOSURE

A. Physical Characteristics:

1. Monocoque, freestanding, self-supporting construction with welded structural and butt joints having external seams ground flush and smooth.

2. Enclosure sides, doors, roof, bottom flange, and steel barriers constructed with 11-gauge hot-rolled, pickled, and oiled sheet steel.

3. Tamper resistant with no externally accessible hardware.

4. Removable lifting tabs bolted to blind-tapped sockets with resilient anticorrosion material between tabs and enclosure.

5. Enclosure Base:

a. Consisting of continuous 90-degree steel flanges welded to enclosure and turned inward for bolting to ground sleeve.

b. Resilient closed-cell PVC gasket applied between flange bottom and ground sleeve.

6. Enclosure Roof: Overlapping edges creating mechanical maze and ventilating openings.

7. Doors:
    a. Constructed with edge flanges overlapping door openings to form mechanical maze.
    b. Two extruded-aluminum hinges with Type 316 stainless steel pins, full length of door extruded-aluminum interlocking supports, and stainless steel mounting hardware for each door.
8. Door Latch:
    a. Automatic positive action, three-point, spring-loaded latching mechanism for each door or set of doors.
    b. Pentahead socket wrench to actuate mechanism for unlatching door and recharging spring for next closing operation in same motion.
9. Finish:
    a. Color: Tan.

B. Functional Characteristics:

1. Hardware in accordance with security requirements of IEEE C57.12.28.
2. Enclosure Base: Coat enclosure flange with wax-based anticorrosion moisture barrier.
3. Enclosure Roof: Insulating nondrip compound applied to underside.
4. Doors:
    a. Access door to power fuses equipped with storage space for replacement fuse components.
    b. Hidden galvanized steel door holders swinging outward when door is in opened position.
5. Door Latch:
    a. Tamper-proof padlocking shackle coordinated with latches to prevent:
        1) Unlatching mechanism until padlock is removed.
        2) Inserting padlock until mechanism is completely latched closed.
6. Finish:
    a. Multistage process applied to interior and exterior surfaces, joints, and blind areas prior to enclosure assembly.
        1) Pretreatment protective film.
        2) Baked epoxy finished coating.
        3) Baked acrylic enamel top coating in accordance with IEEE C57.12.28.

C. Performance Characteristics:

1. Enclosure Base: None.
2. Enclosure Roof: None.
3. Doors: None.
4. Door Latch: None.

5. Finish:
   a. Tests:
      1) Salt-spray test in accordance with ASTM B117.
      2) Humidity test in accordance with ASTM D2247 and ASTM D714.
      3) Accelerated weather tests in accordance with ASTM G154, ASTM D4214, and ASTM D523.
      4) Adhesion tests in accordance with ASTM D3359, Method B and ASTM D2794.
      5) Corrosion tests in accordance with ASTM D1645.
      6) Abrasion tests in accordance with ASTM D4060.
      7) Oil resistance testing with no shift in color, streaking, blistering, or loss of hardness.

2.04 BARRIERS

A. Physical Characteristics:

1. Full-length steel barriers separating side-by-side compartments.
2. BIL Rated Fiberglass-Reinforced Polyester Barriers:
   a. Fixed interphase and end barriers for each interrupter switch and each set of fuses.
   b. Front and rear compartments isolated by fixed barriers.

B. Functional Characteristics:

1. In compliance with NEMA C2.
2. Hanging front barriers with window panel, insertable into open gap when switch is opened, for each interrupter switch.

C. Performance Characteristics: None.

2.05 COMPONENT ENCASEMENT

A. Physical Characteristics:

1. Resilient gasketing between compartment bulkheads and enclosure roof and sides.
2. Dense closed-cell gaskets between fuse-handling mechanisms and compartment bulkhead.
3. Full-length steel barriers separating adjoining termination compartments.
4. BIL rated fiberglass-reinforced polyester barriers to isolate interphase bus from components.
5. Wide-angle viewing window in bulkhead for visual verification of each interrupter switch position.

6. Viewing window in bulkhead adjacent to each fuse-handling mechanism for visual check of blown-fuse indicators.
7. Parking stands adjacent to each bushing well.
8. Cable guides at each fuse-handling mechanism.
9. Switch and fuse components, and interconnecting bus enclosed in inner air-insulated, grounded, steel compartment bulkheads and 22-gauge galvanized steel floor.

B. Functional Characteristics: In compliance with NEMA C2.

C. Performance Characteristics: None.

2.06 GROUND-CONNECTION PADS

A. Physical Characteristics:

1. Provide in each compartment on inside at bottom door stile with momentary rating equal to, or exceeding, short-circuit ratings of switchgear.
2. Constructed of 5/8-inch thick nickel-plated steel, with oxide inhibitor and sealant coating, welded to enclosure.
3. Ground studs of each fuse terminal plus one ground stud at ground connection pad in each fuse compartment and switch terminals.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.07 GROUND RINGS

A. Physical Characteristics:

1. Constructed of 3/8-inch thick copper bolted to the metal enclosure inside at bottom door stile.
2. Cable guides at each fuse-handling mechanism ground ring.

B. Functional Characteristics: Provide full width in each switch compartment and at each fuse-handling mechanism.

C. Performance Characteristics: None.

2.08 INSULATORS

A. Physical Characteristics: Interrupter switch and fuse mounting insulators, insulated operating shafts, and push rods constructed of cycloaliphatic epoxy resin in accordance with NEMA C29.9 and NEMA C29.10.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.09 HIGH VOLTAGE BUS

A. Physical Characteristics:

1. Copper bus bar and bus supports.
2. Square-edged, hard-drawn copper bar in accordance with ASTM B187.
3. Silver-plated copper-to-copper bar connection made with 1/2-inch by 13-inch stainless steel bolts with one flat-brass washer under bolthead and one flat washer and stainless steel split washer between flat washer and nut.

B. Functional Characteristics: Bus rated 600-ampere with provisions for one-cable terminations per phase.

C. Performance Characteristics: None.

2.10 INTERRUPTER SWITCHES

A. Physical Characteristics:

1. Single insulated shaft with blades and journals permanently molded in-place for positive and inherently sequenced blade position.
2. One-piece, formed hard-drawn copper blades with silver-clad contact surfaces.
3. Multifinger, convexed, silver-clad copper jaw contacts with stainless steel springs for constant contact pressure.
4. Equip each switchblade assembly with arc compressor, bushings with removable threaded studs, and support insulators.
5. Mount each switch assembly, bushings with adjacent elbow parking stands, and operator on a rigid, welded steel frame.
6. Bushings, with removable threaded studs, to be constructed of cycloaliphatic epoxy resin and in compliance with IEEE 386.

B. Functional Characteristics:

1. External handle-operated, three-pole, nonfused, group-operated with quick-make quick-break mechanism for live, full load, open and close switching in accordance with IEEE C37.58.
2. Base mounted metal-oxide type distribution class surge arrestors at source switch terminals.
3. Shaft lock for each switch.

C. Performance Characteristics: None.

2.11 FUSE INTERRUPTERS

A. Physical Characteristics:

1. Disconnect style interrupter switches suitable for solid material power fuses, complete with steel base, insulators, loadbreak connector, mounting contacts, and lower hinge and pull-ring operated latch.
2. Fuse-interrupter mounted on a fuse-handling mechanism with mechanical interlock to prevent fuse access before opening the loadbreak connector at the fuse terminal.
3. Fuse mounting jaw contacts with integral load interrupter for live switching with hookstick.
4. Cycloaliphatic epoxy resin housing for load interrupters.
5. Load interrupters with continuous current path, self-resetting, separate contacts for fault-closing and load currents, and self-guiding fuse hinge.
6. Bushing wells to be constructed of cycloaliphatic epoxy resin and in compliance with IEEE 386.

B. Functional Characteristics:

1. Integral load interrupters to have one-time duty-cycle fault-closing capability equal to interrupting rating of fuse, and two-time duty-cycle fault-closing capability of 13,000-ampere rms asymmetrical at 14.4 kV.
2. Equip each fuse interrupter with loadbreak connector and bushing well having parking stand mounted adjacent to interrupter.

C. Performance Characteristics: None.

2.12 FUSES

A. Solid Material Power Fuse:

1. Physical Characteristics: End fitting, upper end pull ring fitting, blown-fuse target, expendable fuse unit, aluminum-bronze lower end fitting, and silencer.
2. Functional Characteristics: In accordance with NEMA SG 2.
3. Performance Characteristics: None.

2.13 SURGE PROTECTION

A. Physical Characteristics:

1. Connect to line side of switch terminals and ground to switchgear ground bus.
2. Sets of three metal-oxide, in accordance with IEEE C62.11 and NEMA LA 1.

B. Functional Characteristics:

1. Class: Distribution.
2. Rating: 12 kV for 13.2 kV system.

C. Performance Characteristics: None.

2.14 LABELING

A. Physical Characteristics: Nonmetallic, self-sticking with integral lettering and symbols.

B. Functional Characteristics:

1. Warning Labels:
   a. Attach to exterior surface of each external door labels reading CAUTION—HIGH VOLTAGE-KEEP OUT.
   b. Attach to internal surface of each external door and on all barriers used to prevent access to live parts, labels reading DANGER—HIGH VOLTAGE—KEEP OUT—QUALIFIED PERSONS ONLY.
   c. Provide inside each interrupter switch access door, labels reading SWITCH BLADES MAY BE ENERGIZED IN ANY POSITION.
   d. Provide inside each fuse access door, labels reading FUSES MAY BE ENERGIZED IN ANY POSITION.
2. Rating Labels:
   a. Attach inside each door, or set of double doors, labels indicating:
      1) Voltage rating.
      2) Main bus continuous rating.
      3) Short-circuit ratings in amperes rms symmetrical and mVA three-phase symmetrical at rated nominal voltage.
      4) Fuse type.
      5) Fuse rating, including duty-cycle fault-closing capability.
      6) Interrupter switch ratings, including duty-cycle fault-closing and short time momentary, amperes rms asymmetrical and 1 second, amperes rms symmetrical.
3. Connection Labels: Attach inside each door, or set of double doors, and inside each switch-operating hub access cover, labels showing three-line connection diagram for interrupter switches, fuses with integral load interrupter, and bus along with manufacturer’s model number.
4. Phase identification number 1, number 2, and number 3 above each phase connection at each fuse unit and interrupter switch.

C. Performance Characteristics: None.

2.15 NAMEPLATES

A. Physical Characteristics: Deep etched aluminum on outside of each door, or set of double doors, indicating manufacturer's name, catalog number, model number, date of manufacture, and serial number.

B. Functional Characteristics: Riveted to door surface.

C. Performance Characteristics: None.

2.16 KEY INTERLOCKS

A. Physical Characteristics: Mechanical lock cylinder located at interrupter switch shaft as shown.

B. Functional Characteristics: Three keys available for each group of four locks for loop primary distribution systems.

C. Performance Characteristics: Meet Los Alamos County Department of Public Utilities interlock requirements.

2.17 EQUIPMENT FOUNDATION

A. Physical Characteristics:

1. Fiberglass reinforced polymer ground sleeve for in-ground installation.
2. Minimum Height: 24 inches.
3. Tapered or straight sides. External support ribs where required by manufacturer.
4. Flanged base.
5. Inserts for lifting eyebolts.
6. Internal bracing as recommended by manufacturer.
7. Exterior gel-coated surface, manufacturer's standard color.

B. Functional Characteristics:

1. Provides rigid mounting surface for mounting and anchoring electrical equipment.
2. UV, fire, corrosion, and tamper resistant.
3. Reinforced stress areas.
4. Sized for provided equipment.

C. Performance Characteristics: Meet Los Alamos County Department of Public Utilities requirements.

2.18 SOURCE QUALITY CONTROL

A. Switchgear assembly shall be production tested in accordance with IEEE C37.20.3.

B. Fuses shall be production tested in accordance with IEEE C37.46.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install equipment in accordance with manufacturer's instructions and recommendations.

B. Secure equipment to equipment foundation with anchor bolts of sufficient size and number adequate for specified seismic conditions.

C. Tighten current-carrying bolted bus connections and enclosure framing and panel bolts to manufacturer's recommendations.

D. Coordinate terminal connections with installation of secondary feeders.

END OF SECTION

SECTION 26 20 00
LOW-VOLTAGE AC INDUCTION MOTORS

PART 1 GENERAL

1.01 RELATED SECTIONS

A. This section applies to low-voltage AC induction motors, whether or not referenced by a motor-driven equipment specification. If equipment specification section deviates from this section in requirements such as, application, horsepower, enclosure type, mounting, shaft type, or synchronous speed, then those listed requirements shall take precedence over this section.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Bearing Manufacturers Association (ABMA):
   a. 9, Load Ratings and Fatigue Life for Ball Bearings.
   b. 11, Load Ratings and Fatigue Life for Roller Bearings.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. 112, Standard Test Procedure for Polyphase Induction Motors and Generators.
   b. 620, Guide for the Presentation of Thermal Limit Curves for Squirrel Cage Induction Machines.
   c. 841, Standard for Petroleum and Chemical Industry—Premium Efficiency Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp).
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. C50.41, Polyphase Induction Motors for Power Generating Stations.
   c. MG 1, Motors and Generators.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 83, Standard for Safety for Thermoplastic-Insulated Wire and Cables.
   b. 674, Standard for Safety for Electric Motors and Generators for Use in Division 1 Hazardous (Classified) Locations.
   c. 2111, Standard for Safety for Overheating Protection for Motors.

1.03 DEFINITIONS

A. DIP: Dust-ignition-proof enclosure.

B. EXP: Explosion-proof enclosure.

C. Inverter Duty (Definite Purpose) Motor: Motor meeting applicable requirements of NEMA MG 1, Section IV, Parts 30 and 31.

D. Motor Nameplate Horsepower: That rating after any derating required to allow for extra heating caused by the harmonic content in the voltage applied to the motor by its controller.

E. ODP: Open drip-proof enclosure.

F. TEFC: Totally enclosed, fan-cooled enclosure.

G. TENV: Totally enclosed, nonventilated enclosure.

H. VPI: Vacuum pressure impregnated.

I. WPI: Open weather protected enclosure, Type I.

J. WPII: Open weather protected enclosure, Type II.

1.04 SUBMITTALS

A. Action Submittals:

1. Manufacturers' Product Data:
   a. Descriptive information.
   b. Nameplate data in accordance with NEMA MG 1.
   c. Additional Rating Information:
      1) Service factor.
      2) Locked rotor current.
      3) No load current.
   d. Enclosure type and mounting (such as, horizontal, vertical).
   e. Dimensions and total weight.
   f. Conduit box dimensions and usable volume as defined in NEMA MG 1 and NFPA 70.
   g. Bearing type.
   h. Bearing lubrication.
   i. Bearing life.
   j. Space heater voltage and watts.
   k. Description, ratings, and wiring diagram of motor thermal protection.
   l. Motor sound power level in accordance with NEMA MG 1.

2. Maximum brake horsepower required by the equipment driven by the motor.

B. Informational Submittals:

1. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
2. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics:

1. For multiple units of the same type of equipment, furnish identical motors and accessories of a single manufacturer.
2. In order to obtain single source responsibility, use a single supplier to provide drive motor, its driven equipment, and specified motor accessories.
3. Lifting lugs on motors weighing 100 pounds or more.
4. Enclosures:
   a. Conform to NEMA MG 1.
   b. TEFC and TENV: Furnish with drain hole with porous drain/weather plug.
5. Bearings and Lubrication:
   a. Food-grade lubricants shall be used for equipment and pumps in contact with potable water.
   b. Horizontal Motors:
      1) 3/4 hp and Smaller: Permanently lubricated and sealed ball bearings, or regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
      2) Regreasable ball bearings in labyrinth sealed end bells with removable grease relief plugs.
      3) For Direct Drive Equipment: Minimum 100,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.
      4) For Belt Driven Equipment: Minimum 30,000 hours L-10 bearing life for ball and roller bearings as defined in ABMA 9 and ABMA 11.

c. Vertical Motors:
   1) Thrust Bearings:
      a) Antifriction bearing.
      b) Manufacturer's standard lubrication.
      c) Minimum 50,000 hours L-10 bearing life.
   2) Guide Bearings:
      a) Manufacturer's standard bearing type.
      b) Manufacturer's standard lubrication.
      c) Minimum 100,000 hours L-10 bearing life.
d. Inverter Duty Rated Motors Larger than 50 hp, Bearing Isolation: Provide electrically isolated bearings to prevent stray current damage.

6. Screen Over Air Openings: Corrosion-resistant on motors with ODP, WPI, and WPII enclosures meeting requirements for guarded machine in NEMA MG 1, and attached with stainless steel screws.
7. Thermostats: Bi-metal disk or rod type thermostats embedded in stator windings.

B. Functional Characteristics:

1. Meet requirements of NEMA MG 1.
2. Provide motors specifically designed for the use and conditions intended, with a NEMA design letter classification to fit the application.
3. Horsepower Rating:
   a. As designated in motor-driven equipment specification.
   b. Constant Speed Applications: Brake horsepower of driven equipment at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.
   c. Adjustable Frequency and Adjustable Speed Applications (Inverter Duty Motor): Driven equipment brake horsepower at any operating condition not to exceed motor nameplate horsepower rating, excluding service factor.
   d. Service Factor:
      1) Inverter-Duty Motors: 1.0 at rated temperature and elevation on inverter power and 1.15 on sine wave power, unless otherwise noted.
      2) Other Motors: 1.15 minimum at rated temperature and elevation on sine wave power, unless otherwise noted.

e. Voltage and Frequency Rating:
   1) System Frequency: 60 Hz.
   2) Voltage Rating:
      a) Unless otherwise indicated in motor-driven equipment specification:

Voltage Rating		
Size	**Voltage**	**Phase**
1/2 hp and smaller	115	1
3/4 hp through 400 hp	460	3

   3) Suitable for full voltage starting.
   4) Suitable for accelerating the connected load with supply voltage at motor starter supply terminals dipping to 90 percent of motor rated voltage.

4. Efficiency:
   a. For all motors except single-phase, under 1 hp, multispeed, short-time rated and submersible motors, or motors driving gates, valves, elevators, cranes, trolleys, and hoists:
      1) Tested in accordance with NEMA MG 1, Paragraph 12.59.
      2) Guaranteed minimum at full load in accordance with NEMA MG 1 Table 12-12, Full-load Efficiencies for NEMA Premium Efficiency Electric Motors Rated 600 Volts or Less (Random Wound), or as indicated in motor-driven equipment specification.
5. Power Factor: Guaranteed minimum at full load shall be manufacturer's standard or as indicated in motor-driven equipment specification.
6. Locked Rotor Ratings:
   a. Locked rotor kVA Code F or lower, if motor horsepower not covered by NEMA MG 1 tables.
   b. Safe Stall Time: 12 seconds or greater.
7. Insulation Systems:
   a. Single-Phase, Fractional Horsepower Motors: Manufacturer's standard winding insulation system.
   b. Three-phase and Integral Horsepower Motors: Unless otherwise indicated in motor-driven equipment specification, Class B or Class F at nameplate horsepower and designated operating conditions.
8. Balance and Vibration: In accordance with NEMA MG 1, Part 7.
9. Winding Thermal Protection:
   a. Contacts rated 120V ac, 5 amps minimum.
   b. Open on excessive temperature.
   c. Automatic reset.

C. Performance Characteristics:

1. Operating Conditions:
   a. Maximum ambient temperature not greater than 40 degrees C.
   b. Site Altitude: Specified in Section 01 61 00, Common Product Requirements.
   c. Provide motors suitable for operating conditions without reduction in nameplate rated horsepower or exceeding rated temperature rise.
   d. Overspeed in either direction in accordance with NEMA MG 1.
2. Noise:
   a. Measured in accordance with NEMA MG 1.
   b. Maximum Sound Level for Motors Controlled by Adjustable Frequency Drive Systems: 3 dBA higher than NEMA MG 1.

2.02 FACTORY TESTING

A. Tests:

1. In accordance with IEEE 112 for polyphase motors.
2. Routine (production) tests in accordance with NEMA MG 1. Test multispeed motors at all speeds.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with manufacturer’s instructions and recommendations.

B. Align motor carefully and properly with driven equipment.

C. Secure equipment to mounting surface with anchor bolts.

END OF SECTION

SECTION 26 22 00
LOW-VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Code of Federal Regulations (CFR): 10 CFR Part 431, DOE 2016 efficiency.
2. Institute of Electrical and Electronics Engineers (IEEE): C57.96, Guide for Loading Dry Type Transformers.
3. National Electrical Contractor's Association (NECA): 409, Recommended Practice for Installing and Maintaining Dry-Type Transformers.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ST 20, Dry-Type Transformers for General Applications.
5. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
6. UL:
   a. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   b. 489, Standard for Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   c. 1561, Standard for Dry-Type, General Purpose, and Power Transformers.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's Product Data:
   a. Descriptive information.
   b. Dimensions and weight.
   c. Transformer nameplate data, including efficiency.
   d. Schematic and connection diagrams.
2. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics:

1. Dry-type, self-cooled, two-winding, with copper windings.
2. Vibration Isolators:
   a. Rated for transformer's weight.
   b. Isolation Efficiency: 99 percent, at fundamental frequency of sound emitted by transformer.
   c. Less Than 30 kVA: Isolate entire unit from structure with external vibration isolators.
   d. 30 kVA and Above: Isolate core and coil assembly from transformer enclosure with integral vibration isolator.

B. Functional Characteristics:

1. UL 1561, NEMA ST 20, unless otherwise indicated.
2. Units larger than 5 kVA suitable for use with 75 degrees C wire at full NFPA 70, 75 degrees C ampacity.
3. Efficiency: Meet or exceed DOE 2016 efficiency requirements.

C. Performance Characteristics:

1. Maximum Sound Level per NEMA ST 20:
   a. 40 decibels for 0 kVA to 9 kVA.
   b. 45 decibels for 10 kVA to 50 kVA.
   c. 50 decibels for 51 kVA to 150 kVA.
2. Overload capability: Short-term overload per IEEE C57.96.

2.02 GENERAL PURPOSE TRANSFORMER

A. Physical Characteristics:

1. Core and Coil:
   a. Encapsulated for single-phase units 1/2 kVA to 25 kVA and for three-phase units 3 kVA to 15 kVA.

b. Thermosetting varnish impregnated for single-phase units 37.5 kVA and above, and for three-phase units 30 kVA and above.

2. Enclosure:
   a. Single-Phase, 3 kVA to 25 kVA: NEMA 250, Type 3R, nonventilated.
   b. Single-Phase, 37-1/2 kVA and Above: NEMA 250, Type 2, ventilated.
   c. Three-Phase, 3 kVA to 15 kVA: NEMA 250, Type 3R, nonventilated.
   d. Three-Phase, 30 kVA and Above: NEMA 250, Type 2, ventilated.
   e. Outdoor Locations: NEMA 250, Type 3R.

B. Functional Characteristics:

1. Insulation Class and Temperature Rise: Manufacturer's standard.
2. Voltage Taps:
   a. Single-Phase, 3 kVA to 10 kVA: Two 5 percent, full capacity below normal voltage rating.
   b. Single-Phase, 15 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
   c. Three-Phase, 3 kVA to 15 kVA: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
   d. Three-Phase, 30 kVA and Above: Four 2-1/2 percent, full capacity; two above and two below normal voltage rating.
3. Impedance: 1.9 percent minimum on units 75 kVA and larger.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NECA and manufacturer's instructions.

B. Load external vibration isolator such that no direct transformer unit metal is in direct contact with mounting surface.

C. Provide moisture-proof, flexible conduit for electrical connections.

D. Connect voltage taps to achieve (approximately) rated output voltage under normal plant load conditions.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. National Electrical Contractor's Association (NECA): 407, Recommended Practice for Installing and Maintaining Panelboards.
2. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. 289, Application Guide for Ground Fault Circuit Interrupters.
   c. KS 1, Enclosed Switches.
   d. PB 1, Panelboards.
   e. PB 1.1, General Instructions for Proper Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less.
3. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
4. UL:
   a. 67, Standard for Panelboards.
   b. 98, Standard for Enclosed and Dead-Front Switches.
   c. 486E, Standard for Equipment Wiring Terminals for use with Aluminum and/or Copper Conductors.
   d. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   e. 508, Standard for Industrial Control Equipment.
   f. 870, Wireways, Auxiliary Gutters and Associated Fittings.
   g. 943, Ground-Fault Circuit-Interrupters.
   h. 1699, Standard for Arc-Fault Circuit-Interrupters.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer's data sheets for each type of panelboard, protective device, accessory item, and component.
2. Manufacturer's shop drawings including dimensioned plan, section, and elevation for each panelboard type, enclosure, and general arrangement.
3. Tabulation of features for each panelboard to include the following:
   a. Protective devices with factory settings.
   b. Provisions for future protective devices.
   c. Space for future protective devices.
   d. Voltage, frequency, and phase ratings.
   e. Enclosure type.

f. Bus and terminal bar configurations and current ratings.
g. Provisions for circuit terminations with wire range.
h. Short circuit current rating of assembled panelboard at system voltage.
i. Features, characteristics, ratings, and factory settings of auxiliary components.

4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Manufacturer's recommended installation instructions.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.

1.03 QUALITY ASSURANCE

A. Listing and Labeling: Provide products specified in this section that are listed and labeled as defined in NEC Article 100.

1.04 EXTRA MATERIALS

A. Extra Materials: Furnish, tag, and box for shipment and storage the following material:

Item	Quantity
Touch-up paint for panelboards	One half-pint container

PART 2 PRODUCTS

2.01 GENERAL

A. Provide low voltage panelboards for application at 600V or less in accordance with this section.

B. Physical Characteristics:

1. Lugs for termination of conductors shall comply with Section 26 05 05, Conductors.
2. Lugs for termination of copper feeder phase and neutral conductors shall be replaceable, bolted mechanical or crimp compression type.

C. Functional Characteristics:

1. Provide equipment in accordance with NEMA PB 1, NFPA 70, and UL 67.
2. Provide panelboard assemblies, including protective devices, suitable for use with 75 degrees C or greater wire insulation systems at NFPA 70, 75 degrees C conductor ampacity, and in accordance with UL 486E.
3. Load Current Ratings:
   a. Unless otherwise indicated, load current ratings for panelboard assemblies, including bus and circuit breakers, are noncontinuous as defined by NEC. Continuous ratings shall be 80 percent of noncontinuous rating.
   b. Where indicated “continuous” or “100 percent”, selected components and protective devices shall be rated for continuous load current at value shown.
4. Short Circuit Current Rating (SCCR): Integrated equipment short circuit rating for each panelboard assembly shall be no less than the fault current available as shown at point of application in distribution system.
5. Series-Connected Short Circuit Current Ratings: Panelboards shall be fully rated; application of series-connected device ratings is unacceptable.
6. Service Equipment Approval: Listed for use as service equipment for panelboards having service disconnecting means.

D. Performance Characteristics: None.

2.02 OVERCURRENT PROTECTIVE DEVICES

A. Physical Characteristics:

1. Provisions for Future Overcurrent Device:
   a. Provide space, mountings and bus connections such that like device may be installed without additional hardware.
   b. Panel openings shall be closed with individual removable cover for each provision for future device.
   c. Unless otherwise indicated, “spaces” in panelboards shall be fully equipped provision for future like devices.
   d. Provisions for future devices shall be suitable devices rated no less than 60 amperes.
2. Branch Protective Devices:
   a. Provide Wire Lug Load Connections: Mechanical or crimp compression type, removable/replaceable, and suitable for 75 degrees C rated conductors without derating switch nor conductor ampacity.
   b. Provide a nameplate for each circuit, blanks for spares.

B. Functional Characteristics:

1. Overcurrent Device Mounting and Arrangement: Design panelboards to accommodate device installation and replacement without disturbing adjacent devices and without removing main bus.
2. Overcurrent Protective Devices: In accordance with NEMA KS 1, UL 98, and UL 489. Protective devices shall be adapted to panelboard installation.
3. Protective Device Locking: Furnish provisions for handle padlocking for main, subfeed, and branch devices where indicated.

C. Performance Characteristic: None.

2.03 CIRCUIT BREAKERS

A. Physical Characteristics:

1. General: Thermal-magnetic unless otherwise indicated, quick-make, quick-break, molded case, of indicating type showing ON/OFF and TRIPPED positions of operating handle. Circuit breakers shall comply with Section 26 05 04, Basic Electrical Materials and Methods.
2. Bus Connection: Bolt-on circuit breakers in 480Y/277-volt, and plug-in circuit breakers in 208Y/120 and 240/120-volt panelboards.
3. Unacceptable Substitution:
   a. Do not substitute single-pole circuit breakers with handle ties for multi-pole breakers.
   b. Do not use tandem or dual circuit breakers in normal single-pole spaces.

B. Functional Characteristics:

1. Trip Mechanism:
   a. Individual permanent thermal and magnetic trip elements in each pole.
   b. Variable magnetic trip elements with a single continuous adjustment 3X to 10X for frames greater than 100 amps.
   c. Two and three pole, common trip.
   d. Automatically opens all poles when overcurrent occurs on one pole.
   e. Test button on cover.
   f. Calibrated for 40 degrees C ambient, unless shown otherwise.
2. Specialty Breakers:
   a. Where indicated, provide breakers with the following features:
      1) Ground Fault Circuit Interrupter (GFCI): Rated to trip on 5-mA ground fault within 0.025 second (UL 943, Class A sensitivity, for protection of personnel). Ground fault sensor

shall be rated same as circuit breaker. Breaker shall include push-to-test and reset buttons.

2) Equipment Ground Fault Interrupter (EGFI): Where indicated, equip breaker with ground fault sensor and rated to trip on 30-mA ground fault (UL listed for equipment ground fault protection).

C. Performance Characteristics: None.

2.04 ENCLOSURES

A. Physical Characteristics:

1. Provide as specified in Section 26 05 04, Basic Electrical Materials and Methods.
2. Type 1, Type 3R, and Type 3S material code-gauge, hot-dip galvanized sheet steel with reinforced steel frame.
3. Provide surface-mount panelboard from trim with same dimensions as box front.
4. Finish: Rust inhibitor prime followed by manufacturer’s standard gray baked enamel or lacquer.
5. Branch Panelboard Enclosure:
   a. Secure front trim to box with concealed trim clamps.
   b. Overlap flush panelboards front trims with box nominal 3/4 inch on all sides.
   c. Provide door in panelboard front trim, with concealed hinges, to access protective device operating handles.
   d. Provide multi-point latching for doors over 30 inches in height.
   e. Door Lock: Secure with flush catch and tumbler lock; all panelboards keyed alike, with two milled keys each lock.
6. Circuit Directory: Metal frame with transparent plastic face and enclosed card, mounted inside each panel door.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.05 BUSSING AND TERMINAL BARS

A. Physical Characteristics:

1. Material: Tin-plated copper full sized throughout length.
2. Provide for mounting of future protective devices along full length of bus regardless of number of units and spaces shown. Machine, drill, and tap as required for current and future positions.

3. Equipment Ground Terminal Bus: Copper with suitably sized provisions for termination of ground conductors, and bonded to box.
    a. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
    b. Provide individual termination points for all other grounding conductors such as feeder, grounding electrode, etc.
4. Neutral Terminal Bus: Copper with suitably sized provisions for termination of neutral conductors, and isolated from box.
    a. Provide individual mechanical termination points no less than the quantity of breaker pole positions.
    b. Provide individual termination points for all other neutral conductors.
5. Provision for Future Devices: Equip with mounting brackets, bus connections, and necessary appurtenances for future protective device ampere ratings indicated.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.06 SPECIAL FEATURES

A. General: Where indicated on the Drawings or schedules, provide special features as specified.

B. Surge Arresters:

1. Physical Characteristics:
    a. Comply with Section 26 43 00, Surge Protection Devices.
    b. Provide protective device within panelboard as disconnecting means and short circuit protection per manufacturer's recommendation.
    c. SPD shall be provided external to panelboard. Provide panelboard circuit breaker for SPD.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

A. Install in accordance with NECA 407, NEMA PB 1.1, and manufacturers' written installation instructions.

B. Install securely, plumb, in-line and square with walls.

C. Install top of cabinet trim 78 inches above floor, unless otherwise shown. Install cabinet so tops of protective device operating handles are no more than 78 inches above the floor.

D. Ground Fault Protection: Install panelboard ground fault circuit interrupter devices in accordance with installation guidelines of NEMA 289.

E. Install filler plates in unused spaces.

F. Wiring in Panel Gutters: Train conductors neatly in groups; bundle and wrap with nylon wire ties.

G. Mount flush panels uniformly flush with wall finish.

H. Provide typewritten circuit directory for each panelboard.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): A167, Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
2. Federal Specifications (FS):
   a. W-C-596G, General Specification for Connector, Electrical, Power.
   b. W-S-896F, Switches, Toggle (Toggle and Lock), Flush Mounted (General Specification).
3. Institute of Electrical and Electronic Engineers, Inc. (IEEE):
   a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000V and less) AC Power Circuits.
   b. C62.45, Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000V and less) AC Power Circuits.
4. National Electrical Contractors Association (NECA): 1, Standard Practice of Good Workmanship in Electrical Contracting.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. FB 11, Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations.
   c. WD 1, General Color Requirements for Wiring Devices.
   d. WD 6, Wiring Devices – Dimensional Specifications.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. UL:
   a. 498, Standard for Safety for Attachment Plugs and Receptacles.
   b. 508, Standard for Safety for Industrial Control Equipment.
   c. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
   d. 1010, Standard for Safety for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
   e. 1436, Standard for Safety for Outlet Circuit Testers and Similar Indicating Devices.
   f. 1449, Standard for Safety for Surge Protective Devices (SPD).

1.02 SUBMITTALS

A. Action Submittals: Manufacturer’s product data for wiring devices.

PART 2 PRODUCTS

2.01 SWITCHES

A. Switch, General Purpose:

1. Physical Characteristics:
   a. Totally enclosed, ac type, with quiet tumbler switch and screw terminal.
   b. Rivetless one-piece brass or copper alloy contact arm with silver alloy contact.
   c. Automatic grounding clip and integral grounding terminal on mounting strap.
   d. Color: Gray.
2. Functional Characteristics:
   a. NEMA WD 1 and FS W-S-896F.
   b. Rating: 20 amps, 120/277 volts.
3. Performance Characteristics: None.

B. Switch, Motor Rated:

1. Physical Characteristics:
   a. Type: Two-pole or three-pole, manual motor starting/disconnect switch without overload protection.
   b. Totally enclosed snap-action switch. Quick-make, slow-break design with silver alloy contacts.
   c. Screw-type terminal.
   d. Color: Gray.
2. Functional Characteristics:
   a. UL 508 listed.
   b. Minimum General Purpose Rating: 30 amperes, 600V ac.
   c. Minimum Motor Ratings:
      1) 2 hp for 120V ac, single-phase, two-pole.
      2) 3 hp for 240V ac, single-phase, two-pole.
      3) 15 hp for 480V ac, three-phase, three-pole.
3. Performance Characteristics: None.

2.02 RECEPTACLES

A. Receptacle, General Purpose:

1. Physical Characteristics:
   a. Duplex, two-pole, three-wire grounding type with screw type wire terminals.
   b. Impact resistant nylon cover and body, with finder grooves in face, unless otherwise indicated.

c. One-piece mounting strap with integral ground contact (rivetless construction).
d. Color: Gray.

2. Functional Characteristics:
a. NEMA WD 1 and FS W-C-596G.
b. Contact Arrangement: Contact to be made on two sides of each inserted blade without detent.
c. Rating: 125 volts, NEMA WD 1, Configuration 5-20R, 20 amps, unless otherwise indicated.
d. Special Features: Provide the following features in comparable devices where indicated: Listed weather-resistant per NEC 406.8 for installation in damp or wet locations.

3. Performance Characteristics: None.

B. Receptacle, Ground Fault Circuit Interrupter:

1. Meet requirements of general-purpose receptacle.
2. Physical Characteristics:
a. Rectangular smooth face with push-to-test and reset buttons.
b. Color: Gray.

3. Functional Characteristics:
a. Listed Class A to UL 943, tripping at 5 mA.
b. Listed weather-resistant per NEC 406.8 for installation in damp or wet locations.
c. Feed-through Capability: 20 amps.

4. Performance Characteristics: None.

2.03 TELEPHONE AND DATA JACK

A. Physical Characteristics:

1. High-impact thermoplastic body.
2. Termination Type:
a. IDC with pair separation towers.
b. Compatible with 110-style termination tool.

3. Snap-on cap to secure connections.
4. Color: White.

B. Functional Characteristics:

1. Compatible with Category 6 cable, and backwards compatible with Category 5 and Category 5e.
2. Listed UL 1863.

C. Performance Characteristics: None.

2.04 DEVICE PLATES

A. Sectional type plate not permitted.

B. Stainless Steel:

1. Physical Characteristics:
   a. Material: Specification grade, one-piece, 0.040-inch nominal thickness stainless steel.
   b. Mounting Screw: Oval-head, finish matched to plate.
2. Functional Characteristics:
   a. Finish: ASTM A167, Type 302/304, satin.
3. Performance Characteristics: None.

C. Cast Metal:

1. Physical Characteristics:
   a. Material: Malleable ferrous metal, with gaskets.
   b. Screw: Oval-head stainless steel.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

D. Sheet Steel:

1. Physical Characteristics:
   a. Finish: Zinc electroplate.
   b. Screws: Oval-head stainless steel.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

E. Weatherproof Receptacle:

1. Physical Characteristics:
   a. Die cast metal cover.
   b. Locking type.
2. Functional Characteristics: UL listed for wet location while in use.
3. Performance Characteristics: None.

F. Weatherproof Switch:

1. Physical Characteristics:
   a. Gasketed, cast-metal or cast-aluminum, incorporating external operator for internal switch.
   b. Mounting Screw: Stainless steel.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

G. Raised Sheet Steel:

1. Physical Characteristics:
   a. 1/2-inch high zinc-plated or cadmium-plated steel designed for one-piece drawn type sheet steel box.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Comply with NECA 1.

B. Coordination with Other Trades:

1. Ensure device and its box are protected. Do not place wall finish materials over device box and do not cut holes for box with router that is guided by riding against outside of box.
2. Keep outlet box free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate raceway system, conductors, and cables.
3. Install device box in brick or block wall such that cover plate does not cross a joint, unless otherwise indicated. Where indicated or directed to cross joint, trowel joint flush with face of wall.
4. Install wiring device after wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.
2. Strip insulation evenly around conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. Length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:
   a. Cut back and pigtail, or replace damaged conductors.
   b. Straighten conductors that remain and remove corrosion and foreign matter.
   c. Pigtailing existing conductors is permitted provided outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction or that show signs they were installed before building finishing operations were complete.
2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
3. Do not remove surface protection, such as plastic film and smudge covers, until last possible moment.
4. Connect devices to branch circuits using pigtails that are not less than 6 inches (150 mm) in length.
5. Use torque screwdriver when a torque is recommended or required by manufacturer.
6. When conductors larger than 12 AWG are installed on 15-amp or 20-amp circuits, splice 12 AWG pigtails for device connections.
7. Tighten unused terminal screws on device.
8. Device Plates:
   a. Do not use oversized or extra deep plate.
   b. Repair wall finishes and remount outlet box when standard device plate does not fit flush or does not cover rough wall opening.

3.02 SWITCH INSTALLATION

A. Switch, General Purpose:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position.
3. Install single-pole, two-way switch such that toggle is in up position when switch is on.

B. Switch, Motor Rated:

1. Mounting Height: See Section 26 05 33, Raceway and Boxes.
2. Install with switch operation in vertical position such that toggle is in up position when ON.
3. Install within sight of motor when used as disconnect switch.

3.03 RECEPTACLE INSTALLATION

A. Duplex Receptacle:

1. Install with grounding slot down, except where horizontal mounting is shown, in which case install with neutral slot down.
2. Ground receptacle to box with grounding wire only.

3. Weatherproof Receptacle:
    a. Install in cast metal box.
    b. Install such that hinge for protective cover is above receptacle opening.
4. Ground Fault Interrupter: Install feed-through model at locations where ground fault protection is specified for “downstream” conventional receptacles.

3.04 DEVICE PLATE INSTALLATION

A. Securely fasten to wiring device; ensure tight fit to box.

B. Flush Mounted: Install with all four edges in continuous contact with finished wall surface without use of mat or similar material. Plaster fillings will not be acceptable.

C. Surface Mounted: Plate shall not extend beyond sides of box, unless plate has no sharp corners or edges.

D. Install with alignment tolerance to box of 1/16 inch.

E. Install weatherproof device plates in damp, wet, and outdoor locations.

F. Interior Locations:

1. Surface Mounted, Metal Box:
    a. General Purpose Areas (Dry, Non-process): Sheet Steel.
    b. Other Areas: Cast metal.
2. Surface Mounted, Sheet Steel Box: Raised sheet steel.
3. Surface Mounted, Cast Box: Cast.

3.05 IDENTIFICATION

A. Use tape labels for identification of individual receptacles in dry indoor locations.

1. Degrease and clean device plate surface to receive tape labels.
2. Use 3/16-inch Kroy black letters on white background, unless otherwise indicated.
3. Identify panelboard and circuit number from which item is served on face of plate.

B. Identify conductors with durable wire markers or tags inside outlet boxes where more than one circuit is present.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections, and prepare test reports.

B. Test Instrument for 125-Volt 20-Amp Receptacle: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

C. Using test plug, verify device and its outlet box are securely mounted.

D. Line Voltage Range: 105 volts to 132 volts.

E. Percent Voltage Drop under 15-Amp Load: Less than 6 percent; 6 percent or higher is not acceptable.

F. Ground Impedance: 2 ohms, maximum.

G. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

H. Tests shall be diagnostic, indicating damaged conductors, high resistance at circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 32 13.16
NATURAL GAS ENGINE GENERATOR SET

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM): A335/A335M, Specification for Seamless Ferritic Alloy-Steel Pipe for High-Temperature Service.
2. Code of Federal Regulations (CFR): Title 40, Chapter 1, Subpart C, Part 89, Control of Emissions from New and In-Use Non-road Compression-Ignition Engines.
3. International Organization for Standardization (ISO): 9001, Quality Management Systems—Fundamentals and Vocabulary.
4. National Electric Manufacturer's Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. MG 1, Motors and Generators.
5. National Electrical Contractors Association (NECA): 404, Recommended Practice for Installing Generator Sets.
6. National Fire Protection Association (NFPA):
   a. 37, Installation and Use of Stationary Combustion Engines and Gas Turbines.
   b. 70, National Electric Code.
   c. 110, Emergency and Standby Power Systems.
7. SAE International (SAE): J1074, Engine Sound Level Measurement.
8. UL:
   a. 489, Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit Breaker Enclosures.
   b. 508, Industrial Control Equipment.
   c. 1236, Battery Chargers for Charging Engine-Starter Batteries.
   d. 2200, Stationary Engine Generator.

1.02 SUBMITTALS

A. Action Submittals:

1. Paragraph by paragraph specification compliance statement, describing differences between specified and proposed equipment.
2. Dimensioned outline drawing showing plan and elevations of engine generator set and drive system.
3. Engine and generator weight, and anchoring requirements.
4. Complete list of accessories provided.

5. Performance curves showing engine efficiency (fuel consumed per kWh output), gross fuel consumption rate, and kW output at design rated output, one-half load, and one-quarter load. Account for design altitude, temperature corrections, and engine parasitic loads.
6. Circuit breaker data, including make model, catalog number, settings, and time current curves.
7. Control panel instrument identification inscriptions.
8. Sample guarantee.
9. Electrical schematic and wiring diagrams for the following:
   a. Generator control panel.
   b. Main generator.
   c. Voltage regulator.
   d. Battery charging system.
   e. Governing system.
   f. Enclosed electrical components.
10. Engine generator set motor starting capability and percent voltage dip curve.
11. Block heater size and voltage.
12. Jacket water heater size and voltage.
13. Noise data for enclosed engine generator at 50 percent, 75 percent, and full load.

B. Informational Submittals:

1. Manufacturer's Certificate of compliance with specified EPA emissions requirements.
2. Certification, copies of analyses, or test reports demonstrating appropriate vibration analysis and design in all modes.
3. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection, Observation, and Testing.
4. Factory Test Report.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.
6. Description of parts and service availability.
7. Manufacturer's Certificate of Proper Installation.
8. Special guarantee.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide the Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the Contracting Officer, material and equipment shall be labeled or listed by a nationally recognized testing

laboratory or other organization to provide a basis for approval under NEC.

2. Materials and equipment manufactured within the scope of standards published by UL shall conform to those standards and shall have an applied UL listing mark.

B. Manufacturer Special Requirements:

1. Engine generator set as a complete unit shall be listed to UL 2200 or submitted to an independent third party certification process to verify compliance as installed.
2. Manufacturer of generator set shall be certified to ISO 9001 and shall have third party certification verifying quality assurance in design/development, production, installation, and service, in accordance with ISO 9001.

1.04 SPECIAL GUARANTEE

A. Provide manufacturer's guarantee or warranty with no deductibles and including travel time, service hours, repair parts and expendables (oil, filters, antifreeze and other items required for the complete repair) with Owner named as beneficiary, in writing, as special guarantee. Special guarantee shall provide for correction of the Work specified in this Specification section found defective during a period of 2 years after the date of Substantial Completion. Duties and obligations for correction or removal and replacement of defective Work.

1.05 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the following spare parts and special tools:

Item	**Quantity**
Air cleaner filter element	1 complete set
Auxiliary jacket water pump packing/seals	1 complete set
Cooling fan drive belt (if applicable)	2 complete sets
Hydrometer	1 each
Two-pronged battery voltmeter	1 each
Spare fuses, if used in control panel	1 complete set
Spare indicating lamps (if applicable)	4 each type used

Item	Quantity
Touch up paint	1 quart each color used
Special tools required to maintain or dismantle engine generator set	1 complete set

PART 2 PRODUCTS

2.01 SERVICE CONDITIONS

A. Ambient Temperature at Air Intake: 104 degrees F maximum.

B. Ambient Temperature at Engine Generator Set: 104 degrees F maximum.

C. Installation Site Altitude: 6,200 feet above mean sea level.

2.02 GENERATOR SET

A. Physical Characteristics:

1. Manufacturer's standard design, unless otherwise specified.
2. Outdoor installation.
3. Design total assembly of generator set and enclosure to be lifted into place using manufacturer recommending lifting and positioning means and methods.
4. Fuel Connections to Engine: Flexible hose, suitable for application.
5. Mount engine generator set on a rigid common steel base frame. Base frame shall be stiffened to minimize deflections.
6. Engine Generator Set and Instrument Panel: Factory-applied primer and two finish coats of manufacturer's standard heat-resistant engine paint.

B. Functional Characteristics:

1. Ratings:
   a. 100 kW minimum at 0.8 PF, based on specified service conditions.
   b. Voltage: 208Y/120 volts, three-phase, four-wire, 60-Hz.
   c. Rated based on standby service.
2. Engine:
   a. Four cycle industrial spark ignited type with unit mounted radiator and fan cooling.
   b. Engine parts designed with adequate strength for specified duty.
3. Starting System:
   a. Automatic, using 12-volt or 24-volt battery-driven starter acting in response to control panel.
   b. Starter shall be capable of three complete cranking cycles without overheating.

c. Batteries: Size and type as recommended by engine manufacturer, housed in acid-resistant frame isolated from engine generator main frame with 120V electric battery warming plate.

4. Battery Charger:
   a. UL 1236 listed and labeled.
   b. 120V input.
   c. 10-amp automatic float, taper and equalize charge type, with plus or minus 1 percent voltage regulation over a plus or minus 10 percent input voltage variation.
   d. Temperature compensated to operate over an ambient range of minus 30 degrees C to 50 degrees C.
   e. Locate charger in automatic transfer switch, generator control panel, or wall mounted in generator enclosure. Generator manufacturer shall coordinate location.
   f. Include:
      1) Ammeter and voltmeter.
      2) Fused ac input and dc output.
      3) Power ON pilot light.
      4) AC failure relay and light.
      5) Low and high dc voltage alarm relay and light.
   g. Alarm relay dry contacts rated 4 amps at 120V ac.
   h. Wire battery charger status and alarm contacts back to generator control panel, terminate and identify contacts.
5. Fuel System:
   a. Natural Gas.
   b. Complete engine fuel system including all pressure regulators, strainers, and control valves. The fuel system shall be plumbed to generator skid for ease of site connections.
6. Governing System:
   a. Electro-mechanical or electro-hydraulic type.
   b. Regulates speed as required to hold generating frequency within tolerable limits and within 5 percent of nominal design speed.
7. Jacket Water Cooling System:
   a. Radiator:
      1) Consisting of jacket water pump, fan assembly, fan guard, and duct flange outlet.
      2) Cooling System: Rated for full load operation as specified in Article Service Conditions.
      3) Fan: Suitable for use in a system with 0.5 in H_2O restriction.
      4) Sized based on a core temperature that is 20 degrees F higher than rated operation temperature.
   b. Engine Thermostat: As recommended by manufacturer to regulate engine water temperature.

c. Jacket Water Heater:
   1) Suitable for operation on 120–volt, single-phase, 60-Hz current.
   2) Thermostatically controlled.
d. Engine Cooling Liquid: Fill cooling system with a 50/50-ethylene glycol/water mixture prior to shipping.

8. Lubrication System:
   a. Type: Full-pressure.
   b. Accessories:
      1) Pressure switch to initiate shutdown on low oil pressure.
      2) Oil filter with replaceable element.
      3) Bayonet type oil level stick.
      4) Valved oil drain extension.
   c. Oil Cooling System: Water-cooled heat exchanger utilizing jacket water as recommended by engine manufacturer.
9. Alternator:
   a. Meet requirements of NEMA MG 1.
   b. Synchronous type with 2/3 pitch, revolving field, drip-proof construction, air cooled by a direct drive centrifugal blower fan.
   c. Stator Windings:
      1) Skewed for smooth voltage waveform.
      2) Reconnectable, 12 lead.
   d. Overspeed Capability: 125 percent.
   e. Waveform Deviation from Sine Wave: 5 percent maximum.
   f. Telephone Interference Factor: 50 maximum.
   g. Total Harmonic Current and Voltage Distortion: 5 percent maximum, measured at generator main circuit breaker.
   h. Insulation System:
      1) Class H, with a maximum rise of 125 degrees C over 40 degree C ambient in accordance with NEMA MG 1.
      2) Vacuum pressure impregnated (VPI), fungus resistant in accordance with MIL E-4970A.
   i. Excitation System: Capable of providing regulated current, at a rate of 300 percent of nameplate current, to a single-phase or three-phase fault for 10 seconds.
   j. Voltage Regulation:
      1) Solid state, three-phase sensing type.
      2) Adjustable output voltage level to plus or minus 5 percent.
      3) Provisions for proper voltage regulation for existing or future adjustable frequency drives as part of generator load.
   k. Short Circuit Capabilities: Sustain 300 percent of rated current for 10 seconds for external three-phase bolted fault without exceeding rated temperatures.
10. Main Circuit Breaker:
   a. Type: Molded case.
   b. Current Rating: As recommended by generator manufacturer.

c. Interrupt Rating: 42 K amps RMS symmetrical at rated voltage.
d. Trips: Thermal-magnetic with inverse time characteristics and adjustable magnetic pickup.
e. Enclosure:
1) Rating: NEMA 250, Type 12.
2) Mounted with vibration isolation from engine generator set.

11. Surge Protective Devices: Three-phase capacitors and arresters mounted in terminal compartment.
12. Air Intake System: Equip with dry type air cleaner with filter service (restriction) indicator.
13. Exhaust System:
a. Muffler: Rated as recommended by generator manufacturer to meet noise requirements specified under Paragraph Sound Attenuation.
b. Wrap exposed length of exhaust pipe and silencer with thermal insulating wrap.
14. Vibration Isolation:
a. Provide vibration isolators, spring/pad type.
b. Include seismic restraints if required by Site location.
15. Automatic run controls suitable for remote interface and control by automatic transfer switch. Engine generator set shall start and run upon closure of a remote dry contact provided by existing transfer switch.
16. Control Panel:
a. Rating: NEMA 250, Type 12.
b. Material: Steel.
c. Instrument Identification: Face label or engraved, black, laminated plastic nameplate with white 1/4-inch-high letters, attached with Type 422 stainless steel screws.
d. UL 508 listed.
e. Tested to meet or exceed IEEE 587 requirements for voltage surge resistance.
f. Solid-state, microprocessor based, designed and built by generator manufacturer, and shall provide operating, monitoring, and control functions for generator set.
g. Power Requirements: 120 volts, single-phase.
h. Maximum installed height of operator interface: 5 feet, 6 inches above generator set mounting surface.
17. Instrumentation:
a. Type: Suitable for engine-mounted vibration environment.
b. Mounting: Nonshock mounted.
c. Alarm and Signal Contacts: Rated 5 amps at 120V ac, dry.
d. Fault Indication Lamps: Manufacturer’s standard.
e. Meters: Digital with analog display, plus or minus 2 percent accuracy.

18. Operator Controls and Indicators:
    a. HANDCRANK/STOP/AUTO/ENGINE TEST selector switch.
    b. Generator voltage adjustment.
    c. Voltmeter PHASE SELECTOR switch.
    d. Ammeter PHASE SELECTOR switch.
    e. Voltmeter.
    f. Ammeter.
    g. FREQUENCY meter.
    h. Engine OIL PRESSURE indicator.
    i. Engine jacket WATER TEMPERATURE indicator.
    j. Engine SPEED indicator (RPM).
    k. Engine OIL TEMPERATURE indicator.
    l. RUNNING TIME indicator.
    m. DC battery voltage.
    n. Emergency Stop button.
19. Alarm Indicators with Manual Pushbutton RESET:
    a. Low oil pressure.
    b. High jacket water temperature.
    c. Engine overspeed.
    d. Engine overcrank.
    e. Low/high dc voltage.
20. External Interfaces:
    a. Furnish a single, common DPDT relay output upon occurrence of alarm condition.
    b. Output:
        1) Dry contacts rated 5 amps at 120V ac for following status indications at remote PLC panel:
            a) Generator in Hand mode.
            b) Generator in Auto mode.
            c) Generator Out of Service.
            d) Generator in Fault/Trouble.
            e) Generator Running.
    c. Accept remote dry start contact closure from automatic transfer switch, rated 10 amps at 32V dc.
21. Control Requirements:
    a. LCD text display of alarm/event descriptions.
    b. Recranking Lockout: When engine fires, starting control shall automatically disconnect cranking control to prevent recranking for a preset period of time after engine stop.
    c. Overcranking Lockout: Initiate after four cranking cycles of 10 seconds on and 10 seconds off or provide continuous cranking cycle with crank time limiter.
    d. Cool-down Timer: Adjustable from 5 minutes to 60 minutes.
    e. Alarms:
        1) Low coolant level.
        2) Low fuel level.

3) Low battery voltage.
4) High battery voltage.
5) Battery charger failure.

f. Engine shutdown upon any of the following conditions:
1) Engine overspeed.
2) Emergency stop button depressed.
3) High jacket water.
4) Low oil pressure.

g. Air Inlet Damper Opening:
1) Upon engine start sequence initiation, a normally closed, dry contact, rated 5 amps at 120V ac, from engine start circuit shall open to provide a signal to open air inlet dampers.
2) Air inlet dampers shall fail open.

C. Performance Characteristics:

1. Engine Emissions: Meet US EPA standard emission requirements specified in Title 40, Chapter 1, Subpart C, Part 60, Standards of Performance for New Stationary Sources, and Subpart U, Part 1048, Control of Emissions from New, Large Nonroad Spark-ignition Engines.
2. Starting System: Capable of providing 15 seconds minimum of cranking current at 0 degree C and three complete 15-second cranking cycles at 40 degrees C.
3. Alternator Voltage and Frequency Regulation Performance:
a. Steady State Voltage Regulation: Less than plus or minus 1 percent from no load to continuous rating point.
b. NEMA MG 1 Defined Transient Voltage Dip:
1) Less than 20 percent at rapid application of rated load.
2) Recovery to rated voltage and frequency within 2 seconds following initial load application.
c. Steady State Frequency Regulation: Plus or minus 1.5-Hz overload range.

2.03 OUTDOOR WEATHER-PROTECTIVE ENCLOSURE

A. Physical Characteristics:

1. Provide generator set with outdoor enclosure, with entire package listed under UL 2200.
2. Package shall comply with requirements of NEC for wiring materials and component spacing.

3. Doors:
    a. Hinged access doors as required to maintain easy access for operating and service functions.
    b. Lockable and include retainers to hold door open during service.
4. Roof: Cambered to prevent rainwater accumulation.
5. Openings: Screened to limit access of rodents into enclosure.
6. Electrical power and control interconnections within perimeter of enclosure.
7. Framework: 12-gauge steel minimum.
8. Panels: 14-gauge steel minimum.
9. Hardware and hinges: austenitic stainless steel.

B. Functional Characteristics:

1. Provide ample airflow for generator set operation at rated load in ambient temperature of 100 degrees F.
2. Finishes:
    a. Prime sheet metal for corrosion protection and finish painted with manufacturer's standard color using a two-step electrocoating paint process, or equal meeting performance requirements specified below.
    b. Prime and paint surfaces of metal parts. Painting process shall result in coating that meets the following requirements:
        1) Primer: 0.5 mil to 2 mils thick.
        2) Top Coat: 0.8 mil to 1.2 mils thick.
        3) Gloss:
            a) Per ASTM D523, 80 percent plus or minus 5 percent.
            b) Gloss retention after 1 year shall exceed 50 percent.
        4) Crosshatch Adhesion: Per ASTM D3359, 4B-5B.
        5) Impact Resistance: Per ASTM D2794, 120-inch to 160-inch pounds.
        6) Salt Spray: Per ASTM B117, plus 1,000 hours.
        7) Humidity: Per ASTM D2247, plus 1,000 hours.
        8) Water Soak: Per ASTM D2247, plus 1,000 hours.
    c. Do not paint hoses, clamps, wiring harnesses, and other nonmetallic service parts.
    d. Fasteners: Corrosion-resistant and designed to minimize marring of painted surface when removed for normal installation or service work.
3. Exhaust Silencer:
    a. Install factory-mounted exhaust silencer inside enclosure.
    b. Exhaust shall exit enclosure through a rain collar and terminate with a rain cap.
    c. Exhaust Connections to Generator Set: Seamless flexible connections.

4. Maintenance Provisions:
   a. Flexible coolant and lubricating oil drain lines that extend to exterior of enclosure, with internal drain valves.
   b. External radiator-fill provision.
5. Provide motorized louvers to minimize air flow through enclosure when generator set is not operating. Louvers shall include provisions to prevent accumulation of ice or snow that might prevent operation.
6. Inlet ducts shall include rain hoods.
7. Provide factory mounted and wired electrical distribution panel to serve generator set and enclosure. Provisions required include:
   a. 60-amp distribution panelboard connected to a 120/240V ac utility service.
   b. Two duplex GFI receptacles, one inside enclosure, and one weatherproof receptacle on outside of enclosure.
   c. Two three-way switches controlling three ac lamps mounted in vapor tight and gasketed fixtures.
   d. Factory-wired normal ac branch circuits from panelboard to engine and alternator heaters, battery charger, and battery warming plate.
8. Sound Attenuation:
   a. Provide with sound-attenuated housing which allows generator set to operate at full rated load in an ambient temperature of up to 100 degrees F.
   b. Insulate enclosure with nonhydroscopic materials.

C. Performance Characteristics: Enclosure shall reduce sound level of generator set while operating at full rated load to a maximum of 74 dBA at any location 7 meters from generator set in a free field environment when tested in accordance with SAE J1074.

2.04 FACTORY TESTS

A. General: Conform to NFPA 110.

B. Steady Load Test: Test engine generator set at steady load run of 60 minutes minimum duration at 100 percent full-rated load.

C. Transient Load Test: Conduct transient load test to demonstrate ability to meet load pickup and load release requirements specified.

D. Harmonic Test: Conduct at full load conditions.

E. Record and Report:

1. Transient response.
2. Load/speed stability.
3. Engine fuel consumption.
4. Power output.

PART 3 EXECUTION

3.01 INSTALLATION

A. Level and securely mount engine generator set in accordance with manufacturer's recommendations.

B. Install in accordance with NECA 404.

C. Where applicable, mount engine generator set on vibration isolators in accordance with isolator manufacturer's recommendations.

3.02 FIELD FINISHING

A. Touch up damaged coating with paint system compatible to existing.

3.03 FIELD TESTS

A. General: Conform to NFPA 110.

B. Performance Test:

1. Perform upon completion of installation.
2. Operate 2 hours minimum.
3. Manufacturer's representative shall make necessary adjustments.
4. Demonstrate ability of engine generator set to carry specified loads.
5. Demonstrate engine generator set safety shutdowns.

C. Test Report:

1. Record and report the following:
   a. Electric load on generator.
   b. Fuel consumption.
   c. Exhaust temperature.
   d. Ambient air temperature.
   e. Safety shutdown performance results.
   f. Noise levels at 7 meters.

D. Post-test Requirements:

1. Make final adjustments.
2. Replace fuel and oil filters.
3. Check belt drive tensions.
4. Demonstrate proper operation of equipment, including automatic operation with control from automatic transfer switch, to Contracting Officer.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative:

1. Present at Site or classroom designated by Owner, for minimum person-days listed below, travel time excluded:
   a. 2 person-days for installation assistance and inspection.
   b. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation.
   c. 1/2 person-day for prestartup classroom or Site training.
   d. 1/2 person-day for facility startup.
   e. 1/2 person-day for post-startup training of Owner's personnel.

END OF SECTION

SECTION 26 43 00
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American National Standards Institute (ANSI).
2. Department of Defense: MIL-STD-220C, Test Method Standard – Method of Insertion Loss Measurement.
3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   a. C62.41.1, IEEE Guide on the Surge Environment in Low-Voltage (1000 V and less) AC Power Circuits.
   b. C62.41.2, IEEE Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and less) AC Power Circuits.
   c. C62.45, IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and less) AC Power Circuits.
4. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
5. UL:
   a. 497A, Standard for Secondary Protectors for Communications Circuits.
   b. 1283, Standard for Electromagnetic Interference Filters.
   c. 1449, Standard for Surge Protective Devices.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturer’s product data on each suppressor type, indicating component values, part numbers, and conductor sizes. Include dimensional drawing for each, showing mounting arrangements.
2. Manufacturer’s UL certified test data and nameplate data for each surge protective device (SPD).

1.03 QUALITY ASSURANCE

A. UL Compliance and Labeling:

1. SPDs for Power and Signal Circuits: Comply with UL 1449 and complimentary listed to UL 1283 as an electromagnetic interference filter. Provide units listed and labeled by UL.
2. SPDs for Telephone Circuit Protection: Comply with UL 497A.

B. ANSI Compliance: Use SPD devices in compliance with the recommendations of IEEE C62.41.1, IEEE C62.41.2, and IEEE C62.45.

PART 2 PRODUCTS

2.01 GENERAL

A. Physical Characteristics:

1. Unless indicated otherwise, provide external to protected equipment.
2. Connect SPDs through a fused switch or circuit breaker as selected by manufacturer. Provide overcurrent protection to allow full surge handling capabilities and afford safety protection from thermal overloads and short circuits.

B. Functional Characteristics:

1. SPD Operating Conditions: Capable of performing at ambient temperatures between minus 40 degrees C and 60 degrees C, at relative humidity ranging from 0 percent to 95 percent, and at altitudes ranging from sea level to 12,000 feet.
2. SPD Short Circuit Current Rating (SCCR): No less than the SCCR of distribution equipment.
3. Design SPD devices to protect all modes (L-L, L-N, L-G, N-G) of electrical system being used.
4. Power Filter: Include a high-frequency extended range power filter for each SPD complimentary listed to UL 1283 as an electromagnetic interference filter.
5. Provide SPDs with the following monitoring and diagnostics:
   a. LED-type indication lights to show normal and failed status of each protected phase.
   b. Surge event counter.
   c. Form C dry contact which operates when unit fails.
6. Provide UL Type 2 SPDs.
7. Voltage Protection Rating (VPR):

Voltage Rating	L-N	N-G	L-G	L-L
208Y/120	700	700	700	1200
480Y/277	1200	1200	1200	1800
120/240 3-wire	700	700	700	1200
240 Δ	--	--	1000	1000
480 Δ	--	--	1800	1800

8. Enclosure type rated equal to protected equipment.

C. Performance Characteristics:

1. EMI/RFI Noise Suppression: Minus 50 dB attenuation at 100 kHz, tested per MIL-STD 220C.

2.02 SERVICE ENTRANCE AND DISTRIBUTION SPD

A. Physical Characteristics: None.

B. Functional Characteristics:

1. Meet IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category C.
2. Surge Current Capacity:
   a. Service Entrance:
      1) 200 kA per phase.
      2) 100 kA per mode.
   b. Distribution:
      1) 120 kA per phase.
      2) 60 kA per mode.
3. Maximum Continuous Operating Voltage (MCOV): Not less than 115 percent of nominal system voltage.
4. Nominal Discharge Current (IN): 20 kA.

C. Performance Characteristics: None.

2.03 PANELBOARD SPD

A. Physical Characteristics: None.

B. Functional Characteristics:

1. Meet IEEE C62.41.1 and IEEE C62.41.2 Location in accordance with Category B.
2. Surge Current Capacity:
   a. Distribution: 120 kA per phase; 60 kA per mode.
   b. Branch: 80 kA per phase; 40 kA per mode.
3. Maximum Continuous Operating Voltage (MCOV): Not less than 125 percent of the nominal system voltage.
4. Nominal Discharge Current (IN): 10 kA.

C. Performance Characteristics: None.

2.04 PAIRED CABLE DATA LINE INTERIOR SUPPRESSORS

A. Physical Characteristics: Bi-polar 1,500-watt silicon avalanche diodes between protected conductor and earth ground.

B. Functional Characteristics:

1. Provide units meeting IEEE C62.41, Location Category A.
2. Provide units with a maximum single impulse current rating of 80 amperes (10 by 1,000 microsecond-waveform).
3. Breakdown voltage shall not exceed 36 volts.

C. Performance Characteristics: None.

2.05 PAIRED CABLE DATA LINE EXTERIOR SUPPRESSORS

A. Physical Characteristics: Hybrid design with a minimum of three stages, using solid-state components and operating bi-directionally.

B. Functional Characteristics: Provide units meeting IEEE C62.41, Location Category A.

C. Performance Characteristics:

1. Meet or exceed the following criteria:
   a. Maximum single impulse current rating of 10,000 amperes (8 by 20 microsecond-waveform).
   b. Pulse Life Rating: 3,000 amperes (8 by 20 microsecond-waveform); 2,000 occurrences.
   c. Maximum clamping voltage at 10,000 amperes (8 by 20 microsecond current waveform), shall not exceed the peak of normal applied signal voltage by 200 percent.

PART 3 EXECUTION

3.01 APPLICATION REQUIREMENTS

A. Provide SPDs when indicated on the Drawings or in the equipment specifications.

B. Electronic Equipment Paired Cable Conductors: Install data line suppressors at the low voltage input and output of each piece of equipment, including telephone cable entrance.

1. Use secondary protectors on lines that do not exit the structure.
2. Use primary protectors on lines that exit and enter the structure.

3.02 GENERAL INSTALLATION REQUIREMENTS

A. Install suppressors according to manufacturer’s recommendations.

B. Install suppressors directly to the cabinet which houses the circuit to be protected so that the suppressor leads are straight and short, with conductors

laced, running directly to the point of connection within the panel, without loops or bends. If bends are unavoidable, no bend may exceed 90 degrees and bending radius may not be less than 6 inches.

C. Provide connecting wires as short as possible with gently twisted conductors, tied together, to prevent separation.

1. Maximum Length: 24 inches.

D. Field Installed Conductors: As specified for building wire, not smaller than 8 AWG and not larger than 4 AWG. Provide device leads not longer than the maximum length recommended by manufacturer, unless specifically reviewed and approved by manufacturer.

E. Provide dedicated disconnecting means for SPD devices installed at main service entrance location, switchgear, and motor control centers. Provide dedicated 30-60-ampere circuit breakers (size dependent upon wire size used) with number of poles as required, as disconnecting means for SPD devices. Provide circuit breakers with interrupting capacity equal to that specified for other breakers at that location.

END OF SECTION

SECTION 26 50 00
LIGHTING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Wood Protection Association (AWPA): M6, Brands Used on Forest Products.
2. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   c. A572/A572A, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
   d. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick.
   e. A595/A595M, Standard Specification for Steel Tubes, Low-Carbon or High-Strength Low-Alloy, Tapered for Structural Use.
   f. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   g. A1011/A1011M, 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.
   h. D6576, Standard Specification for Flexible Cellular Rubber Chemically Blown.
   i. G154, Standard Practice for Operating Fluorescent Light Apparatus for UV Exposure of Nonmetallic Materials.
3. Canadian Standards Association (CSA).
4. Certified Ballast Manufacturer (CBM).
5. Federal Communications Commission (FCC).
6. Illuminating Engineering Society of North America (IESNA).
   a. HB-9, Lighting Handbook.
   b. LM-79, IES Electrical and Photometric Measurements of Solid-State Lighting Products.
   c. LM-80, IESNA Approved Method for Measuring Lumen Maintenance of LED Light Sources.
   d. RP (Recommended Practices) Series.
   e. TM-21, Projecting Long Term Lumen Maintenance of LED Light Sources.

7. Institute of Electrical and Electronics Engineers (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
8. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 6, Industrial Control and Systems: Enclosures.
9. National Energy Policy Act.
10. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC) – Softbound Version.
11. Rural Utilities Service (RUS): 1728F-700, Specification for Wood Poles, Stubs and Anchor Logs.
12. UL:
   a. 773, UL Standard for Safety Plug-In Locking Type Photocontrols for Use with Area Lighting - Fourth Edition; Reprint with Revisions Through and Including March 08, 2002.
   b. 844, Electric Lighting Fixtures for Use in Hazardous (Classified) Locations.
   c. 924, Emergency Lighting and Power Equipment.
   d. 1598, UL Standard for Safety Luminaires.
   e. 2108, UL Standard for Safety Low Voltage Lighting Systems - First Edition; Reprint with Revisions through and Including February 24, 2014.
   f. 8750, UL Standard for Safety Light Emitting Diode (LED) Equipment for Use in Lighting Products - First Edition; Reprint with Revisions Through and Including April 1, 2015.
   g. 8753, UL Standard for Field-Replaceable Light Emitting Diode (LED) Light Engines.
13. U.S. Environmental Protection Agency and U.S. Department of Energy: Energy Star.

1.02 SUBMITTALS

A. Action Submittals:

1. Manufacturers' Product Data:
   a. General:
      1) Provide catalog data sheets and pictures for all products listed below.
      2) Proposed Luminaire Substitutions (Interior and Exterior): Provide an electronic photometric file in standard '.ies' file format per the Illumination Engineering Society of North America (IESNA) for any proposed luminaire substitution not identified on the project Luminaire Schedule on the Drawings. Obtain file from the luminaire manufacturer or approved independent photometric testing laboratory.

Include the proposed substitute luminaire with all options identified on the Project Luminaire Schedule on the Drawings.

b. Interior Luminaires:
   1) Catalog data sheets with pictures.
   2) Luminaire material, finish, dimensions, and metal gauge.
   3) Lens material, pattern, and thickness.
   4) Candle power distribution curves in two or more planes.
   5) Candle power chart 0 degree to 90 degrees.
   6) Lumen output chart.
   7) Mounting or suspension details.

c. Exterior Luminaires:
   1) Catalog data sheets with pictures. Luminaire material, finish, dimensions, and metal gauge.
   2) Lens material, pattern, and thickness. Filters.
   3) IESNA lighting classification (BUG rating).
   4) Isolux diagram.
   5) Lighting distribution data and lighting distribution classification type as defined in IESNA HB 9.
   6) Fastening details to wall, pendant, or pole.
   7) Documentation for Energy Star qualifications for equipment provided under this section.
   8) Brackets and supports.

d. LED Source Systems:
   1) General:
      a) IESNA LM-80 test reports.
      b) IESNA TM-21 ratings.
      c) Operating temperature range. Data sheet (chart/graph) describing life as a function of temperature.
      d) Warranty: Light engine and driver.
      e) Rated life.
      f) Surge protection.
      g) Thermal control device, heat sink.
      h) Enclosure and wiring information.
      i) Operating voltage range.
   2) Electronic Module/Light Engine:
      a) Correlated Color Temperature (CCT).
      b) Color Rendering Index (CRI).
   3) Drivers:
      a) Input Current Total Harmonic Distortion.
      b) Power factor.
      c) Sound rating.

B. Informational Submittals:

1. Manufacturer's printed installation instructions.
2. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.

1.03 QUALITY ASSURANCE

A. Authority Having Jurisdiction (AHJ):

1. Provide Work in accordance with NFPA 70, National Electrical Code (NEC). Where required by the AHJ, provide material and equipment labeled or listed by a nationally recognized testing laboratory or other organization acceptable to the AHJ to provide a basis for approval under NEC.
2. Provide materials and equipment manufactured within the scope of standards published by UL in conformance with those standards and with an applied UL listing mark.

B. Standard Products:

1. Provide materials and equipment of manufacturers regularly engaged in the production of products specified in this section and that are of equal material, design, and workmanship.
2. Provide products that have been in satisfactory commercial or industrial use for 2 years prior to Bid opening in similar applications under similar circumstances and of similar size. Provide products that have been on sale on the commercial market through advertisements, manufacturers' catalogs, or brochures during the 2-year period.
3. Material and Equipment Manufacturing Date: Do not use products manufactured more than 3 years prior to date of delivery to Site.

PART 2 PRODUCTS

2.01 LUMINAIRES

A. General:

1. Specific requirements relative to execution of the Work of this section are located in Luminaire Schedule on the Drawings.
2. Physical Characteristics:
   a. Luminaire Labels:
      1) External label per ANSI C136.15.
      2) Internal label per ANSI C136.22.
   b. Feed-through type, or separate junction box.

c. Wire Leads: Minimum 18 AWG.
d. Component Access: Accessible and replaceable without removing luminaire from ceiling.

3. Functional Characteristics:
a. Provide luminaires and components tested, listed, and labeled by UL, or other approved testing agency.
b. Provide luminaires with Illumination Engineering Society of North America (IESNA) formatted photometric files, ".ies" format, certified by the luminaire manufacturer for use with lighting software.
c. Provide luminaires rated by the manufacturer to start and operate to their full lumen capacity for rated life of the luminaire at the minimum low and maximum high ambient temperatures as defined in the Contract Documents at their installation location.
d. Exterior Installations:
1) UL Labeled: SUITABLE FOR WET LOCATIONS.
2) When factory-installed photocells are provided, entire assembly shall have UL label.
e. Provide electrical equipment with factory-applied painting systems that, at minimum, meet the requirements of NEMA 250 corrosion-resistance test.

4. Performance Characteristics: None.

B. Illuminated Exit Signs:

1. Physical Characteristics:
a. Body: As scheduled.
b. Face: Stencil.
1) Letters:
a) 6-inch high by 3/4-inch stroke.
b) Color: As scheduled.
c. Mounting: Universal.
d. Directional Arrows: As indicated on the Drawings.
e. Power Pack: Self-contained, 120/277-volt transformer, inverter/charger, sealed battery, and indicator switch in accordance with UL 924.
f. Lighted, push-to-test indicator.

2. Functional Characteristics:
a. Capable of protecting against excess charging and discharging.
b. Emergency Self-Diagnostic System:
1) Solid state device with LED display and audible alarm.
2) Automatic and manual test unit.
3) Test for malfunction of lamps, battery, and charger board.

3. Performance Characteristics:
    a. Capable of providing full illumination for 1-1/2 hours in emergency mode.
    b. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.

C. Emergency Lighting Units:

1. Physical Characteristics:
    a. Power Pack: Self-contained, 120/277-volt transformer, inverter/charger, sealed battery, and indicator switch in accordance with UL 924.
    b. Lighted, push-to-test indicator.
2. Functional Characteristics:
    a. Capable of protecting against excess charging and discharging.
    b. Emergency Self-Diagnostic System:
        1) Solid state device with LED display and audible alarm.
        2) Automatic and manual test unit.
        3) Test for malfunction of lamps, battery, and charger board.
3. Performance Characteristics:
    a. Capable of providing full illumination for 1-1/2 hours in emergency mode.
    b. Capable of full recharge in 24 hours, automatically upon resumption of normal line voltage.

2.02 LED SOURCE SYSTEMS

A. General:

1. Physical Characteristics: As shown in Luminaire Schedule on the Drawings.
2. Functional Characteristics:
    a. Provide IESNA LM-80 test reports.
    b. Provide Energy Star compliance for solid state luminaires.
    c. Listed To: UL 8750 Standard for Safety for Light Emitting Diode (LED) Equipment for use in Lighting Products.
    d. Provide RoHS compliant LED light source(s) and driver(s).
3. Performance Characteristics:
    a. Warranty: 5 years minimum.

B. Electronic Module/Light Engine:

1. Physical Characteristics:
    a. Components mounted to a single plate and factory prewired with quick-disconnect plugs.
    b. Driver, thermal control device, thermal protector device, and surge protector device.

c. LEDs mounted to a metal-core circuit board and aluminum heat sink.

2. Functional Characteristics: Surge protection tested in accordance with IEEE/ANSI C62.41.2 to Category C Low.
3. Performance Characteristics:
   a. Light Engine Rating per TM-21: 60,000 at 65 degrees C, L84.
   b. Correlated Color Temperature (CCT): As indicated on the Luminaire Schedule on the Drawings.
   c. Color Rendering Index (CRI): Minimum of 70.

C. Drivers:

1. Physical Characteristics: Drivers mounted in an all metal can.
2. Functional Characteristics:
   a. Operating Voltage Range: 50/60-Hz input source voltage range as indicated on the Luminaire Schedule on the Drawings with sustained variations of plus or minus 10 percent voltage with no damage to the driver.
   b. Sound rating: Class A.
3. Performance Characteristics:
   a. Expected life of 60,000 hours at 65 degrees C.
   b. Input Current Total Harmonic Distortion: Less than 20 percent up to 50 percent of full load rating.
   c. Power Factor: Greater than 0.90 for primary application up to 50 percent of full load rating.
   d. Comply with NEMA 410 for inrush current limits.

PART 3 EXECUTION

3.01 LUMINAIRES

A. General:

1. Install in accordance with manufacturer’s recommendations.
2. Provide proper hangers, pendants, and canopies as necessary for complete installation.
3. Provide additional ceiling bracing, hanger supports, and other structural reinforcements to building required to safely mount.
4. Install plumb and level.
5. Install each luminaire outlet box with galvanized stud.

B. Mounting:

1. General:
   a. Coordinate mounting, fastening, and environmental conditions with Section 26 05 02, Basic Electrical Requirements.
   b. Refer to Fastener Schedule in Section 05 50 00, Metal Fabrications.
2. Wall Mounted: Measure mounting heights from center of mounting plate to finished floor or finished grade, whichever is applicable.
3. Pendant Mounted:
   a. Provide swivel type hangers and canopies to match luminaires, unless otherwise noted.
   b. Space single-stem hangers on continuous-row fluorescent luminaires nominally 48 inches apart.
   c. Provide twin-stem hangers on single luminaires.
   d. Measure mounting heights from bottom of luminaire to finished floor or finished grade, whichever is applicable.
4. Swinging Type: Provide, at each support, safety cable capable of supporting four times vertical load from structure to luminaire.

C. Finished Areas:

1. Install symmetrically with tile pattern.
2. Locate with centerlines either on centerline of tile or on joint between adjacent tile runs.
3. Install recessed luminaires tight to finished surface such that no spill light will show between ceilings and sealing rings.
4. Combustible Low Density Cellulose Fiberboard: Provide spacers and mount luminaires 1-1/2 inches from ceiling surface, or use fixtures suitable for mounting on low density ceilings.
5. Junction Boxes:
   a. Flush and Recessed Luminaires: Locate minimum 1-foot from luminaire.
   b. In concealed locations, install junction boxes to be accessible by removing luminaire.
6. Wiring and Conduit:
   a. Provide wiring of temperature rating required by luminaire.
   b. Provide flexible steel conduit.
7. Provide plaster frames when required by ceiling construction.
8. Independent Supports:
   a. Provide each recessed fluorescent luminaire with two safety chains or two No. 12 soft-annealed galvanized steel wires of length needed to secure luminaire to building structure independent of ceiling structure.

b. Select chain or wire with tensile strength and method of fastening to structure adequate to support luminaire weight.
c. Fasten chain or wire to each end of luminaire.

D. Unfinished Areas: Locate luminaires to avoid conflict with other building systems or blockage of luminaire light output.

1. Fixture Suspension: Provide 1/4-inch threaded steel hanger rods. Scissor type hangers not permitted.
2. Attachment to Steel Beams: Provide flanged beam clips and straight or angled hangers.

E. Building Exterior: Flush-mounted back box and concealed conduit, unless otherwise indicated.

3.02 EMERGENCY LIGHTING UNIT

A. Install in accordance with manufacturer's recommendations.

B. Provide permanent circuit connections with conduit and wire.

C. Connect to branch circuit feeding normal lighting in area ahead of local switches.

D. Provide separate circuit wiring to luminaire.

3.03 FIELD QUALITY CONTROL

A. Upon completion of installation, verify equipment is properly installed, connected, and adjusted. Conduct an operating test to show equipment operates in accordance with the requirements of this section.

3.04 CLEANING

A. Remove labels and markings, except UL listing mark.

B. Wipe luminaires inside and out to remove construction dust.

C. Clean luminaire plastic lenses with antistatic cleaners only.

D. Touch up painted surfaces of luminaires and poles with matching paint ordered from manufacturer.

E. Replace defective lamps at time of Substantial Completion.

END OF SECTION

SECTION 31 10 00
SITE CLEARING

PART 1 GENERAL

1.01 DEFINITIONS

A. Clearing: Removal of interfering or objectionable material lying on or protruding above ground surface including but not limited to stumps, bushes, rubbish, refuse, and other deleterious materials.

B. Debris: Broken concrete or asphalt, trash, rubbish, rubble, destroyed ruins or other similar items.

C. Interfering or Objectionable Material: Trash, rubbish, and junk; vegetation and other organic matter, whether alive, dead, or decaying; topsoil.

D. Project Limits: Areas, as shown or specified, within which Work is to be performed.

E. Stripping: Removal of topsoil layer from inorganic subsoil.

F. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction and defined by drip line of individual trees or perimeter drip line of groups of trees, unless otherwise indicated.

1.02 SUBMITTALS

A. Action Submittals: Overall Site Plan along with applicable drawings clearly showing clearing, grubbing, and stripping limits for planned work prior to construction and as part of the Quality Assurance.

B. Information Submittals: Provide survey information delineating limits of debris disposal if applicable. Survey to include top elevation of piles.

1.03 QUALITY ASSURANCE

A. Obtain Contracting Officer’s approval of staked clearing, grubbing, and stripping limits, prior to commencing clearing, grubbing, and stripping.

1.04 SCHEDULING AND SEQUENCING

A. Prepare Site only after adequate erosion and sediment controls are in place and in accordance with Section 01 57 23, Temporary Storm Water Pollution Prevention.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Comply with federal, state, and local regulations concerning control of erosion and sediment. Sequence work to reduce erosion as directed in construction sequence. Comply with erosion and sedimentation regulations and permit conditions.

B. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

C. Clearly mark construction limits and ensure all staff are familiar with construction limits. No construction activity is permitted outside construction limits. Within construction limits, the Contracting Officer in consultation with the Park will identify trees, shrubs, and other vegetation to remain. Clearly mark these areas with flagging, staking, etc.

D. Clear, grub, and strip areas needed for waste disposal, borrow, or Site improvements within limits shown or specified. The Park may identify “DO NOT MOVE” areas in which topsoil is not to be moved from its location to another site within the project due to contamination with invasive plant species.

E. Do not injure or deface vegetation that is not designated for removal.

F. Protect remaining Site improvements from damage during construction. Restore damaged improvements to their original condition.

G. Fenced enclosures shall be erected around trees to protect crowns from contact by equipment, to preserve roots and soil conditions, and to identify tree protection zones (TPZ) in which no soil disturbance is permitted, and activities are restricted unless otherwise approved by Contracting Officer.

H. Invasive plants are present in the area. To avoid additional spread of invasive plant species, minimize soil disturbance and transport of soils that may contain seed of invasive species.

3.02 TREE PROTECTION

A. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Cleanly cut roots as close to excavation as possible.

B. Replace removed trees designated for removal and trees that are damaged by construction operations as specified in Section 32 93 00, Plants.

C. Review permits and applicable tree preservation plans prior to construction.

3.03 UTILITY LINE PROTECTION

A. Verify existing utilities had been identified and flagged in field.

B. Protect existing utility lines that are indicated to remain from damage.

C. Repair damage to existing utility lines identified to remain.

D. Coordinate in accordance with Section 01 31 00, Project Management and Coordination.

3.04 LIMITS

A. As follows, but not to extend beyond Project limits.

1. Excavation Excluding Trenches: 5 feet beyond top of cut slopes.
2. Trench Excavation: 4 feet from trench centerline, regardless of actual trench width.
3. Fill:
   a. Clearing and Grubbing: 5 feet beyond toe of permanent fill.
   b. Stripping and Scalping: 2 feet beyond toe of permanent fill.
4. Waste Disposal:
   a. Clearing: 5 feet beyond perimeter.
   b. Scalping and Stripping: Not required.
   c. Grubbing: Around perimeter as necessary for neat, finished appearance.
5. Structures: 15 feet outside of new structures.
6. Roadways: Clearing, grubbing, scalping and stripping 4 feet from roadway shoulders.

3.05 CLEARING

A. Clear areas within limits shown or specified.

B. All trees required to be removed shall be cut and disposed off of NPS lands.

1. Fell trees so they fall away from facilities and vegetation not designated for removal.
2. Remove felled timber.
3. Clearing materials are not allowed to be placed in wetlands or streams.

C. Cut stumps not designated for grubbing flush with the ground surface.

D. Trees and other woody vegetation shall be stump cut flush to the ground. No root pulling is permitted. Stump grinding is permitted to reduce the stump at grade.

E. As few trees as possible shall be removed during this project. Trees that do not have to be removed from the project area shall be cut so that limbs are severed, and the trunk of the tree lies as flat as possible on the ground.

F. Trees and their roots should be protected from damage when possible. If removal is necessary, the Park Cultural Resources Manager must be consulted in advance. Tree roots must be protected from digging.

G. Cut off shrubs, brush, weeds, and grasses to within 2 inches of ground surface.

H. Clearing with wetland and stream areas shall be completed by hand.

3.06 STRIPPING

A. Do not remove topsoil until after scalping is completed.

B. Strip areas within limits to minimum depths shown or specified. Do not remove subsoil with topsoil.

C. Stockpile strippings, meeting requirements of Section 32 91 13, Soil Preparation, for topsoil, separately from other excavated material.

3.07 TREE REMOVAL OUTSIDE CLEARING LIMITS

A. Remove Within Project Limits: Dead, dying, leaning, or otherwise unsound trees that may strike and damage Project facilities in falling.

B. Cut stumps off flush with ground, remove debris, and if disturbed, restore surrounding area to its original condition.

3.08 DISPOSAL

A. Combustible Clearing and Grubbing Debris: Burning of combustible debris onsite is prohibited. Dispose of debris off NPS lands.

B. Strippings:

1. Dispose of strippings that are unsuitable for topsoil or that exceed quantity required for topsoil off NPS lands.
2. Stockpile topsoil in sufficient quantity to meet Project needs. Dispose of excess strippings as specified for clearing and grubbing.

3.09 EROSION AND DUST CONTROL

A. Perform clearing and grubbing operations to minimize erosion and dust transport.

B. Provide additional protective measures to prevent sediment and dust from being removed from Site.

C. Provide equipment or stabilize areas to prevent dust.

END OF SECTION

SECTION 31 23 13
SUBGRADE PREPARATION

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. D1556/D1556M, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   b. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   c. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Optimum Moisture Content: As defined in Section 31 23 23, Fill and Backfill.

B. Prepared Ground Surface: Ground surface after completion of clearing and grubbing, scalping of sod, stripping of topsoil, dewatering, excavation to grade, and scarification and compaction of subgrade.

A. Proof-Rolling: Test rolling of subgrade by heavily load vehicle or roller to identify areas that will not support the future loading without excessive settlement or rutting.

B. Relative Compaction: As defined in Section 31 23 23, Fill and Backfill.

C. Relative Density: As defined in Section 31 23 23, Fill and Backfill.

D. Subgrade: Layer of existing soil after completion of clearing, grubbing, scalping of topsoil prior to placement of fill, roadway structure or base for floor slab.

E. Unsuitable Material: Subgrade material unsuitable for the Project consisting of rubble, debris, vegetation, and undocumented fill.

1.03 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; Section 31 23 19.01, Dewatering; and Section 31 23 16, Excavation, prior to subgrade preparation.

1.04 QUALITY ASSURANCE

A. Notify Contracting Officer when subgrade is ready for compaction or proof-rolling or whenever compaction or proof-rolling is resumed after a period of extended inactivity.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Prepare subgrade when unfrozen and free of ice and snow.

B. Contaminated soil containing 4,4-Dichlorodiphenyltrichloroethane (DDT) will be encountered in locations identified on the Drawings. See Work specified in Section 02 61 00, Removal and Disposal of Contaminated Soil if excavation of subgrade occurs in these areas.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Keep subgrade free of water, debris, and foreign matter during compaction or proof-rolling.

B. Bring subgrade to proper grade and cross-section and uniformly compact surface.

C. Do not use sections of prepared ground surface as haul roads. Protect prepared subgrade from traffic.

D. Maintain prepared ground surface in finished condition until next course is placed.

3.02 COMPACTION

A. Under Earthfill: Scarify and compact upper 8 inches to minimum of 90 percent relative compaction as determined in accordance with ASTM D1557.

B. Under Pavement Structure, Floor Slabs On Grade, and Granular Fill Under Structures: Scarify and compact the upper 6 inches to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

C. Proof-rolling Equipment: Subgrades under pavements, structures, footings, slabs and fill under structures shall be proof-rolled prior to pavement, structure, concrete or fill placement using a heavily loaded vehicle. The vehicle must have a loaded gross vehicle weight (GVW) of 40,000 pounds with a loaded single axle weight of at least 18,000 pounds and a minimum tire

pressure of 90 pounds per square inch (psi). Vehicle must complete a minimum of two passes in opposite directions over each area.

D. Subgrade rutting or pumping during compaction because of excessive water buildup, indicate that groundwater dewatering efforts or moisture conditioning efforts are ineffective. Discontinue compaction until requirements specified in Section 31 23 19.01, Dewatering, are met.

3.03 MOISTURE CONDITIONING

A. Dry Subgrade: Add water, then mix to make moisture content uniform throughout.

B. Wet Subgrade: Aerate material by blading, discing, harrowing, or other methods, to hasten drying process.

3.04 TESTING

A. In-place density test in accordance with ASTM D1556/D1556M or ASTM D6938. Test as follows:

1. One test every 1,000 square feet of subgrade.

B. Additionally, in areas determined by the Contracting Officer, proof-roll subgrade with equipment specified in Article Compaction, to detect soft or loose subgrade or unsuitable material, as determined by Contracting Officer.

3.05 CORRECTION

A. Soft or Loose Subgrade:

1. Adjust moisture content and recompact.
2. Overexcavate as specified in Section 31 23 16, Excavation, and replace with suitable material from the excavation or Granular Fill as specified in Section 31 23 23, Fill and Backfill.

END OF SECTION

SECTION 31 23 16
EXCAVATION

PART 1 GENERAL

1.01 DEFINITIONS

A. Common Excavation: Removal of material not classified as rock excavation.

B. Overexcavation: Excavation beyond lines, grades and dimensions as shown on the Drawings and Specifications.

C. Rock Excavation:

1. Excavation (Excluding Trench Excavation): Excavation of solid material which by demonstration cannot, in Contracting Officer's opinion, be reasonably loosened or ripped by single-tooth, hydraulically operated ripper mounted on crawler tractor in good condition and rated at minimum 300 flywheel horsepower; and which must be systematically broken by power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means prior to removal.
2. Trench Excavation: Excavation of solid material which by demonstration cannot, in Contracting Officer's opinion, be reasonably excavated with minimum 135-hp backhoe in good condition and equipped with manufacturer's standard boom, two rippers, and rock points or similar approved equipment; and which must be and is systematically broken by power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means prior to excavation.
3. Term "rock" as used in this section is defined as being such by required means of excavation as specified above and does not necessarily correspond to "rock" as implied by names of geologic formations.
4. Excavation of boulders larger than 1/2 cubic yard will be classified as rock excavation, if breaking them apart with power-operated hammer, hydraulic rock breaker, expansive compounds, or other similar means is both necessary and used for their removal.

1.02 SUBMITTALS

A. Informational Submittals:

1. Excavation Plan, Detailing:
   a. Methods and sequencing of excavation.
   b. Proposed locations of stockpiled excavated material.

c. Proposed onsite and offsite spoil disposal sites.
d. Numbers, types, and sizes of equipment proposed to perform excavations.
e. Anticipated difficulties and proposed resolutions.
f. If less than 1 acre is disturbed at any one time, submit construction stormwater permit.

2. Required excavation permits from applicable governing agencies.

1.03 QUALITY ASSURANCE

A. Provide adequate survey control to avoid unauthorized overexcavation.

1.04 WEATHER LIMITATIONS

A. Material excavated when frozen or when air temperature is less than 32 degrees F shall not be used as fill or backfill until material completely thaws.

B. Material excavated during inclement weather shall not be used as fill or backfill until after material drains and dries sufficiently for proper compaction.

1.05 SEQUENCING AND SCHEDULING

A. Demolition: Complete applicable Work specified in Section 02 41 00, Demolition, prior to excavating.

B. Clearing, Grubbing, and Stripping: Complete applicable Work specified in Section 31 10 00, Site Clearing, prior to excavating.

C. Dewatering: Conform to applicable requirements of Section 31 23 19.01, Dewatering, prior to initiating excavation.

D. Excavation Support: Install and maintain, as specified in Section 31 41 00, Shoring, as necessary to support sides of excavations and prevent detrimental settlement and lateral movement of existing facilities, adjacent property, and completed Work.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Excavate to lines, grades, and dimensions shown and as necessary to accomplish Work. Excavate to within tolerance of plus or minus 0.1 foot, except where dimensions or grades are shown or specified as maximum or minimum. Allow for forms, working space, granular base, topsoil, and similar items, wherever applicable. Trim to neat lines where concrete is to be deposited against earth.

B. Do not overexcavate without written authorization of Contracting Officer.

C. Remove or protect obstructions as shown and as specified in Section 01 50 00, Temporary Facilities and Controls, Article Protection of Work and Property.

D. Blasting not allowed.

E. Refer to Section 02 61 00, Removal and Disposal of Contaminated Soil for requirements for the contaminated soil area as identified on the Drawings.

3.02 CLASSIFIED EXCAVATION

A. Excavation is classified; see Article Definitions for classifications of common excavation and rock excavation. Notify Contracting Officer whenever that may be classified as rock is encountered.

B. Before beginning rock excavation, comply with following requirements:

1. Remove overlying material as common excavation and expose rock surface for examination by Contracting Officer.
2. Demonstrate that removal of remaining material classifies as rock excavation unless waived by Contracting Officer.
3. Assist Contracting Officer with measurement and documentation of rock excavation. Volume of rock excavation shall be determined by estimated quantity of in-place, undisturbed rock, and based on required subgrade elevation.
4. Assist Contracting Officer with measurement and documentation of quantity of rock hauled offsite. Quantity of rock hauled offsite shall not be considered for measurement or documentation for efforts related to rock excavation.

3.03 TRENCH WIDTH

A. Minimum Width of Trenches:

1. Single Pipes, Conduits, Direct-Buried Cables, and Duct Banks:
   a. Less than 4-inch Outside Diameter or Width: 18 inches.
   b. Greater than 4-inch Outside Diameter or Width: 18 inches greater than outside diameter or width of pipe, conduit, direct-buried cable, or duct bank.
2. Multiple Pipes, Conduits, Cables, or Duct Banks in Single Trench: 18 inches greater than aggregate width of pipes, conduits, cables, duct banks, plus space between.
3. Increase trench widths by thicknesses of sheeting.

B. Maximum Trench Width: Unlimited, unless otherwise shown or specified, or unless excess width will cause damage to existing facilities, adjacent property, or completed Work.

3.04 PIPE BEDDING GROOVES FOR NONPERFORATED DRAIN LINES

A. Semicircular, trapezoidal, or 90-degree-V.

B. Excavated or plowed into trench bottom. Forming groove by compaction will not be acceptable.

3.05 EMBANKMENT AND CUT SLOPES

A. Remove loose stones and rock that exceed 3-inch diameter. Remove exposed roots from cut slopes.

B. Round tops of cut slopes in soil to not less than a 6-foot radius, provided such rounding does not extend offsite or outside easements and rights-of-way, or adversely impacts existing facilities, adjacent property, or completed Work.

C. Appropriate soil stabilization matting may be used especially on steep access ramps to help stabilize soil on the slopes.

3.06 STOCKPILING EXCAVATED MATERIAL

A. Stockpile excavated material that is suitable for use as fill or backfill until material is needed.

B. Post signs indicating proposed use of material stockpiled. Post signs that are readable from all directions of approach to each stockpile. Signs should be clearly worded and readable by equipment operators from their normal seated position.

C. Confine stockpiles to within easements, rights-of-way, and approved work areas. Do not obstruct roads or streets.

D. Do not stockpile excavated material adjacent to trenches and other excavations, unless excavation side slopes and excavation support systems are designed, constructed, and maintained for stockpile loads.

E. Do not stockpile excavated materials near or over existing facilities, adjacent property, or completed Work, if weight of stockpiled material could cause damage by structural failure or settlement.

F. Refer to Section 02 61 00, Removal and Disposal of Contaminated Soil, for stockpiling requirements for the contaminated soil area as identified on the Drawings.

3.07 DISPOSAL OF SPOIL

A. Dispose of excavated materials, which are unsuitable or exceed quantity needed for fill or backfill, offsite.

B. Refer to Section 02 61 00, Removal and Disposal of Contaminated Soil, for disposal requirements for the contaminated soil area as identified on the Drawings.

C. Dispose of debris resulting from removal of underground facilities as specified in Section 02 41 00, Demolition, for demolition debris.

END OF SECTION

SECTION 31 23 19.01
DEWATERING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Water control plan.
2. Well permits.
3. Discharge permits.
4. Water Level Elevations Observed in Observation Wells: Submit same day measured.
5. Settlement Benchmark Elevations: Submit weekly record.
6. Inflow Measurements: Submit weekly record.

1.02 WATER CONTROL PLAN

A. As a minimum, include:

1. Descriptions of proposed groundwater and surface water control facilities including, but not limited to, equipment; methods; standby equipment and power supply, pollution control facilities, discharge locations to be utilized, and provisions for immediate temporary water supply as required by this section.
2. Drawings showing locations, dimensions, and relationships of elements of each system, including extraction wells, piezometers and observation wells, conveyance piping, pumps, sedimentation control facilities, discharge locations, and other components necessary to facilitate sufficient dewatering.
3. Design calculations demonstrating adequacy of proposed dewatering systems and components.
4. Water control plan and design calculations shall be stamped by professional engineer, licensed in the State of New Mexico.

B. If system is modified during installation or operation, revise or amend and resubmit Water Control Plan. Do not commence excavation until revised and amended Water Control Plan has been received and approved.

C. Review of Contractor's Water Control Plan (original and any subsequent revisions) shall be only for compliance with specific stated requirements for its content and that it is stamped by a licensed engineer as specified and not for accuracy of content or for adequacy of the Plan, both of which shall be solely the responsibility of Contractor.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL

A. Continuously control water during course of construction, including weekends and holidays and during periods of work stoppages, and provide adequate backup systems to maintain control of water.

3.02 SURFACE WATER CONTROL

A. See Section 01 50 00, Temporary Facilities and Controls, Article Temporary Controls.

B. Remove surface runoff controls when no longer needed.

3.03 DEWATERING SYSTEMS

A. Provide, operate, and maintain dewatering systems of sufficient size and capacity to permit excavation and subsequent construction in dry and to lower and maintain groundwater level a minimum of 3 feet below the lowest point of excavation. Continuously maintain excavations free of water, regardless of source, including artesian and perched groundwater and until backfilled to final grade.

B. Design and Operate Dewatering Systems:

1. To prevent loss of ground as water is removed.
2. To allow required compaction of subgrade.
3. To avoid inducing settlement or damage to existing facilities, completed Work, or adjacent property.
4. To relieve artesian pressures and resultant uplift of excavation bottom.
5. To allow excavation and construction of structures free of water.
6. To prevent instability of faces of excavation.

C. Provide sufficient redundancy in each system to keep excavation free of water in event of component failure.

D. Provide 100 percent emergency power backup with automatic startup and switchover in event of electrical power failure.

E. Provide supplemental ditches and sumps only as necessary to collect water from local seeps. Do not use ditches and sumps as primary means of dewatering.

3.04 MONITORING FLOWS

A. Monitor volume of water pumped each calendar day from wells, well points, and excavations. Also monitor volume of water introduced each day into excavations for performance of Work. Monitor flows using measuring devices acceptable to Contracting Officer.

3.05 DISPOSAL OF WATER

A. Obtain discharge permit for water disposal from authorities having jurisdiction.

B. Treat water collected by dewatering operations, as required by regulatory agencies, prior to discharge.

C. Discharge water as required by discharge permit and in manner that will not cause erosion or flooding, or otherwise damage existing facilities, completed Work, or adjacent property.

D. Remove and dispose of solids from treatment facilities per federal, state, and local regulations and perform other maintenance of treatment facilities as necessary to maintain their efficiency.

3.06 PROTECTION OF PROPERTY

A. Make assessment of potential for dewatering induced settlement. Provide and operate devices or systems, including but not limited to reinjection wells, infiltration trenches and cutoff walls, necessary to prevent damage to existing facilities, completed Work, and adjacent property.

B. Securely support existing facilities, completed Work, and adjacent property vulnerable to settlement due to dewatering operations. Support shall include, but not be limited to, bracing, underpinning, or compaction grouting.

3.07 REMEDIATION OF GROUNDWATER DEPLETION

A. If dewatering reduces quantity or quality of water produced by existing wells, temporarily supply water to affected well owners from other sources. Furnish water of a quality and quantity equal to or exceeding the quality and quantity available to well owner prior to beginning the Work or as satisfactory to each well owner.

END OF SECTION

SECTION 31 23 23
FILL AND BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C117, Standard Test Method for Materials Finer Than 75-Micrometers (No. 200) Sieve in Mineral Aggregates by Washing.
   b. C136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. D75, Standard Practice for Sampling Aggregates.
   d. D1556, Standard Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
   e. D1557, Test Method for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   f. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   g. D4254, Standard Test Method for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   h. D6938, Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Borrow Material: Material from required excavations or from designated borrow areas on or near Site.

B. Geosynthetics: Geotextiles, geogrids, or geomembranes.

C. Completed Course: A course or layer that is ready for next layer or next phase of Work.

D. Embankment Material: Fill materials required to raise existing grade in areas other than under structures.

E. Imported Material: Materials obtained from sources offsite, suitable for specified use.

F. Influence Area:

1. Area within planes sloped downward and outward at 60-degree angle from horizontal measured from:
   a. 1 foot outside outermost edge at base of foundations or slabs.
   b. 1 foot outside outermost edge at surface of roadways or shoulder.
   c. 0.5 foot outside exterior at spring line of pipes or culverts.

G. Lift: Loose (uncompacted) layer of material.

H. Optimum Moisture Content:

1. Determined in accordance with ASTM Standard specified to determine maximum dry density for relative compaction.
2. Determine field moisture content on basis of fraction passing 3/4-inch sieve.

I. Prepared Ground Surface: Ground surface after completion of required demolition, clearing and grubbing, scalping of sod, stripping of topsoil, excavation to grade, and subgrade preparation.

J. Relative Compaction:

1. Ratio, in percent, of as-compacted field dry density to laboratory maximum dry density as determined in accordance with ASTM D1557.
2. Apply corrections for oversize material to either as-compacted field dry density or maximum dry density, as determined by Contracting Officer.

K. Relative Density: Calculated in accordance with ASTM D4254 based on maximum index density determined in accordance with ASTM D4253 and minimum index density determined in accordance with ASTM D4254.

L. Selected Backfill Material: Materials available onsite that Contracting Officer determines to be suitable for specific use.

M. Structural Fill: Fill materials as required under structures, pavements, and other facilities.

N. Well-Graded: As specified in Section 31 23 23.15, Trench Backfill.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Backfill material around buried tank.

B. Informational Submittals:

1. Manufacturer's data sheets for compaction equipment.
2. Certified test results from independent testing agency.

1.04 QUALITY ASSURANCE

A. Notify Contracting Officer when:

1. Structure or tank is ready for backfilling, and whenever backfilling operations are resumed after a period of inactivity.
2. Soft or loose subgrade materials are encountered wherever embankment or site fill is to be placed.
3. Fill material appears to be deviating from the Specifications.

1.05 SEQUENCING AND SCHEDULING

A. Complete applicable Work specified in Section 02 41 00, Demolition; Section 31 10 00, Site Clearing; Section 31 23 16, Excavation; and Section 31 23 13, Subgrade Preparation, prior to placing fill or backfill.

B. Backfill against concrete structures only after concrete has attained compressive strength, specified in Section 03 30 00, Cast-in-Place Concrete. Obtain Contracting Officer's acceptance of concrete work and attained strength prior to placing backfill.

C. Backfill around water-holding structures only after completion of satisfactory leakage tests as specified in Section 03 30 00, Cast-in-Place Concrete.

D. Backfill around buried tanks only after tank is set in position, securely anchored, and ready to be backfilled.

E. Do not place granular base, subbase, or surfacing until after subgrade has been prepared as specified in Section 31 23 13, Subgrade Preparation.

PART 2 PRODUCTS

2.01 SOURCE QUALITY CONTROL

A. Gradation Tests: As necessary to locate acceptable sources of imported material.

B. Samples: Collected in accordance with ASTM D75. Clearly mark to show source of material and intended use.

2.02 EARTHFILL

A. Excavated material from required excavations free from rocks larger than 3 inches, from roots and other organic matter, ashes, cinders, trash, debris, and other deleterious materials.

2.03 GRANULAR FILL

A. 1-inch minus crushed gravel or crushed rock.

B. Free from dirt, clay balls, and organic material.

C. Well-graded from coarse to fine and containing sufficient fines to bind material when compacted, but with maximum 8 percent by weight passing No. 200 sieve.

2.04 SAND

A. Free from clay, organic matter, or other deleterious material.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136:

Sieve Size	Percent Passing by Weight
1/4-inch	100
No. 4	95 - 100
No. 200	0 - 8

2.05 BACKFILL AROUND BURIED TANKS

A. As specified for earthfill.

2.06 GRANULAR DRAIN MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

2.07 GRANULAR FILTER MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

2.08 WATER FOR MOISTURE CONDITIONING

A. Free of hazardous or toxic contaminates, or contaminants deleterious to proper compaction.

2.09 BASE COURSE ROCK

A. As specified in Section 32 11 23, Aggregate Base Course(s).

2.10 FOUNDATION STABILIZATION ROCK

A. Crushed rock or pit run rock.

B. Uniformly graded from coarse to fine.

C. Free from excessive dirt and other organic material.

D. Maximum 2-1/2-inch particle size.

2.11 CRUSHED ROCK FOR SUBSTATIONS

A. Clean, hard, durable crushed rock, free from foreign materials and washed.

B. Gradation as determined in accordance with ASTM C117 and ASTM C136.

C. Base Course:

Sieve Size	**Percent Passing by Weight**
2 inches	100
1-1/2 inches	95 - 100
3/4 inch	55 - 75
1/4 inch	35 - 50
No. 10	4 - 60

D. Finish Grade Rock:

Sieve Size	**Percent Passing by Weight**
2 inches	100
1-1/2 inches	90 - 100

Sieve Size	Percent Passing by Weight
1 inch	30 - 65
3/4 inch	0 - 15

E. Access Road Surfacing: Gradation same as for base course.

2.12 SOIL COVER OVER GEOTEXTILES

A. Particle Size: Maximum 1 inch.

B. Free of sharp angular pieces that may damage geotextile.

2.13 SOIL COVER OVER GEOMEMBRANES

A. Granular material.

B. Particle Size: Maximum 1/4 inch.

C. Particle Shape: Rounded.

PART 3 EXECUTION

3.01 GENERAL

A. Keep placement surfaces free of water, debris, and foreign material during placement and compaction of fill and backfill materials.

B. Place and spread fill and backfill materials in horizontal lifts of uniform thickness, in a manner that avoids segregation, and compact each lift to specified densities prior to placing succeeding lifts. Slope lifts only where necessary to conform to final grades or as necessary to keep placement surfaces drained of water.

C. During filling and backfilling, keep level of fill and backfill around each structure and buried tank even.

D. Do not place fill or backfill, if fill or backfill material is frozen, or if surface upon which fill or backfill is to be placed is frozen.

E. If pipe, conduit, duct bank, or cable is to be laid within fill or backfill:

1. Fill or backfill to an elevation 2 feet above top of item to be laid.
2. Excavate trench for installation of item.
3. Install bedding, if applicable, as specified in Section 31 23 23.15, Trench Backfill.

4. Install item.
5. Backfill envelope zone and remaining trench, as specified in Section 31 23 23.15, Trench Backfill, before resuming filling or backfilling specified in this section.

F. Tolerances:

1. Final Lines and Grades: Within a tolerance of 0.1 foot unless dimensions or grades are shown or specified otherwise.
2. Grade to establish and maintain slopes and drainage as shown. Reverse slopes are not permitted.

G. Settlement: Correct and repair any subsequent damage to structures, pavements, curbs, slabs, piping, and other facilities, caused by settlement of fill or backfill material.

3.02 BACKFILL UNDER AND AROUND STRUCTURES

A. Under Facilities: Within influence area beneath structures, slabs, pavements, curbs, piping, conduits, duct banks, and other facilities, backfill with granular fill, unless otherwise shown. Place granular fill in lifts of 6-inch maximum thickness and compact each lift to minimum of 95 percent relative compaction as determined in accordance with ASTM D1557.

B. Subsurface Drainage: Backfill with granular drain material, where shown. Place granular drain material in lifts of 6-inch maximum thickness and compact each lift to minimum of 90 percent relative density.

C. Other Areas: Backfill with earthfill to lines and grades shown, with proper allowance for topsoil thickness where shown. Place in lifts of 6-inch maximum thickness and compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.

3.03 BACKFILL AROUND TANKS

A. Backfill to top of tank, unless otherwise shown, with granular fill and thoroughly water settle by saturating backfill and vibrating saturated backfill with a concrete vibrator inserted through full depth of backfill on 1-foot maximum centers.

B. Backfill above top of tank with earthfill placed in 8-inch lifts. Compact each lift to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.

3.04 FILL

A. Outside Influence Areas beneath Structures, Tanks, Pavements, Curbs, Slabs, Piping, and Other Facilities:

1. Unless otherwise shown, place earthfill as follows:
   a. Allow for 6-inch thickness of topsoil where required.
   b. Maximum 8-inch thick lifts.
   c. Place and compact fill across full width of embankment.
   d. Compact to minimum 90 percent relative compaction as determined in accordance with ASTM D1557.
   e. Dress completed embankment with allowance for topsoil, crest surfacing, and slope protection, where applicable.

3.05 SITE TESTING

A. Gradation:

1. One sample from each 1,500 tons of finished product or more often as determined by Contracting Officer, if variation in gradation is occurring, or if material appears to depart from Specifications.
2. If test results indicate material does not meet Specification requirements, terminate material placement until corrective measures are taken.
3. Remove material placed in Work that does not meet Specification requirements.

B. In-Place Density Tests:

1. In accordance with ASTM D1556 and ASTM D6938. If ASTM D6938 is used to test in-place density, verify test results by performing at least one test per day using ASTM D1556 at location already tested in accordance with ASTM D6938. Perform at least one additional test using ASTM D1556 for every ten tests performed with a nuclear device, at locations checked in accordance with ASTM D6938. During placement of materials, test at follows:
   a. Granular Fill: 30 cubic yards.
   b. Sand: 30 cubic yards.
   c. Backfill Around Buried Tanks: 30 cubic yards.
   d. Granular Drain Material: 30 cubic yards.
   e. Granular Filter Material: 30 cubic yards.
   f. Base Course Rock: 30 cubic yards.
   g. Foundation Stabilization Rock: 30 cubic yards.
   h. Crushed Rock for Substations:
      1) Base Course: 30 cubic yards.
      2) Finish Grade Rock: 30 cubic yards.
      3) Access Road Surfacing: 30 cubic yards.

3.06 GRANULAR BASE, SUBBASE, AND SURFACING

A. Place and Compact as specified in Section 32 11 23, Aggregate Base Course(s).

3.07 REPLACING OVEREXCAVATED MATERIAL

A. Replace excavation carried below grade lines shown or established by Contracting Officer as follows:

1. Beneath Footings: As specified in granular fill.
2. Beneath Fill or Backfill: Same material as specified for overlying fill or backfill.
3. Beneath Slabs-On-Grade: Granular fill.
4. Trenches:
   a. Unauthorized Overexcavation: Either trench stabilization material or granular pipe base material, as specified in Section 31 23 23.15, Trench Backfill.
   b. Authorized Overexcavation: Trench stabilization material, as specified in Section 31 23 23.15, Trench Backfill.
5. Permanent Cut Slopes (Where Overlying Area is Not to Receive Fill or Backfill):
   a. Flat to Moderate Steep Slopes (3:1, Horizontal Run: Vertical Rise or Flatter): Earthfill.
   b. Steep Slopes (Steeper than 3:1):
      1) Correct overexcavation by transitioning between overcut areas and designed slope adjoining areas, provided such cutting does not extend offsite or outside easements and right-of-ways, or adversely impacts existing facilities, adjacent property, or completed Work.
      2) Backfilling overexcavated areas is prohibited, unless in Contracting Officer’s opinion, backfill will remain stable, and overexcavated material is replaced as compacted earthfill.

3.08 ACCESS ROAD SURFACING

A. Place and compact as specified in Section 32 11 23, Aggregate Base Course(s).

END OF SECTION

SECTION 31 23 23.15
TRENCH BACKFILL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Public Works Association (APWA): Uniform Color Code.
2. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   c. C117, Standard Test Method for Materials Finer than 75 Micrometer (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C136, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   e. C150/C150M, Standard Specification for Portland Cement.
   f. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   g. C1012/C1012M, Standard Test Method for Length Change of Hydraulic-Cement Mortars Exposed to a Sulfate Solution.
   h. D1140, Standard Test Methods for Amount of Material in Soils Finer than No. 200 (75 micrometer) Sieve.
   i. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
   j. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
   k. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
   l. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
   m. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   n. D4832, Standard Test Method for Preparation and Testing of Controlled Low Strength Material (CLSM) Test Cylinders.
   o. D5084, Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter
3. National Electrical Manufacturers Association (NEMA): Z535.1, Safety Colors.

1.02 DEFINITIONS

A. Base Rock: Granular material upon which manhole bases and other structures are placed.

B. Bedding Material: Granular material upon which pipes, conduits, cables, or duct banks are placed.

C. Controlled Low Strength Material (CLSM): A mixture of portland cement, aggregates, or native material (approved by the Engineer), water, and admixtures proportioned to provide a nonsegregating, self-consolidating, free flowing, and excavatable material that will result in a hardened, dense, nonsettling fill.

D. Imported Material: Material obtained by Contractor from source(s) offsite.

E. Lift: Loose (uncompacted) layer of material.

F. Pipe Zone: Backfill zone that includes full trench width and extends from prepared trench bottom to an upper limit above top outside surface of pipe, conduit, cable, or duct bank.

G. Prepared Trench Bottom: Graded trench bottom after excavation and installation of stabilization material, if required, but before installation of bedding material.

H. Relative Compaction: The ratio, in percent, of the as-compacted field dry density to the laboratory maximum dry density as determined by ASTM D1557. Corrections for oversize material may be applied to either as-compacted field dry density or maximum dry density, as determined by Contracting Officer.

I. Relative Density: As defined by ASTM D4253 and ASTM D4254.

J. Selected Backfill Material: Material available onsite that Contracting Officer determines to be suitable for a specific use.

K. Well-Graded:

1. A mixture of particle sizes that has no specific concentration or lack thereof of one or more sizes producing a material type that, when compacted, produces a strong and relatively incompressible soil mass free from detrimental voids. Satisfying both of the following requirements, as defined in ASTM D2487:
   a. Coefficient of Curvature: Greater than or equal to 1 and less than or equal to 3.

b. Coefficient of Uniformity: Greater than or equal to 4 for materials classified as gravel, and greater than or equal to 6 for materials classified as sand.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Manufacturer's descriptive literature for marking tape.

B. Informational Submittals:

1. Catalog and manufacturer's data sheets for compaction equipment.
2. Certified Gradation Analysis: Submit not less than 30 days prior to delivery for imported materials or anticipated use for excavated materials, except for trench stabilization material that will be submitted prior to material delivery to Site.
3. Controlled Low Strength Material: Certified mix design, strength test results and permeability test results. Include material types and weight per cubic yard for each component of mix.

PART 2 PRODUCTS

2.01 MARKING TAPE

A. Physical Characteristics:

1. Detectable:
   a. Solid aluminum foil, visible on unprinted side, encased in protective high visibility, inert polyethylene plastic jacket.
   b. Foil Thickness: Minimum 0.35 mils.
   c. Laminate Thickness: Minimum 5 mils.
   d. Width: 6 inches.
   e. Identifying Lettering: Minimum 1-inch high, permanent black lettering imprinted continuously over entire length.
   f. Joining Clips: Tin or nickel-coated furnished by tape manufacturer.
2. Color: In accordance with APWA Uniform Color Code.

Color*	**Facility**
Red	Electric power lines, cables, conduit, and lightning cables
Orange	Communicating alarm or signal lines, cables, or conduit
Yellow	Gas, oil, steam, petroleum, or gaseous materials
Green	Sewers and drain lines

Color*	Facility
Blue	Potable water
Purple	Reclaimed water, irrigation, and slurry lines
*As specified in NEMA Z535.1, Safety Color Code.	

B. Functional Characteristics: To warn excavating personnel that utility is buried below.

C. Performance Characteristics: Suitable for direct bury as an underground warning tape and locatable with a metal detector.

2.02 TRENCH STABILIZATION MATERIAL

A. Base Rock:

1. Clean, hard, durable 3-inch minus crushed rock or gravel, or pit run, free from clay balls, other organic materials, or debris.
2. Uniformly graded from coarse to fine, less than 8 percent by weight passing the 1/4-inch sieve.

B. Granular Fill:

1. Clean gravel or crushed rock, well-graded from coarse to fine.
2. Maximum Particle Size: 1-inch.
3. Dry sand, accepted by Contracting Officer, may be provided for trenches above maximum groundwater level.

2.03 BEDDING MATERIAL AND PIPE ZONE MATERIAL

A. Unfrozen, friable, and no clay balls, roots, or other organic material.

B. Clean or gravelly sand with less than 5 percent passing No. 200 sieve, as determined in accordance with ASTM D1140, or gravel or crushed rock within maximum particle size and other requirements as follows unless otherwise specified.

1. Duct Banks: 3/4-inch maximum particle size.
2. PVC Irrigation System Piping and Ductile Iron Pipe with Polyethylene Wrap: 3/8-inch maximum particle size.
3. Pipe Under 18-Inch Diameter: 3/4-inch maximum particle size, except 1/4 inch for stainless steel pipe, copper pipe, tubing, and plastic pipe under 3-inch diameter.
4. Pipe 18-Inch Diameter and Greater: 1-1/2-inch maximum particle size for ductile iron pipe, concrete pipe, welded steel pipe, and pretensioned or prestressed concrete cylinder pipe.

5. Perforated Pipe: Granular drain material.
6. Conduit and Direct-Buried Cable:
   a. Sand, clean or clean to silty, less than 12 percent passing No. 200 sieve.
   b. Individual Particles: Free of sharp edges.
   c. Maximum Size Particle: Pass a No. 4 sieve.
   d. If more than 5 percent passes No. 200 sieve, the fraction that passes No. 40 sieve shall be nonplastic as determined in accordance with ASTM D4318.

2.04 GRANULAR DRAIN MATERIAL

A. Gradation: ASTM C117 and ASTM C136.

Sieve Size	Percent Passing by Weight
1-1/2 inches	100
1 inch	95-100
1/2 inch	25-60
No. 4	0-10
No. 8	0-5

2.05 EARTH BACKFILL

A. Soil, loam, or other excavated material suitable for use as backfill.

B. Free from roots or organic matter, refuse, boulders, and material larger than 1/2 cubic foot, or other deleterious materials.

2.06 PROCESSED EARTH BACKFILL

A. Class A Backfill: Earth backfill, meeting the following additional requirement.

1. Cohesionless, free-draining material with 100 percent passing 3-inch sieve, at least 70 percent passing 1-1/2-inch sieve, and less than 15 percent passing No. 200 sieve.

2.07 CONTROLLED LOW STRENGTH MATERIAL (CLSM)

A. Select and proportion ingredients to obtain:

1. Compressive strength between 50 psi and 150 psi at 28 days in accordance with ASTM D4832.
2. Maximum permeability of $1x10^{-9}$ m/s in accordance with ASTM D5084

B. Materials:

1. Cement: ASTM C150/C150M, Type I or Type II.
2. Aggregate: ASTM C33/C33M, Size 7.
3. Fine Aggregate: ASTM C33/C33M, Fine Aggregate
4. Fly Ash (Pozzolan): Class F or Class C fly ash in accordance with ASTM C618, except as modified herein:
   a. ASTM C618, Table 1, Loss on Ignition: Unless permitted otherwise, maximum 3 percent.
   b. Test in accordance with ASTM C1012/C1012M to verify sulfate resistance is acceptable.
5. Water: Clean, potable, containing less than 500 ppm of chlorides.

2.08 CONCRETE BACKFILL

A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

2.09 GRAVEL SURFACING ROCK

A. As specified in Section 32 11 23, Aggregate Base Course(s).

2.10 TOPSOIL

A. As specified in Section 32 91 13, Soil Preparation.

2.11 SOURCE QUALITY CONTROL

A. Perform gradation analysis in accordance with ASTM C136 for:

1. Earth backfill, including specified class.
2. Trench stabilization material.
3. Bedding and pipe zone material.

B. Certify Laboratory Performance of Mix Designs:

1. Controlled low strength material.
2. Concrete.

PART 3 EXECUTION

3.01 TRENCH PREPARATION

A. Water Control:

1. As specified in Section 31 23 19.01, Dewatering.
2. Remove water in a manner that minimizes soil erosion from trench sides and bottom.
3. Provide continuous water control until trench backfill is complete.

B. Remove foreign material and backfill contaminated with foreign material that falls into trench.

3.02 TRENCH BOTTOM

A. Firm Subgrade: Grade with hand tools, remove loose and disturbed material, and trim off high areas and ridges left by excavating bucket teeth. Allow space for bedding material if shown or specified.

B. Soft Subgrade: If subgrade is encountered that may require removal to prevent pipe settlement, notify Contracting Officer. Contracting Officer will determine depth of overexcavation, if any required.

3.03 TRENCH STABILIZATION MATERIAL INSTALLATION

A. Rebuild trench bottom with trench stabilization material.

B. Place material over full width of trench in 6-inch lifts to required grade, providing allowance for bedding thickness.

C. Compact each lift so as to provide a firm, unyielding support for the bedding material prior to placing succeeding lifts.

3.04 BEDDING

A. Furnish imported bedding material where, in the opinion of Contracting Officer, excavated material is unsuitable for bedding or insufficient in quantity.

B. Place over full width of prepared trench bottom in two equal lifts when required depth exceeds 8 inches.

C. Hand grade and compact each lift to provide a firm, unyielding surface.

D. Minimum Thickness as follows:

1. Pipe 15 Inches and Smaller: 4 inches.
2. Pipe 18 Inches to 36 Inches: 6 inches.
3. Pipe 42 Inches and Larger: 8 inches.
4. Conduit: 3 inches.
5. Direct-Buried Cable: 3 inches.
6. Duct Banks: 3 inches.

E. Check grade and correct irregularities in bedding material. Loosen top 1 inch to 2 inches of compacted bedding material with a rake or by other means to provide a cushion before laying each section of pipe, conduit, direct-buried cable, or duct bank.

F. Install to form continuous and uniform support except at bell holes, if applicable, or minor disturbances resulting from removal of lifting tackle.

G. Bell or Coupling Holes: Excavate in bedding at each joint to permit proper assembly and inspection of joint and to provide uniform bearing along barrel of pipe or conduit.

3.05 BACKFILL PIPE ZONE

A. Upper limit of pipe zone shall not be less than following:

1. Pipe: 12 inches, unless shown otherwise.
2. Conduit: 3 inches, unless shown otherwise.
3. Direct-Buried Cable: 3 inches, unless shown otherwise.
4. Duct Bank: 3 inches, unless shown otherwise.

B. Restrain pipe, conduit, cables, and duct banks as necessary to prevent their movement during backfill operations.

C. Place material simultaneously in lifts on both sides of pipe and, if applicable, between pipes, conduit, cables, and duct banks installed in same trench.

1. Pipe 10-Inch and Smaller Diameter: First lift less than or equal to 1/2 pipe diameter.
2. Pipe Over 10-Inch Diameter: Maximum 6-inch lifts.

D. Thoroughly tamp each lift, including area under haunches, with handheld tamping bars supplemented by “walking in” and slicing material under haunches with a shovel to ensure voids are completely filled before placing each succeeding lift.

E. Do not use power-driven impact compactors to compact pipe zone material. After full depth of pipe zone material has been placed as specified, compact material by a minimum of three passes with a vibratory plate compactor. Each lift shall be compacted with a minimum of two passes by either a vibratory plate compactor or a power-driven impact compactor. Take care to avoid damaging pipe and pipe coating.

3.06 MARKING TAPE INSTALLATION

A. Continuously install marking tape along centerline of buried piping, on top of last lift of pipe zone material. Coordinate with piping installation drawings.

1. Detectable Marking Tape: Install with nonmetallic piping and waterlines.

3.07 BACKFILL ABOVE PIPE ZONE

A. General:

1. Process excavated material to meet specified gradation requirements.
2. Adjust moisture content as necessary to obtain specified compaction.
3. Do not allow backfill to free fall into trench or allow heavy, sharp pieces of material to be placed as backfill until after at least 2 feet of backfill has been provided over top of pipe.
4. Do not use power driven impact type compactors for compaction until at least 4 feet of backfill is placed over top of pipe.
5. Backfill to grade with proper allowances for topsoil, crushed rock surfacing, and pavement thicknesses, wherever applicable.
6. Backfill around structures with same class backfill as specified for adjacent trench, unless otherwise shown or specified.

B. Class A Backfill:

1. Place in lifts not exceeding thickness of 6 inches.
2. Mechanically compact each lift to a minimum of 95 percent relative compaction prior to placing succeeding lifts.

C. Controlled Low Strength Material:

1. Discharge from truck mounted drum type mixer into trench.
2. Place in lifts as necessary to prevent uplift (flotation) of new and existing facilities.
3. In traveled areas fill entire trench section to pavement finish grade for a temporary driving surface, and screed off excess and finish with a float.
4. In other areas fill trench section as shown.

3.08 REPLACEMENT OF TOPSOIL

A. Replace topsoil in top 12 inches of backfilled trench.

B. Maintain finished grade of topsoil even with adjacent area and grade as necessary to restore drainage.

3.09 MAINTENANCE OF TRENCH BACKFILL

A. After each section of trench is backfilled, maintain surface of backfilled trench even with adjacent ground surface until final non-vegetative surface restoration is completed.

B. Gravel Surfacing Rock: Add gravel surfacing rock where applicable and as necessary to keep surface of backfilled trench even with adjacent ground surface, and grade and compact as necessary to keep surface of backfilled

trenches smooth, free from ruts and potholes, and suitable for normal traffic flow.

C. Topsoil: Add topsoil where applicable and as necessary to maintain surface of backfilled trench level with adjacent ground surface.

D. Concrete Pavement: Replace settled slabs as specified in Section 32 12 16, Asphalt Paving.

E. Asphaltic Pavement: Replace settled areas or fill with asphalt as specified in Section 32 12 16, Asphalt Paving.

F. Other Areas: Add excavated material where applicable and keep surface of backfilled trench level with adjacent ground surface.

3.10 SETTLEMENT OF BACKFILL

A. Settlement of trench backfill, or of fill, or facilities constructed over trench backfill will be considered a result of defective compaction of trench backfill.

END OF SECTION

SECTION 31 32 19.16
GEOTEXTILE

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM):
   a. D737, Standard Test Method for Air Permeability of Textile Fabrics.
   b. D4355, Standard Test Method for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc Type Apparatus.
   c. D4491, Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   d. D4533, Standard Test Method for Trapezoid Tearing Strength of Geotextiles.
   e. D4595, Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
   f. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   g. D4716, Test Method for Determining the (In-Plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic Using a Constant Head.
   h. D4751, Standard Test Method for Determining Apparent Opening Size of a Geotextile.
   i. D4833, Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
   j. D4884, Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.
   k. D4886, Standard Test Method for Abrasion Resistance of Geotextiles (Sand Paper/Sliding Block Method).
   l. D5199, Standard Test Method for Measuring the Nominal Thickness of Geosynthetics.
   m. D5261, Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
   n. D6193, Standard Practice for Stitches and Seams.

1.02 DEFINITIONS

A. Fabric: Geotextile, a permeable geosynthetic comprised solely of textiles.

B. Maximum Average Roll Value (MaxARV): Maximum of series of average roll values representative of geotextile furnished.

C. Minimum Average Roll Value (MinARV): Minimum of series of average roll values representative of geotextile furnished.

D. Nondestructive Sample: Sample representative of finished Work, prepared for testing without destruction of Work.

E. Overlap: Distance measured perpendicular from overlapping edge of one sheet to underlying edge of adjacent sheet.

F. Seam Efficiency: Ratio of tensile strength across seam to strength of intact geotextile, when tested according to ASTM D4884.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Manufacturer material specifications and product literature.
   b. Installation drawings showing geotextile sheet layout, location of seams, direction of overlap, and sewn seams.
   c. Description of proposed method of geotextile deployment, sewing equipment, sewing methods, and provisions for holding geotextile temporarily in place until permanently secured.
2. Samples: Geotextile: One-piece, minimum 18 inches long, taken across full width of roll of each type and weight of geotextile furnished for Project. Label each with brand name and furnish documentation of lot and roll number from which each Sample was obtained.

B. Informational Submittals:

1. Certifications from each geotextile manufacturer that furnished products have specified property values. Certified property values shall be either minimum or maximum average roll values, as appropriate, for geotextiles furnished.
2. Field seam efficiency test results.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver each roll with sufficient information attached to identify it for inventory and quality control.

B. Handle products in manner that maintains undamaged condition.

C. Do not store products directly on ground. Ship and store geotextile with suitable wrapping for protection against moisture and ultraviolet exposure. Store geotextile in way that protects it from elements. If stored outdoors, elevate and protect geotextile with waterproof cover.

1.05 SCHEDULING AND SEQUENCING

A. Where geotextile is to be laid directly upon ground surface, prepare subgrade as specified in Section 31 23 13, Subgrade Preparation, first.

B. Notify Engineer whenever geotextiles are to be placed. Do not place geotextile without Engineer's approval of underlying materials.

PART 2 PRODUCTS

2.01 NONWOVEN GEOTEXTILE

A. Physical Characteristics:

1. Pervious sheet of polyester, polypropylene, or polyethylene fabricated into stable network of fibers that retain their relative position with respect to each other.
2. Nonwoven geotextile shall be composed of continuous or discontinuous (staple) fibers held together through needle-punching, spun-bonding, thermal-bonding, or resin-bonding.
3. Geotextile Edges: Selvaged or otherwise finished to prevent outer material from pulling away from geotextile.
4. Unseamed Sheet Width: Minimum 6 feet.
5. Nominal Weight per Square Yard: 10 ounces per ASTM D5261.
6. Physical Properties: Conform to requirements in Table No. 1 for Class 1 Geotextile.

Table No. 1: Class 1
Physical Property Requirements for Nonwoven Geotextile

Property	Requirement	Test Method
Water Permittivity	1.35 sec.[1], MinARV	ASTM D4491 (Falling Head)
Water Flow Rate	80 gpm/sq ft, MinARV	ASTM D4491
Apparent Opening Size (AOS)	80 U.S. Standard Sieve Size	ASTM D4751
Grab Tensile Strength, Machine Direction	205 lb/in, MinARV	ASTM D4632
Grab Elongation, Machine Direction	50 percent, MaxARV	ASTM D4632
Puncture Strength	130 lb, MinARV	ASTM D4833
CBR Puncture	600 lb, MinARV	ASTM D6241

Table No. 1: Class 1 Physical Property Requirements for Nonwoven Geotextile		
Property	**Requirement**	**Test Method**
Trapezoid Tear Strength	85 lb, MinARV	ASTM D4533
Ultraviolet Radiation Resistance	70 percent strength retention, MinARV after 500 hours	ASTM D4355

B. Functional Characteristics:

1. Prevent soil erosion by slowing water infiltration through material.
2. Provide matted base to contain rip rap.

C. Performance Characteristics: None.

2.02 SEWING THREAD

A. Physical Characteristics: Polypropylene, polyester, or Kevlar thread.

B. Functional Characteristics: Attach geotextile sheets together and to repair tears.

C. Performance Characteristics: Durability that is equal to or greater than durability of geotextile sewn.

2.03 SECURING PINS

A. Physical Characteristics:

1. Steel Rods or Bars:
   a. 3/16-inch diameter.
   b. Pointed at one end.
   c. With head on other end sufficiently large to retain washer.
   d. Minimum Length: 12 inches.
2. Steel Washers for Securing Pins:
   a. Outside Diameter: Not less than 1.5 inches.
   b. Inside Diameter: 1/4 inch.
      Thickness: 1/8 inch.
      Steel Wire Staples:
   c. U-shaped.
   d. 10 gauge.
   e. Minimum Length: 6 inches.

B. Functional Characteristics: To affix geotextile to the soil.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 LAYING GEOTEXTILE

A. Lay and maintain geotextile smooth and free of tension, folds, wrinkles, or creases.

3.02 SHEET ORIENTATION ON SLOPES

A. Orient geotextile with long dimension of each sheet parallel to direction of slope.

B. Geotextile may be oriented with long dimension of sheet transverse to direction of slope only if sheet width, without unsewn seams, is sufficient to cover entire slope and anchor trench and to extend at least 18 inches beyond toe of slope.

3.03 JOINTS

A. Unseamed Joints:

1. Overlapped.
2. Overlap, unless otherwise shown:
   a. Foundation/Subgrade Stabilization: Minimum 18 inches.
   b. Riprap: Minimum 18 inches.
   c. Drain Trenches: Minimum 18 inches, except overlap shall equal trench width if trench width is less than 18 inches.
   d. Other Applications: Minimum 12 inches.

B. Sewn Seams: Made wherever stress transfer from one geotextile sheet to another is necessary. Sewn seams, as approved by Engineer, also may be used instead of overlap at joints for applications that do not require stress transfer.

1. Seam Efficiency:
   a. Minimum 70 percent.
   b. Verified by preparing and testing minimum of one set of nondestructive Samples per acre of each type and weight of geotextile installed.
   c. Tested according to ASTM D4884.
2. Types:
   a. Preferred: “J” type seams.
   b. Acceptable: Flat or butterfly seams.
3. Stitch Count: Minimum three to maximum seven stitches per inch.

4. Stitch Type: Double-thread chainstitch according to ASTM D6193.
5. Sewing Machines: Capable of penetrating four layers of geotextile.
6. Stitch Location: 2 inches from geotextile sheet edges, or more, if necessary to develop required seam strength.

3.04 SECURING GEOTEXTILE

A. Secure geotextile during installation as necessary with sandbags or other means approved by Engineer.

B. Secure Geotextile with Securing Pins or Staples:

1. Insert securing pins with washers through geotextile.
2. Securing Pin Alignment:
   a. Midway between edges of overlaps.
   b. 6 inches from free edges.
3. Spacing of Securing Pins:

Slope	Maximum Pin Spacing
Steeper than 3:1	2 feet
3:1 to 4:1	3 feet
Flatter than 4:1	5 feet

4. Install additional pins across each geotextile sheet as necessary to prevent slippage of geotextile or to prevent wind from blowing geotextile out of position.
5. Push each securing pin through geotextile until washer bears against geotextile and secures it firmly to subgrade.
6. Where staples are used instead of securing pins, install in accordance with alignment and spacing above. Push in to secure geotextile firmly to subgrade.

3.05 PLACING PRODUCTS OVER GEOTEXTILE

A. Before placing material over geotextile, notify Engineer. Do not cover installed geotextile until after Engineer provides authorization to proceed.

B. If tears, punctures, or other geotextile damage occurs during placement of overlying products, remove overlying products as necessary to expose damaged geotextile. Repair damage as specified in Article Repairing Geotextile.

3.06 INSTALLING GEOTEXTILE IN TRENCHES

A. Place geotextile in a way to completely envelope granular drain material to be placed in trench and with specified overlap at joints. Overlap geotextile in

direction of flow. Place geotextile in a way and with sufficient slack for geotextile to contact trench bottom and sides fully when trench is backfilled.

B. After granular drain material is placed to required grade, fold geotextile over top of granular drain material, unless otherwise shown. Maintain overlap until overlying fill or backfill is placed.

3.07 RIPRAP APPLICATIONS

A. Overlap geotextile at each joint with upstream sheet of geotextile overlapping downstream sheet.

B. Sew joints where wave run-up may occur.

C. Limit height of riprap fall onto geotextile to prevent damage.

D. Drop Height:

1. 1 foot or less for riprap grader than or equal to 12-inches in diameter.
2. 3 feet or less for riprap less than 12-inches in diameter.

3.08 REPAIRING GEOTEXTILE

A. Repair or replace torn, punctured, flawed, deteriorated, or otherwise damaged geotextile.

B. Repair Procedure:

1. Place patch of undamaged geotextile over damaged area and at least 18 inches in all directions beyond damaged area.
2. Remove interfering material as necessary to expose damaged geotextile for repair.
3. Sew patches or secure them with heat fusion tacking or with pins and washers, as specified above in Article Securing Geotextile, or by other means approved by Engineer.

END OF SECTION

SECTION 31 37 00
RIPRAP

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   b. C136/C136M, Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   c. C150/C150M, Standard Specification for Portland Cement.
   d. C535, Standard Test Method for Resistance to Degradation of Large-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.

1.02 DEFINITIONS

A. Refer to applicable definitions in Section 31 23 23, Fill and Backfill.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Description and location of proposed sources of riprap bedding and riprap.

B. Informational Submittals:

1. Certified Test Results:
   a. Riprap:
      1) Gradation.
      2) Abrasion resistance.
      3) Bulk density.
2. Trip tickets showing source, type, and weight of each load of material delivered to Site.

1.04 QUALITY ASSURANCE

A. Riprap Source: Quarry that has produced riprap and has performed satisfactorily on other projects for at least 3 years.

1.05 SCHEDULING AND SEQUENCING

A. Complete subgrade preparation as specified in Section 31 23 13, Subgrade Preparation, and geotextile installation as specified in Section 31 32 19.16, Geotextile, prior to placing riprap.

PART 2 PRODUCTS

2.01 RIPRAP

A. Physical Characteristics:

1. Hard and durable quarry stone free from fractures, bedding planes, pronounced weathering, and earth or other adherent coatings.
2. On-site material may be used as riprap if material conforms to bulk density, abrasion resistance and other specifications listed below.
3. Minimum Dimension of Individual Pieces: Not less than 1/3 maximum dimension.
4. Abrasion Resistance: Maximum 35 percent wear as determined in accordance with ASTM C535.
5. Bulk Density: Minimum 160 pounds per dry cubic foot.
6. Gradation: Smaller pieces shall generally fill voids between larger pieces without either excess or deficiency of one or more sizes of stone.
7. Conform to the following requirements for size gradation and thickness:

Classification and Gradation of Ordinary Rip Rap			
Rip Rap Designation by Weight	**% Smaller Than Given Size**	**Intermediate Rock Dimension (inches)**	**d50* (inches)**
Class I	100	12	6
	50 – 70	9	
	35 – 55	6	
	10	3	
*d50 = Mean particle size. Thickness is typically 2 times the d50 size.			

B. Functional Characteristics: Prevent erosion of soil from water discharge.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 PREPARATION

A. Excavate areas to receive riprap to the subgrade for soil riprap to the specified depth (bedding material is not required for soil riprap).

B. Ensure that subgrade materials are stable. If unsuitable materials are encountered, remove and replace in accordance with Section 31 23 13, Subgrade Preparation.

C. Additional compaction will not be required unless specified by Engineer. When subgrade is built up with embankment material, compact to in accordance with Section 31 23 23.15, Trench Backfill.

D. Bed riprap with geotextile as specified in Section 31 32 19.16, Geotextile.

E. Geotextile:

1. After an acceptable subgrade is established, immediately place and level the geotextile to the specified elevation.
2. Immediately following the placement of the geotextile, place the riprap.
3. Replace the geotextile if the geotextile is disturbed for any reason.
4. In-place geotextile are not to be contaminated with soils, debris or vegetation before the riprap is placed. If contaminated, remove and replace the geotextile material.

3.02 PLACING RIPRAP

A. Place riprap over geotextile to uniform thickness as shown.

B. No mechanical compaction of riprap is required; however, work riprap bedding as necessary to distribute it and to eliminate detrimental voids. Avoid overworking or long pushes that result in segregation of particle sizes.

C. Grade surface of riprap bedding free from irregularities and to tolerances of 0.2 foot from established grade.

D. Place and grade riprap in a manner that avoids subgrade disturbance and displacement or damage to geotextile. Do not push riprap bedding down slope. If wrinkles form in geotextile as riprap bedding is placed, correct them as specified in Section 31 32 19.16, Geotextile.

E. Place riprap on geotextile without puncturing or damaging geotextile. If accidentally damaged, repair geotextile prior to proceeding.

END OF SECTION

SECTION 31 40 00
TUNNELED CROSSINGS

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section includes requirements for the tunneled installation of 24-inch steel casing pipe. Base bids and select equipment based on the soil and groundwater conditions defined in this section. In no case will any geotechnical data or reports take precedence over soil and groundwater conditions defined for the tunneled crossings and associated shafts and risers in this section.

1.02 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. ASTM International (ASTM): D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

1.03 SUBMITTALS

A. Informational Submittals:

1. Abandonment-Recovery Contingency Plan: Prepare an Abandonment Contingency Plan to handle the possibility that a tunneled crossing cannot be completed. Submit the Abandonment Contingency Plan in writing to the Contracting Officer 2 weeks prior to commencement of tunnel operations. Follow and manage provisions of the approved Plan.

1.04 DEFINITIONS

A. Horizontal Auger Boring: As defined in Section 31 42 00, Horizontal Auger Boring.

B. Radial Overcut: Radial overcut is defined as the difference between the maximum diameter created by the cutting teeth, cutting shoe, or overcut band on the machine or auger (whichever is greater) and the outer diameter of the casing, divided by two.

C. Riser Pipe: Segment of the pipeline that transitions from the trenchless crossing to the shallow open cut portion of the pipeline.

1.05 DESIGN CRITERIA

A. Employ methods and equipment that will control surface settlement and heave above the tunnel to prevent damage to existing utilities, facilities, and improvements. Limit ground movements (settlement/heave) to values that do not cause damage or distress to surface features, utilities, or improvements. In no case will settlements exceed the shutdown values provided in Section 31 44 00, Settlement Monitoring. Repair, damage to existing features, improvements, or utilities to the satisfaction of the Contracting Officer.

B. Initial tunnel support will be provided by a jacked steel casing.

C. The allowable construction methods for the tunneled crossings shown on the Drawings is Horizontal Auger Boring in accordance with Section 31 42 00, Horizontal Auger Boring.

D. If desired, propose other tunneling means and methods in accordance with the General Conditions. Proposed alternative tunneling methods shall install the specified steel casing and meet the intent of the allowable tunneling methods. Demonstrate that the proposed alternate tunneling method is technically feasible, and will result in settlement less than the shutdown values presented in Section 31 44 00, Settlement Monitoring.

E. Submit three examples of crossings of similar lengths and in similar subsurface conditions where the proposed alternate was successfully completed. The alternative tunneling method description must be signed and sealed by a professional engineer registered in the State of New Mexico who attests to the suitability of the method and the degree to which it meets the above-described intent of the allowable tunneling methods.

F. The maximum radial overcut is 3/4 inch. The maximum allowable radial overcut value has been selected to minimize potential settlements of the ground and subsurface facilities.

G. The use of water under pressure water jetting or puddling will not be permitted to facilitate boring, pushing, or jacking operations.

1.06 PERMITS

A. Obtain and comply with permits as required and as applicable from entities that are crossed by tunneled crossings.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Soil conditions anticipated to be encountered during construction of the shafts, tunnels, and associated riser pipes are presented in Table 1. Base bids and develop schedules from these tables, which defines the subsurface conditions.

B. The soils are classified according to the Unified Soil Classification System (USCS) in accordance with ASTM D2487, including fines content and particle size, and the relative density or consistency is based on the correlations presented in Table 2. In addition, for fine-grained soils (clays and silts) the unconfined compressive strength is defined according to the consistency presented in Table 2.

C. Soil behavior is classified according to the system presented in Table 3.

3.02 GEOTECHNICAL CONDITIONS

A. The primary purpose of the defined subsurface conditions presented herein is to establish a contractual understanding of the geotechnical conditions anticipated to be encountered during construction of the tunneled portions of the Project in order to provide a basis for bidding and to assist in resolution of disputes that may arise over subsurface conditions during tunneling. Secondarily, the definitions:

1. Present the geotechnical and construction conditions that formed the basis of tunnel design.
2. Provide information to assist the Contractor in evaluating requirements for excavating and supporting the ground.
3. Provide guidance to the Contracting Officer in administering the Contract.

B. The defined subsurface conditions contained herein provide the basis for identifying geotechnical and geologic conditions that qualify as “Differing Subsurface or Physical Conditions,” as defined in the General Conditions.

C. The defined subsurface conditions contained within this specification, are not necessarily geotechnical fact. The defined conditions were developed using judgment to interpolate between borings and extrapolate beyond the boring logs and laboratory test data. The judgment applied in the interpolations and extrapolations reflects the view of the Contracting Officer.

D. Bidders will use the defined conditions in defining the subsurface conditions and the surface conditions which can be observed during a Site visit as the

basis for bids. The Project design was based on assumed construction methods and levels of workmanship. The behavior of the geologic materials present in the surface and subsurface excavations will be influenced by the Contractor's selected equipment, means, and methods.

E. The results of the Project geotechnical investigation applicable to the crossings are included and bound separately. If there are disagreements or ambiguities between the defined conditions presented in this specification and the geotechnical data, this specification takes precedence.

F. Bidders should have a geotechnical engineer or engineering geologist licensed in the State of New Mexico review and explain the information to assure a complete understanding of the reported information as a basis for submitting a bid.

G. Where unstable soil conditions exist, boring or tunneling operations shall be conducted in such a manner as not to be detrimental to the surface being crossed.

3.03 RISK ALLOCATION

A. Risks associated with subsurface conditions consistent with, or less adverse than, the defined conditions are allocated to the Contractor. The risk of higher construction costs associated with subsurface conditions more adverse than the conditions presented herein are accepted by the Owner.

B. The definition of the subsurface conditions in the Contract is not a warranty that the defined conditions will be encountered. The defined conditions are the contractual standard that the Owner and the Contractor will agree to use when interpreting the differing subsurface conditions or physical conditions clause, contained in the General Conditions.

C. In the event that Contractor believes more adverse conditions have been encountered, Owner will negotiate with the Contractor for additional compensation if Owner determines the following four conditions exist:

1. Notify Owner of the differing conditions in writing in accordance with the General Conditions.
2. The actual subsurface conditions encountered are materially more adverse than the defined conditions.
3. Documentation that the subsurface conditions are more adverse than those defined and that the conditions materially and significantly increased the cost and/or time required to complete the Work.
4. Diligent efforts were made to complete the Work described in the Contract Documents, including any changes to methods, equipment, labor, and materials made necessary by the more adverse conditions.

D. If the foregoing conditions are satisfactorily met, additional compensation will be negotiated in accordance with the General Conditions.

3.04 OBSTRUCTIONS

A. If the tunneling operations should encounter an object or condition that impedes the forward progress of the machine, notify the Contracting Officer immediately.

B. Submit a plan to correct the condition, and remove, clear, or otherwise make it possible for the tunneling machine and casing pipe to advance past any and all objects or obstructions that impede forward progress of the casing.

C. Upon written notification of the Contracting Officer, immediately proceed with removal of the object or obstruction by means of an obstruction removal shaft or by other approved methods, as submitted by the Contractor. An obstruction removal shaft shall consist of a small excavation for the purpose of removing the obstruction.

D. The Contractor will receive compensation for removal of obstructions, which consist of metallic debris, reinforced concrete, whole trees, rocks and other hard objects larger than 33 percent of the outer diameter of the shield, cutterhead, or cutting shoe, which cannot be broken up by the cutting tools with diligent effort, and that are partially or wholly within the cross-sectional area of the bore.

E. Payment will be negotiated with the Contractor by the Owner on a case-by-case basis. However, any removal process that does not allow direct inspection of the nature and position of the obstruction will not be considered for payment.

F. The Contractor will receive no additional compensation for removing, clearing, or otherwise making it possible to advance past objects consisting of cobbles, boulders, wood, nonreinforced concrete, and other nonmetallic objects or debris with maximum lateral dimensions less than 33 percent of the outer diameter of the cutterhead or steel casing.

3.05 DEFINED SUBSURFACE CONDITIONS

Table 1 Defined Subsurface Conditions – Crossing Under Highway 4 Between Station 5+05 and 6+46			
Depth (ft)	**Elevation (ft)**	**USCS Soil Type**	**Consistency or Relative Density**
North Shaft			
0-8	6714.6 – 6706.6	Silty Sand (SM)	Medium Dense
8-9	6706.6 – 6705.6	Silty Sand (SM)	Extremely Weak
9-21	6705.6 – 6693.6	Rhyolite	Extremely Weak
South Shaft			
0-8	6714.6 – 6706.6	Silty Sand (SM)	Medium Dense
8-9	6706.6 – 6705.6	Silty Sand (SM)	Extremely Weak
9-21	6705.6 – 6693.6	Rhyolite	Extremely Weak
Tunnel: The tunnel will be completed in a full face of Rhyolite having a strength ranging from 50 psi to 300 psi. The material will behave as firm if unsupported. No groundwater is anticipated at this crossing.			

Table 2 Summary of Consistency or Relative Density			
Soil Type	**Description**	**Corrected SPT Blow Count (blows/ft)**	**Unconfined Compressive Strength (tons/ft^2)**
Cohesive (silts, clays, limestone, and shale)	Very Soft	0-2	<0.25
	Soft	3-4	0.25-0.50
	Firm	5-8	0.50-1.00
	Stiff	9-15	1.00-2.00
	Very Stiff	16-30	2.00-4.00
	Hard	>30	4.00-100.00

Table 2 Summary of Consistency or Relative Density			
Soil Type	**Description**	**Corrected SPT Blow Count (blows/ft)**	**Unconfined Compressive Strength (tons/ft^2)**
Noncohesive (sands and gravels)	Very Loose	0-4	Not Applicable
	Loose	5-10	
	Medium Dense	11-30	
	Dense	31-50	
	Very Dense	>50	

Table 3 General Ground Behavior and Tunnelman's Ground Classification	
Classification	**General Ground Behavior When Exposed in Tunnel**
Firm	Heading can be advanced without initial support.
Raveling	Chunks or flakes of material begin to drop out of the arch or walls sometime after the ground has been exposed. "Fast raveling" begins within a few minutes; otherwise, the ground is "slow raveling."
Cohesive Running	Material with sufficient cohesion to stand for a brief period of raveling before it breaks down and runs.
Running	Granular materials without cohesion are unstable at a slope greater than the angle of repose (+/- 30° to 35°). When exposed at steeper slopes, they run like granulated sugar or dune sand until the slope flattens to the angle of repose.
Cohesive Flowing	Material with sufficient cohesion to stand for a brief period of raveling before it breaks down and flows as a mixture of soil and water.
Flowing	A mixture of soil and water flows into the tunnel like a viscous fluid. The material can enter the tunnel from the invert as well as from the face, crown, and walls, and can flow for great distances as it accumulates in the tunnel.
Source: Modified after Heuer, 1974.	

END OF SECTION

SECTION 31 41 00
SHORING

PART 1 GENERAL

1.01 REFERENCES

A. Occupational Safety and Health Administration (OSHA): Regulations for Underground Construction, 29 CFR Part 1926, Subpart S, Underground Construction, and Subpart P, Excavation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Provide an excavation support plan for open cut reaches and below grade structures of the Project when non-traditional shoring systems are used to be designed and sealed by a registered professional engineer in the State of New Mexico. Traditional shoring systems are trench sloping or pre-engineered supports (such as trench boxes). Include, as a minimum, the following information:
   a. Details of shoring, bracing, sloping, or other provisions for worker protection from hazards of caving ground.
   b. Qualifications of excavation support design engineer.
   c. Design assumptions and calculations including adjacent ground movement limits.
   d. Methods and sequencing of installing excavation support.
   e. Proposed locations of stockpiled excavated materials.
   f. Minimum lateral distance from the crest of slopes for vehicles and stockpiled excavated materials.
   g. Anticipated difficulties and proposed resolutions including provisions for subgrade stability and protection.
2. Provide Shaft/Pit Excavation Support Plan for the trenchless crossing that is designed and sealed by a registered professional engineer in the State of New Mexico. Include, as a minimum, the following information:
   a. Scaled drawings (plan and section views with dimensions and sizes) showing the proposed Shaft/Pit elements, adjacent and nearby existing structures and utilities; details of tunneled pipe penetrations; details of pipe penetrations for connection to open cut sections of the pipeline; staging areas for Shaft/Pit construction operations, such as storage, and minimum setbacks from the excavation.
   b. Details for locating and protecting existing utilities and structures.
   c. Methods and sequencing of soil excavation and installation of staged excavation support.

d. Procedures for checking and maintaining plumbness of the Shaft/Pit and ensuring proper elevation is reached.

e. Calculations for the Shaft/Pit support elements and bracing, indicating it can withstand earth and groundwater pressures, equipment, applicable traffic, and construction loads and other surcharge in accordance with the soil conditions anticipated by the Contractor, and other requirements described in the Drawings and Specifications. Indicate the assumed subsurface conditions used in the design.

1.03 QUALITY ASSURANCE

A. The Contractor is responsible for quality control, including workmanship and material furnished by their subcontractors and suppliers.

B. Provide surveys to monitor movements of critical facilities.

C. Provide trench excavation support designed by a professional engineer registered in the State of New Mexico who has a minimum of 5 years of experience in the design of retaining structures.

PART 2 PRODUCTS

2.01 GENERAL

A. Structural Steel: ASTM A36 or better, unless otherwise approved.

PART 3 EXECUTION

3.01 GENERAL

A. Utilize the type of shoring and protection methods that meet the specification requirements and that are of a size large enough to facilitate the necessary groundwater control, construction operations, pipeline equipment and operations, trenchless operations, and to accommodate indicated connections to open cut reaches of the Project.

B. Provide excavation support systems for areas to support earth pressure, unrelieved hydrostatic pressures, bottom heave, utility loads, equipment, jacking loads, applicable traffic loads, and other loads in such manner as to allow safe construction and to prevent damage to adjacent structures (including existing pipelines and utilities) and injury to workers and the public. In addition, the installation of excavation support systems will not cause a disruption to public convenience or access.

C. Provide excavation support systems to be compatible with the geologic conditions presented in Section 31 40 00, Tunneled Crossing, and in the geotechnical data report completed for the Project.

D. Provide the support system to protect adjacent utilities from damage and to minimize horizontal and vertical movements to the maximum allowable values for deformation which are specified in Section 31 44 00, Settlement Monitoring.

E. Provide Shaft/Pit for the removal of the upper 5 feet to accommodate construction of connections and backfill sequences.

3.02 TRENCHES

A. For trench excavation at or exceeding 5 feet in depth, provide adequate safety system meeting requirements of applicable local construction safety orders, and OSHA requirements.

B. When personnel are not present within the immediate vicinity of the Work, plate, fence, or barricade open excavations to protect the public and to provide for worker safety.

3.03 REMOVAL OF SUPPORT SYSTEM

A. Do not remove excavation support until support can be removed without damage to existing facilities, completed Work, or adjacent property.

B. Remove excavation support in a manner that will maintain support as excavation is backfilled and will not leave voids in backfill. Perform removal of the support system in a manner that will not disturb the pipeline, the compacted backfill, or adjacent construction or facilities.

C. Remove the excavation support from the excavation and from the Site.

END OF SECTION

SECTION 31 42 00
HORIZONTAL AUGER BORING

PART 1 GENERAL

1.01 WORK INCLUDED

A. Furnish labor, equipment, and materials necessary for horizontal auger boring installation of a steel casing, and other associated work.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Where conflicts between these specifications and the referenced specification, code, or standard occur, the more restrictive specification shall govern. The publications are referenced in the text by basic designation only. Where a date is given for referenced standards, that edition shall be used. Where no date is given for referenced standards, use the latest edition available on the date of issue of Contract Documents.

1. Occupational Safety and Health Administration (OSHA) Regulations and Standards for Underground Construction, 29 CFR Part 1926, Subpart S, Underground Construction, and Subpart P, Excavations.

1.03 SUBMITTALS

A. Informational Submittals:

1. Qualifications: Submit the name of the subcontractor that will perform the horizontal auger boring work and submit qualifications and detailed qualifying project experience for the subcontractor, subcontractor's superintendent, and horizontal auger boring machine operator(s) that meet the requirements of Article Quality Assurance. In addition, submit names and training/qualifications of personnel that will perform air quality monitoring, the Site Safety Representative, and the professional Land Surveyor.
2. Pre-Construction and Post-Construction Surveys: Submit pre-construction and post-construction surveys including photographs, videos, field notes, written records, and sketches in accordance with Contract Documents.
3. Quality Control Methods:
   a. Submit a description of the quality control methods proposed for the horizontal auger boring operation at least 30 days prior to the start of work. Include the following:
      1) Supervision: Supervisory control to ensure that Work is performed in accordance with the Drawings and

Specifications, and horizontal auger boring Work Plan and as shown on the Drawings.

2) Line and Grade: Procedures for surveying, controlling and checking line and grade, including field forms.

3) Observation and Monitoring. Procedures for preparing and submitting daily logs of trenchless operations, including field forms.

4) Products and Materials: A plan for testing and submittal of test results to demonstrate compliance with the Specifications and Contractor's criteria for permanent products, materials, and installations. Identify applicable standards and procedures for testing and acceptance.

4. Safety Plan:

a. A Safety Plan for the horizontal auger boring operations including air monitoring equipment and procedures, and provisions for lighting, ventilation, and electrical system safeguards. The plan should also include at a minimum:

1) Protection against soil instability and groundwater inflow.

2) Safety for tunnel and shaft access and exit including ladders, stairs, walkways, and hoists.

3) Protection against mechanical and hydraulic equipment operations, and for lifting and hoisting equipment and material.

4) Monitoring for hazardous gases.

5) Means for emergency evacuation and self-rescue.

6) Protection of shaft including traffic barriers, accidental or unauthorized entry, and falling objects.

7) Precautions and measure for stabilizing the horizontal auger boring machine to prevent upset.

5. Schedule:

a. Provide a schedule for horizontal auger boring work, identifying major construction activities as independent items. Include, as a minimum, the following activities:

1) Mobilization.

2) "One call" utility locate requests and visual confirmation of all crossing utilities and parallel utilities within 10 feet laterally of the bore centerline.

3) Groundwater control at jacking and receiving shafts/pits.

4) Groundwater control along the proposed crossing alignment.

5) Shaft excavation and support.

6) Working slab construction (if applicable).

7) Thrust wall construction (if applicable).

8) Augering equipment setup.

9) Augering boring and jacking.

10) Installation of the carrier pipe inside the steel casing.

11) Backfill grouting.

12) Shaft backfill.
13) Site restoration.
14) Cleanup.
15) Demobilization.
16) Include the work hours and workdays for each activity, and a written description of the construction activities. Update every 2 weeks, or more frequently if requested by the Construction Manager.

6. Daily Records: Submit the following daily records by noon on the day following the shift for which the data or records were taken.
   a. Jacking Records: Provide complete jacking records. Include, at a minimum: Date, time, name of operator, tunnel crossing identification, installed pipe number and corresponding casing length, auger rotation speed and torque, rate of advance for each pipe, jacking forces, spoil feed rates, including estimated insitu excavation volume per cubic foot of advance and assumed bulking factor (with comparison to theoretical excavation volume), line and grade offsets, problems with the auger boring machine or other components or equipment, and durations and reasons for delays. Make manually recorded observations at intervals of not less than 3 feet of advance, as conditions change, and as directed by the Contracting Officer. Submit samples of the manual jacking records at least 7 days prior to the start of augering.
   b. Survey Measurements: Survey measurements of casing alignment.

B. Action Submittals:

1. Horizontal Auger Boring Operations:
   a. Submit a horizontal auger boring Work Plan. Include the following items, at a minimum, in the horizontal auger boring Work Plan, (including drawings):
      1) Contractor’s construction drawings, manufacturer literature, and written description identifying details of the proposed method of construction and the sequence of operations to be performed during construction, as required by the method of trenchless installation. Sufficiently detail the drawings and descriptions to demonstrate whether the proposed materials and procedures will meet the requirements of this section. Include the following items, at a minimum, in the Horizontal Auger Boring Work Plan, (including drawings):
         a) Dimensions.
         b) Cutter types and arrangement.
         c) Cutterhead position relative to casing.
         d) Casing and band diameters.
         e) Cut diameter based on gage cutter position and casing band diameter and resulting excavation diameter.

f) Torque, speed, and thrust.
g) Auger and muck casing diameters.
h) Mucking system for horizontal auger boring machine (ABM).

2) Method of maintaining and controlling line and grade of horizontal auger boring operation.
3) Method and details of spoil removal, including equipment type and numbers, processing, and disposal procedures and locations.
4) Details of the horizontal auger boring method and operation.
5) Plans for storage and handling of casing.

2. Contingency Plans: The following list includes problem scenarios that may be encountered during the horizontal auger boring operations. Submit contingency plans for dealing with each problem scenario while satisfying the Specifications. Include the observations and measurements required to clearly identify the cause of the problems.
   a. Machine Unable to Advance:
      1) Insufficient auger torque or jacking capacity.
      2) Machine malfunction.
      3) Casing or auger obstructed by a hard object such as sheeting, a pile, a casing, a utility, or boulder.
   b. Spoil Feed Problems:
      1) Strong hydrocarbon smell is detected in the spoils or in the shaft / pits.
      2) Rock fragment jamming auger mucking system.
   c. Jacking Forces:
      1) Jacking forces increase dramatically or suddenly.
      2) Jacking forces reach design capacity of casing, jacking frame, or thrust wall (treat these scenarios as separate incidents).
   d. Settlement and Subsidence:
      1) Survey measurements indicate deformations exceed allowable limits as defined in Section 31 44 00, Settlement Monitoring.
      2) Excavated volumes with appropriate bulking factors exceed casing volume installed by over 20 percent.
   e. Unable to maintain line and/or grade in soft or loose ground or mixed-face ground.
   f. Pipe has been damaged or has been found to be out of compliance with Specifications during, or after installation.
   g. Thrust block deforms excessively under jacking loads, or provides insufficient capacity to advance casing.
3. Abandonment-Recovery Contingency Plan: Prepare an Abandonment Contingency Plan to handle the possibility that a tunneled crossing cannot be completed. Submit the Abandonment Contingency Plan in

writing to the Contracting Officer 2 weeks prior to commencement of tunnel operations. Follow and manage provisions of the approved plan.

1.04 DEFINITIONS

A. Carrier Pipe: Permanent pipe for operational use that is used to convey flows.

B. Casing: A pipe installed by horizontal auger boring that supports the ground and provides a stable underground excavation for the installation of a carrier pipe.

C. Horizontal Auger Boring: Auger boring technique using an auger boring machine to bore a hole and remove spoil via auger flights and jacks to advance casing.

D. Jacking Record: A manually recorded report that contains information on horizontal auger boring operations and may include date, time, name of operator, tunnel crossing identification, installed tunnel length, rate of advance, jacking forces, spoil production rates, line and grade offsets, any movement of the guidance system, problems encountered with the horizontal auger boring machine or other components or equipment, and durations and reasons for delays.

E. Monitoring Point: Surface points, as defined in Section 31 44 00, Settlement Monitoring. Re-survey the point as specified to monitor ground movements.

F. Radial Overcut: The difference between the maximum diameter created by the cutting teeth, cutting shoe, or overcut band on the machine or auger (whichever is greater) and the outer diameter of the casing, divided by two.

1.05 DESIGN CRITERIA

A. Horizontal Auger Boring Equipment:

1. Select horizontal auger boring equipment suitable for and capable of efficiently advancing through the geologic conditions anticipated by the Contractor.
2. Provide a lubrication injection system to inject pipe lubricant around the casing. Lubrication materials may include a mixture of bentonite and/or polymers and water.
3. Provide a water level system to measure the grade of the casing during augering. Install and protect the system on the outside of the casing. In the event a water level system is not provided Contractor to remove augers from the casing every 40 feet of casing installed and use a pipe laser to measure the line and grade of the casing.

B. Utilize methods and equipment to control surface settlement and heave above the pipeline to prevent damage to existing utilities, facilities, and improvements. Limit ground movements (settlement/heave) to values that do not cause damage or distress to surface features, utilities, or improvements. In no case shall settlements exceed the applicable values listed in Section 31 44 00, Settlement Monitoring.

C. Comply with the requirements of Section 31 44 00, Settlement Monitoring.

D. Design casing for jacking loads and acceptable fabrication tolerances. Do not exceed 50 percent of the ultimate compressive strength of the casing material or the maximum design strength of the casing as established by the manufacturer, whichever is lower for the maximum jacking loads applied to the casing.

E. If Contractor elects to increase the casing diameter from the dimension shown on the Drawings, the Contractor shall match casing crown elevation such that the depth of cover is not decreased.

F. The maximum radial overcut is as specified in Section 31 40 00, Tunneled Crossings.

G. Use a thrust block to transfer jacking loads to the soil behind the jacking shaft. Construct the thrust block face perpendicular to the proposed casing alignment. Design the thrust block to withstand the maximum jacking forces developed by the main jacks, without excessive deflection or displacement. The thrust pressures transmitted to the soil adjacent to the thrust block shall not exceed an allowable passive earth pressure based on a minimum factor of safety of 2.0 relative to the computed maximum passive earth pressure.

1.06 QUALITY ASSURANCE

A. Perform horizontal auger boring work by an experienced subcontractor who has at least 5 years of experience in performing horizontal auger boring work in similar soil and has completed at least three similar projects involving at least a 140-foot horizontal auger bores on each project.

B. Provide a subcontractor Superintendent with at least 5 years of experience supervising horizontal auger boring operations.

C. Provide a horizontal auger boring machine operator(s) technically trained in the operation of the proposed horizontal auger boring equipment and having completed, as a primary operator, at least three similar horizontal auger boring projects involving at least a 140-foot horizontal auger bores in similar subsurface conditions on each project.

D. Provide a Site Safety Representative and personnel responsible for air quality monitoring experienced in tunnel construction and having current certification by OSHA as may be required to perform the work.

E. Provide a Professional Land Surveyor licensed in the State of New Mexico who has prior experience in similar underground projects to be responsible for line-and-grade control.

F. Provide a water level system (dutch level) on the casing to permit measurement of the casing grade from within the jacking shaft. Protect the equipment from damage during horizontal auger boring and attach it to the casing securely. In the event the water level is damaged, completely remove the auger from the casing every 40 feet and perform a manual measurement of casing line and grade using surveying techniques.

G. Provide at least 72 hours advance written notice to Contracting Officer of the start of the horizontal auger boring. Immediately notify the Contracting Officer, in writing, when problems are encountered with equipment or materials, or if the conditions encountered are materially and significantly different than those represented within the Contract Documents. Perform Work in the presence of the Contracting Officer unless the Contracting Officer grants prior written approval to perform such Work in Contracting Officer's absence.

H. Allow access to the Contracting Officer and furnish necessary assistance and cooperation to aid the Contracting Officer in observations, measurements, data, and sample collection, including, but not limited to the following:

1. Allow Contracting Officer full access to the jacking and reception shafts prior to, during, and following jacking operations. Access includes, but is not to be limited to, visual inspection of installed casing and verification of line and grade. Provide safe access in accordance with safety regulations.
2. Allow Contracting Officer full access to the spoil material. Allow the Contracting Officer to collect soil samples from the spoil removal system a minimum of once per installed casing section, or every 8 feet, whichever is more often, and at any time when changes in soil conditions or obstructions are apparent or suspected.

1.07 SAFETY

A. Be responsible for safety on the Site. Utilize methods of construction to ensure the safety of the Work, personnel onsite, and the public. Perform Work in accordance with current applicable regulations and safety requirements of the federal, state, and local agencies. Comply with applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA.

B. No gasoline powered equipment is permitted in jacking and receiving shafts and pits. Diesel, electrical, hydraulic, and air powered equipment is acceptable, subject to applicable local, state, and federal regulations.

C. Furnish and operate a temporary ventilation system in accordance with applicable safety requirements when personnel are in the shaft or in the casing. Perform required air and gas monitoring. Provide a ventilation system to provide a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in underground Work areas.

PART 2 PRODUCTS

2.01 MATERIALS

A. Carrier Pipe: Pipes used as a carrier pipe, to be installed inside the jacked steel casing in accordance with Section 33 05 01.14, Fusible PVC Pressure Pipe and Fittings, for the waterline, Section 22 10 01, Plumbing Piping and Accessories, for the natural gas line, and Section 40 27 00.10, Polyvinyl Chloride (PVC) Pipe and Fittings, for the “FC” line conduit.

B. Steel Casing Pipe: Steel casing to be installed by horizontal auger boring to serve as continuous casing for carrier pipe shall conform to Section 31 43 00, Steel Casing Pipe.

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Do not begin horizontal auger boring until the following tasks have been completed:

1. Required Submittals have been provided, reviewed, and approved to include requirements indicated in the following Sections:
   a. 31 40 00, Tunneled Crossings.
   b. 31 41 00, Shoring.
   c. 31 43 00, Steel Casing Pipe.
   d. 31 44 00, Settlement Monitoring.
   e. 31 45 00, Installation of Carrier Pipe in Steel Casing.
   f. 31 46 00, Backfill Grouting.
2. Jacking shaft/pit and receiving shaft/pit excavations and support systems have been completed in accordance with approved Submittals. Locations and elevations of shafts/pits have been surveyed to confirm that Work can be completed in accordance with alignment and grade as shown on the Drawings.
3. Monitoring points have been installed and baseline measurements established.

4. The location, orientation and grade of the jacking frame or guide rails have been surveyed to ensure they are on the proper line and grade and to verify that they are properly supported. Take special care when setting the guide rails or jacking frame in the jacking shaft to ensure stability and accuracy of the alignment and grade. Securely attached guide rails or jacking frame shall to a concrete working slab, with supplementary concrete or grout, if necessary, to prevent movement or shifting during the Work.
5. A startup inspection of mechanical and hydraulic systems associated with the horizontal auger boring operations has been completed. Test the system on the surface to ensure that the horizontal auger boring machine and supporting equipment is functioning properly.
6. The operation of the dutch level has been checked and verified to be operating correctly.
7. Site Safety Representative has prepared a code of safe practices and an emergency plan in accordance with OSHA and other applicable requirements. Provide the Contracting Officer with a copy of each prior to starting horizontal auger boring. Hold safety meetings and provide safety instruction for new employees as required by OSHA. Conduct a pre-construction safety conference in accordance with OSHA requirements. Arrange this conference and inform the Contracting Officer of the time and place of the conference at least 7 days in advance.

B. Properly manage and dispose of groundwater and surface water inflows to the shafts in conformance with approved Dewatering and Construction Stormwater Discharge Permits. Do not discharge groundwater inflows into storm sewers, sanitary sewers, drainage ditches, water bodies, or streets without an approved discharge permit.

C. Conduct operations such that trucks and other vehicles do not interfere with traffic or create a mud, dust, or noise nuisance in the streets and to adjacent properties. Promptly clean up, remove, and dispose of mud and spoils spillage, and any material discharges.

D. Conduct Work so as not to disturb roadways, adjacent structures, landscaped areas, or existing utilities. Repair damage immediately to original or better condition and to the satisfaction of Contracting Officer.

E. Operate with a full crew 24 hours a day whenever there is a condition that is likely to endanger the stability of the excavation or adjacent structures, including weekends and holidays, without interruption, until those conditions no longer jeopardize stability.

3.02 JACKING OPERATIONS

A. Provide a suitable jacking frame and thrust block (if required) to carry out the Work.

B. Transport the casing from storage to the jacking shaft without damage. Utilize transport methods acceptable to casing manufacturer. Do not use damaged casing in the Work, unless permitted in writing by the Contracting Officer. Set the casing on properly braced and supported guide rails or jacking frame.

C. Distribute the axial forces from the thrust jacks to the casing uniformly through a thrust ring and cushion material, if applicable, to prevent damage to the ends of the pipe. Do not exceed the specified allowable compressive stresses for the jacking forces applied to the casing.

D. Jack casing into position following the design line and grade without damaging the casing.

3.03 HORIZONTAL AUGER BORING

A. Complete horizontal auger boring in accordance with approved Submittals, and applicable permit conditions.

B. Conduct horizontal auger boring operations to control surface settlement and heave above the pipeline to prevent damage to existing utilities, facilities, and improvements. Repair damage resulting from construction activities. Pressure grout voids caused by or encountered during the shaft construction and horizontal auger boring. Modify equipment and procedures as required to avoid recurrence of excessive settlements or damage.

C. Control the advance of the auger and casing so as to restrict the excavation of the materials to a volume equal to the pipe jacked plus allowance for the allowable radial overcut and bulking, to prevent loss of ground and settlement or possible damage to overlying structures. Control the advance rate and monitor the volume of material excavated and adjust advance rate, as required, to avoid loss of ground, over excavation, or surface heave.

D. Completely contain, transport, and dispose of excavated materials and fluid additives away from the construction site. Contain spoils in trucks or other containers. Dumping of spoil on the ground, discharge into sewers or ditches, or discharge into the shafts is not permitted. Only use the disposal sites identified in approved Submittals for muck and spoil disposal.

3.04 CONTROL OF LINE AND GRADE

A. Establish and protect benchmarks as necessary prior to the start of construction.

B. After establishing required benchmarks, use these benchmarks to furnish and maintain reference lines and grades for horizontal auger boring. Use these lines and grades to establish the exact location of the casing using a laser or theodolite guidance system. Submit to Contracting Officer copies of field notes used to establish lines and grades and allow Contracting Officer to check guidance system setup prior to beginning each horizontal auger boring drive. Provide access for Contracting Officer to perform survey checks of guidance system and line-and-grade of casing, as necessary. Be fully responsible for the accuracy of the Work and the correction of it, as required.

C. Install the casing in accordance with the following tolerances:

1. Variations from Design Line: 6 inches maximum.
2. Variations from Design Grade: 6 inches maximum.

D. Control the auger and casing advancement to maintain line and grade within the tolerances specified. If the installation is off line or grade, attempt to make the necessary corrections, as identified in the Contractor's Contingency Plans.

E. Mount the guidance system independently from the thrust block and jacking frame to maintain alignment if there is movement of equipment during jacking. Stop horizontal auger boring operations and reset guidance system if its alignment shifts or is moved off design alignment and grade for any reason. Check guidance system setup at least once per shift. Guidance system shall only be reset by experienced, competent surveying personnel in accordance with approved procedures outlined in the Submittals.

F. Monitor line and grade continuously during horizontal auger boring operations using a water level. Record deviation with respect to design line and grade at least once per 10 feet and submit records to Contracting Officer as requested. Control line and grade of the casing to within the specified tolerances. In the event the water level is damaged or not provided, completely remove the augers from the casing every 40 feet of advance and record the line and grade of the casing using surveying techniques.

G. Correct the installation, including any necessary redesign of the pipeline or structures and acquisition of necessary easements, if the casing installation does not meet the specified tolerance. Performance of corrective work is subject to the written approval of the Contracting Officer.

3.05 INSTALLATION OF CARRIER PIPE

A. Installation of carrier pipe within the casing and backfilling of annular space between the casing and carrier shall be in accordance with Section 31 45 00, Installation of Carrier Pipe in Steel Casing, and Section 31 46 00, Backfill Grouting.

3.06 CLEANUP

A. After completion of horizontal auger boring and carrier pipe installation, remove construction debris, spoils, oil, grease, and other materials from the tunneled casing, jacking and receiving shafts, and Work areas.

END OF SECTION

SECTION 31 43 00
STEEL CASING PIPE

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section provides the minimum requirements for steel casing pipe to be installed in accordance with Section 31 42 00, Horizontal Auger Boring, at locations as shown on the Drawings.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Where conflicts between these Specifications and the referenced specification, code, or standard occur, the more restrictive language governs. The publications are referenced in the text by basic designation only. Where a date is given for referenced standards, use that edition. Where no date is given for referenced standards, use the latest edition available on the date of issue of Contract Documents.

1. American Waterworks Association (AWWA): C200, Standard Specification for Steel Water Pipe (Sizes 6 inches and Over).
2. American Welding Society (AWS): D1.1, Structural Welding Code – Steel.
3. ASTM International (ASTM):
   a. A36, Standard Specification for Carbon Structural Steel.
   b. A139, Standard Specification for Electric Fusion (Arc) Welded Steel Pipe (NPS 4 and Over).
   c. A515, Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service; Grade 60.
   d. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel; Grade 42.

1.03 SUBMITTALS

A. Action Submittals:

1. Steel Casing Pipe for the Trenchless Crossings: Furnish Shop Drawings illustrating the details of the casing pipe, joint details, and any miscellaneous items to be furnished and fabricated for the pipe. Show dimensions, tolerances, wall thickness, properties and strengths, and other pertinent information. Submit to Contracting Officer prior to fabrication.

1.04 DESIGN CRITERIA

A. Be fully responsible for the design of steel casing pipe that meets or exceeds the design requirements of this specification and that is specifically designed for installation using the selected trenchless method.

B. For trenchless installations, provide design of the casing pipe accounting for installation and service loads, including:

1. Jacking loads.
2. External groundwater and earth loads.
3. Practical consideration for handling, shipping, and other construction operations.
4. Any other live or dead loads reasonably anticipated, including, but not limited to truck loads.
5. Provide design sealed and signed by a registered professional engineer licensed in the State of New Mexico.

C. Do not exceed the allowable jacking capacity of 50 percent of the minimum steel yield stress.

D. Provide steel casing pipe with a minimum wall thickness 0.312 inch. The casing thickness is a minimum value. Determine final thickness based on external soil loading and estimated jacking forces and submit to Contracting Officer for approval.

E. Provide steel casing pipe with diameters as shown on the Drawings. Install the required carrier pipe with casing spacers as required in Section 31 45 00, Installation of Carrier Pipe in Steel Casing.

F. Furnish steel casing pipe with lengths between 10 feet and 20 feet, depending on the installation requirements, available work and staging areas, shaft dimensions, as well as the shop practices of the pipe manufacturer.

G. Welding and welding inspection shall be in conformance to the requirements of AWS D1.1.

PART 2 PRODUCTS

2.01 MATERIALS FOR TUNNELED CROSSINGS

A. Physical Characteristics: New, smooth-wall, carbon steel pipe. If using locking joint steel casing pipe, material to be new, smooth-wall, carbon steel pipe conforming to ASTM A515, Grade 60, or ASTM 572, Grade 42, with a watertight T7 joint profile.

B. Functional Characteristics: Provide casing pipe for containing carrier pipes.

C. Performance Characteristics: Conform to the requirements of ASTM A139, Grade B, AWWA C200 and AWWA Manual M11 “Steel Pipe – A Guide for Design and Installation,” except as modified herein.

D. Dimensional Tolerances:

1. Bear sole responsibility for furnishing and installing steel casing pipe with dimensional tolerances in accordance with ASTM A139.
2. When pipe ends have to be field beveled for welding, bevel the ends on the outside to an angle of 35 degrees with a tolerance of plus or minus 2-1/2 degrees and with a width of root face 1/16 inch plus or minus 1/32 inch.

E. Prior to delivery of the pipe, furnish and install end/internal bracing as recommended by the manufacturer, for protection during shipping, storage, and installation.

PART 3 EXECUTION

3.01 GENERAL

A. Installation for Tunneled Crossings:

1. Install steel casing pipe using horizontal auger boring in accordance with Section 31 42 00, Horizontal Auger Boring.
2. Install carrier pipe inside steel casing pipe in accordance with Section 31 45 00, Installation of Carrier Pipe in Steel Casing.

END OF SECTION

SECTION 31 44 00
SETTLEMENT MONITORING

PART 1 GENERAL

1.01 WORK INCLUDED

A. The Work specified in this section includes furnishing and installing settlement instrumentation to monitor ground movements around and above tunneled crossings and where otherwise shown. The Work includes, but is not limited to, installing settlement instrumentation and recording observations and measurements from the monitoring points on a periodic basis as specified before, during, and after tunneling related activities or casing installation.

B. The minimum required settlement instrumentation is as shown on the Drawings. The Contractor shall add additional instrumentation as necessary to manage the Work and demonstrate compliance with settlement monitoring limits provided herein.

1.02 SUBMITTALS

A. Informational Submittals:

1. Qualifications: Submit surveying personnel qualifications in accordance with the requirements herein.
2. Submit the following, at least 1 month before scheduled installation of monitoring points:
   a. Instrumentation Schedule: Submit the proposed schedule for installing the monitoring points.
   b. Description of methods and materials for installing monitoring points.
   c. Drawings with locations of proposed monitoring points shown in plan and profile.
   d. Monitoring Plan: Submit the monitoring plan for each monitoring location separately. The plan should identify the procedures (including instruments used, datum, bench marks used, monuments used, and surveying methodologies) and frequency of measurements, the procedure by which the information is tabulated graphically for each point and submitted electronically in Microsoft Excel format to the Contracting Officer, and the procedures to be used to identify and communicate values that have exceeded the threshold values defined in this section.

3. Reports and Records:
   a. Within 72 hours following installation of the monitoring points (x, y, z), submit drawings to the Contracting Officer showing the actual as-built installed location, the identification number, the type, the installation date and time, the coordinates of the point, and the tip elevation and instrument length. Include details of installed instruments, accessories and protective measures including all dimensions and materials used.
   b. At least 72 hours prior to commencement of any adjacent construction activities, including dewatering, submit to the Contracting Officer pre-construction survey of existing conditions, documenting any existing damage, distress, settlement, cracking, etc., of streets, roadways, sidewalks, curbs, gutter, utilities, buildings, and foundations. Include photographs, video, and written notes for each item or instance of damage or distress existing before construction. Provide photographs and video in accordance with the Contract Documents.

B. Action Submittals:

1. Shop Drawings: Indicate sizes, materials, and details of monuments and posts.

1.03 DEFINITIONS

A. Surface Monitoring Point (SM): Settlement monitoring point established as a reference for measuring elevation of the ground surface or structural element using optical survey methods.

1.04 QUALITY CONTROL

A. Surveyor Qualifications: Perform surveying for establishing monitoring points by a professional land surveyor licensed in the State of New Mexico with previous experience surveying for the detection of structural or surface deformations.

B. Install monitoring points as shown on the Drawings, or as directed by the Contracting Officer. Install additional monitoring points if directed by the Contracting Officer.

C. Should actual field conditions prevent installation of instruments at the locations as shown on the Drawings, or specified herein, obtain written acceptance from the Contracting Officer for new instrument locations and elevations.

PART 2 PRODUCTS

2.01 MATERIALS

A. Surface Monitoring Points: Establish surface monitoring points by an inscribed marking or approved surveyor's nail driven flush with the surface in asphalt or concrete paved areas.

B. In unimproved areas, establish surface monitoring points by driving a 5/8-inch diameter by 30-inch long reinforcing bar flush with the ground having a rounded top.

C. Provide each monitoring point with a tag or marking indicating the station and offset from centerline. Assign each point a unique identification number and protect from damage or burial. Flag each point so as to remain visible.

PART 3 EXECUTION

3.01 GENERAL

A. Install instrumentation at the locations as shown on the Drawings, as described in these Specifications, and as approved by the Contracting Officer. Install instruments in accordance with the approved installation schedule.

B. Install instruments and perform a baseline survey of surface monitoring points at least 7 days prior to the commencement of any construction activities within 100 feet of the monitoring point, including the start of dewatering.

C. Once tunneling or casing installation commences, survey monitoring points located within 50 feet of the excavation face once a day and settlement monitoring points once a day while the shaft/pit is open.

D. Once tunneling or casing installation operations are complete and the shafts or trench backfilled, survey settlement monitoring points once every other day for a period of 1 week, and once again at 14 days after tunneling and backfill are completed or as directed by the Contracting Officer.

E. Provide access and assistance to the Contracting Officer for obtaining additional monitoring data, as discussed herein and as requested by Contracting Officer.

3.02 MONITORING POINT LOCATIONS AND INSTALLATION

A. Establish an array of surface monitoring points in as shown on the Drawings and as defined herein.

B. Instrumentation shall be installed at locations shown along the centerline of proposed alignment. An array shall be installed with the center point on the

proposed alignment with two additional markers offset 5 feet either side of the centerline perpendicular to the alignment.

C. Contracting Officer shall have access to instrument locations and Contractor's cooperation is required in obtaining monitoring data, including the provision of assistance, as required.

D. All instruments shall be clearly marked, permanently labeled, and protected to avoid being obstructed or otherwise damaged by construction operations or the general public. Protective housing and box or vault covers shall be marked.

E. Geotechnical instrumentation shall be installed, and baseline surveys or initial readings completed before commencing any excavation work for workshafts and tunnels.

F. Location Surveying: Promptly following installation, the Subcontractor shall survey and provide horizontal coordinates and vertical elevations of the ground surface and top of all instruments.

G. Initial Reading: Following instrument installation and prior to the start of any construction activity within 100 feet of the tunnel alignment centerline or edge of the workshafts, the Subcontractor's surveyor, shall take a minimum of two sets of initial readings to provide baseline readings and to demonstrate the adequacy of the completed installation.

1. Installation of the instrumentation by the Subcontractor does not preclude the Contracting Officer, through an independent contractor, from installing instrumentation in, on, near, or adjacent to the construction work.
2. Elevations shall be recorded to a precision of 0.001 of a foot. Horizontal survey accuracy shall be at least 0.01 foot.
3. The Subcontractor shall take additional survey(s) as requested by the Contracting Officer if in the opinion of the Contracting Officer the two sets of initial readings do not adequately establish the baseline level. After initial readings are approved by the Contracting Officer, the average of the two sets of initial readings shall be used to establish the baseline level of the instrument, unless otherwise directed by the Contracting Officer.

H. Surface Settlement Markers (SM): SMs shall be installed as shown on the Drawings, and approved submittals. Markers shall be installed firmly to prevent loosening and in a manner and location that allows survey rods to be consistently placed on the high point of the marker head or point being measured.

3.03 INSTRUMENT PROTECTION, MAINTENANCE, AND REPAIR

A. Protect the monitoring points from damage. Replace or repair damaged installations within 24 hours prior to continuing dewatering, excavation, or tunneling, unless permitted otherwise in writing by the Contracting Officer.

3.04 RESPONSE VALUES

A. Response Values:

	Threshold Value (Action Required)	**Response Value**	**Shutdown Value**
Settlement Monitoring Points	0.5 inch H or V	0.9 inch H or V	1.0 inch H or V

B. When the instruments indicate movement equal to 50 percent of the maximum allowable value has occurred, the Threshold Value is said to have been reached. Meet with the Contracting Officer to discuss construction means and methods to determine what changes, if any, will be made to better control ground movement. Instrument readings will be taken by the Contracting Officer on a daily basis until five consecutive working days of stabilized readings are observed, or more often as specified elsewhere in this section.

C. When the instruments indicate movement equal to 90 percent of the maximum allowable value has occurred, the Response Value is said to have been reached. Actively control ground movement in accordance with the approved plan to prevent reaching the Shutdown Value. Instrument readings will be taken by the Contracting Officer on a daily basis until 5 consecutive working days of stabilized readings are observed, or more often as specified elsewhere in this section.

D. When the instruments indicate movement equal to 100 percent of the maximum allowable value has occurred, the Shutdown Value is said to have been reached. Stop excavation Work immediately at the Contracting Officer's direction. Meet with the Contracting Officer to develop a plan of action before excavation Work can be resumed. No standby time will be paid if excavation Work is shut down because the Shutdown Value is reached.

3.05 ABANDONMENT OF INSTRUMENTS

A. At the completion of the job, abandon or remove instrumentation. Salvaged material shall become the property of the Contractor.

B. All SMs shall be removed by the Contractor during the cleanup and restoration work, or sooner as allowed or required by the Contracting Officer.

END OF SECTION

SECTION 31 45 00
INSTALLATION OF CARRIER PIPE IN STEEL CASING

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section includes requirements for installation of carrier pipe into steel casings at locations as shown on the Drawings.

B. For requirements regarding the installation of the trenchless crossing, see Section 31 42 00, Horizontal Auger Boring.

1.02 REFERENCES

A. The publications listed below form a part of this specification to the extent referenced. Where conflicts between these Specifications and the referenced codes and/or standards occur, the more restrictive language governs. The publications are referred to in the text by basic designation only. Where a date is given for referenced standards, use that edition. Where no date is given for referenced standards, use the latest edition available on the date of issue of Contract Documents.

1. Safety Codes: Occupational Safety and Health Administration (OSHA) Regulations and Standards for Underground Construction, 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavation.

1.03 SUBMITTALS

A. Informational Submittals:

1. Submit the following describing the carrier pipe installation equipment, materials, and construction methods to be employed.
   a. A safety plan for the carrier pipe installation operations including air monitoring equipment and procedures and provisions for lighting, ventilation, and electrical system safeguards. Provide name of Site Safety Representative responsible for implementing safety program. Notify Contracting Officer if safety plan is the same as for tunneling operations.
   b. Emergency Response Plan for rescuing personnel trapped in a shaft, pipe, or steel casing.

2. Describe methods, procedures, and equipment for installing carrier pipe inside the casing in accordance with manufacturer recommendations, and methods for backfill grouting between the carrier pipe and the casing in accordance with Section 31 46 00, Backfill Grouting. Include methods for checking backfill progress and stability of pipes.

B. Action Submittals:

1. Shop Drawings of carrier pipe supports for installation in steel casing.
2. Written confirmation that the model, type and spacing of the carrier pipe supports meets the minimum requirements of the carrier pipe support manufacturer for the specific casing and carrier pipe combination.

1.04 QUALITY CONTROL

A. Carrier Pipe Installation Experience: In accordance with Section 31 42 00, Horizontal Auger Boring.

B. For the surveyor responsible for carrier pipe line-and-grade control, use a professional land surveyor licensed in the State of New Mexico who has prior experience in similar underground projects.

C. See Section 33 05 01.14, Fusible PVC Pressure Pipe and Fittings, for waterline carrier pipe line-and-grade tolerances.

D. See Section 22 10 01, Plumbing Piping and Accessories , for Natural Gas carrier pipe line-and-grade tolerances.

E. See Section 40 27 00.10, Polyvinyl Chloride (PVC) Pipe and Fittings, for “FC” conduit line-and-grade tolerances.

1.05 DEFINITIONS

A. Carrier Pipe: Permanent pipe for operational use that is used to convey flows.

B. Casing: A pipe installed by open cut methods that supports the ground and provides a stable underground excavation for installation of the carrier pipe.

1.06 BASIS OF DESIGN

A. Install casing pipe within the horizontal and vertical tolerances as indicated in Section 31 42 00, Horizontal Auger Boring and as indicated in the appropriate specification sections for each pipe material utilized.

B. Fill voids between the carrier pipe and the casing with Low-Density Cellular Concrete (LDCC), in accordance with Section 31 46 00, Backfill Grouting, and as described herein. Install applicable exterior carrier pipe surfaces and

interior casing surfaces in contact with backfill grout. Install bulkheads to allow filling of annular space.

PART 2 PRODUCTS

2.01 CARRIER PIPE SUPPORTS/INSULATORS

A. Physical Characteristics:

1. Single carrier casing, 12 inches wide, band with steel risers (if steel risers are used) and 2-inch wide non-conductive glass reinforced polyester runners.
2. Steel band to have nonconductive polyvinyl chloride inner liner.
3. Provide studs, nuts, and washers of similar material to prevent galvanic corrosion from occurring.

B. Functional Characteristics:

1. Provide environmentally safe runner lubrication and within manufacturer's recommendations.
2. Suitable for supporting weight of carrier pipe.

C. Performance Characteristics:

1. Steel riser (if used) height with attached runner to be sufficient to provide:
   a. A minimum clearance of 1 inch and a maximum of 2 inches between the runner and the inside of the casing.
   b. A minimum clearance of 1 inch between outside of carrier pipe bells or couplings and the inside of the casing.

PART 3 EXECUTION

3.01 GENERAL

A. Tunneled Crossings:

1. Do not begin carrier pipe installation until the following is completed:
   a. No water enters casing from any sources.
   b. The casing has been cleaned of tunneled materials and debris.
   c. Rough welds at casing joints have been ground smooth.

B. Install the carrier pipe within the casings as shown on the Drawings to the specified lines and grades, and utilizing methods that include due regard for safety of workers, adjacent structures and improvements, utilities, and the public.

C. Install carrier pipe in the direction of the bell end of the casing pipe to the spigot end of the casing pipe.

D. Furnish necessary equipment, power, water, and utilities for carrier pipe installation, insulator runner lubricant, grouting, and other associated Work required for the methods of construction.

E. Do not disturb roadways, adjacent structures, landscaped areas, or existing utilities. Repair damage to original or better condition and to the satisfaction of Contracting Officer.

3.02 CONTROL OF LINE AND GRADE

A. Where the carrier pipe installation exceeds the specified line and grade tolerances, correct the installation, including, if necessary, redesign of the pipe or structures. Manufacture and install custom carrier pipe supports as required for carrier pipe installation within casing to satisfy allowable tolerance requirements specified herein.

3.03 INSTALLATION OF CARRIER PIPE

A. Pipe Installation: Install carrier pipe as shown on the Drawings in accordance with specified tolerances and approved submittals. Remove loose soil, and debris from casing. Provide carrier pipe supports, as required, to prevent flotation, movement, or damage to the pipe during pipe installation and backfill placement.

B. Support every individual carrier pipe sections with at least two sets of spacers and as shown on the Drawings. Install carrier pipe without sliding or dragging it on the ground or in the casing in a manner that could damage the pipe or coatings. Coat the casing spacer runners with a noncorrosive/environmentally safe lubricant to minimize friction when installing the carrier pipe.

C. Install carrier pipe in accordance with the carrier pipe manufacturer’s recommendations to prevent damage to the pipe.

D. Electrical Isolation: Verify that the casing and carrier pipe are electrically isolated prior to backfilling and again after backfilling is complete. If electrical isolation is not achieved, perform the necessary work including, but not limited to, removing, and replacing the carrier pipe within the casing until isolation is achieved.

E. Testing of Carrier Pipe: Complete hydrostatic testing of the carrier pipe prior to backfilling the shafts and backfilling the annular space between the casing and carrier pipe.

F. Perform pressure testing in accordance with Section 33 05 01.14, Fusible PVC Pressure Pipe and Fittings. Correct leakage found during testing prior to proceeding with the filling of the annular space. In addition, provide and select location of test heads for each end of the carrier pipe outside tunneled crossings. Show test head locations on Shop Drawings.

G. Install bulkheads in accordance with Section 31 46 00, Backfill Grouting.

H. Backfill annular space in accordance with Section 31 46 00, Backfill Grouting.

3.04 SAFETY

A. Be responsible for safety at the Site. Perform Work in accordance with the current applicable regulations of the federal, state, and local agencies. In the event of conflict, comply with the more restrictive applicable requirement.

B. Gasoline-powered equipment is not permitted in shafts. Diesel, electrical, hydraulic, and air-powered equipment is acceptable, subject to applicable local, state, and federal regulations.

C. Ensure the safety of the Work, employees onsite, and the public.

D. Furnish and operate a temporary ventilation system in accordance with applicable safety requirements when personnel are underground. Perform required air and gas monitoring. Provide ventilation system with a sufficient supply of fresh air and maintain an atmosphere free of toxic or flammable gasses in underground Work areas.

E. Perform Work in accordance with current applicable regulations and safety requirements of the federal, state, and local agencies. Comply with applicable provisions of 29 CFR Part 1926, Subpart S, Underground Construction and Subpart P, Excavations, by OSHA.

F. Develop an emergency response plan for rescuing personnel trapped underground in a shaft excavation or pipe if personnel will enter the pipe during construction. Keep equipment required for emergency response in accordance with the agency having jurisdiction onsite.

END OF SECTION

SECTION 31 46 00
BACKFILL GROUTING

PART 1 GENERAL

1.01 WORK INCLUDED

A. The Work specified in this section includes requirements for filling the annular space between the outside of carrier pipe installed in casing and the inside of the casing with Low-Density Cellular Concrete (LDCC).

1.02 DEFINITIONS

A. Low-Density Cellular Concrete (Foam Grout): A lightweight cementitious material that contains stable air or gas cells uniformly distributed throughout the mixture and with a minimum air percentage of 20 percent.

1.03 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Concrete Institute (ACI):
   a. 523.1R, Guide for Cast-in-Place Low-Density Concrete.
   b. 523.3R, Guide for Cellular Concretes Above 50 pcf, and for Aggregate Concretes above 50 pcf with Compressive Strengths Less-than 2500 psi.
2. ASTM International (ASTM):
   a. C94, Specification for Ready-Mixed Concrete.
   b. C138, Standard Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete.
   c. C150, Specifications for Portland Cement.
   d. C495, Standard Test Method for Compressive Strength of Lightweight Insulating Concrete.
   e. C567, Standard Test Method for Unit Weight of Structural Lightweight Concrete.
   f. C618, Specifications for Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Portland Cement Concrete.
   g. C796, Standard Method of Testing Foaming Agents for Use in Producing Cellular Concrete Using Preformed Foam.
   h. C869, Standard Specification for Foaming Agents Used in Making Preformed Foam for Cellular Concrete.

1.04 SUBMITTALS

A. Informational Submittals:

1. Submit a work plan for placing LDCC including:
   a. Sequence of work.
   b. Type(s) of equipment.
   c. Location of equipment.
   d. Placing procedures, (i.e., batching, mixing, and pumping location and procedures).
   e. Method for protecting conduits from deformation caused by the exothermic reaction from the heat of hydration during curing of the LDCC.
   f. Pump line arrangement (including moving and breaking).
   g. Maximum pipe length to be backfilled.
   h. Method of determining LDCC levels placed or completion of void filling.
   i. Communications provisions.
   j. Methods for monitoring mix.
   k. Testing procedures.
   l. Cleanup procedures.
   m. Pumping pressures.
   n. Pumping rate.
   o. Volumes to be placed per day.
   p. Theoretical annulus volume for actual casing ID and carrier pipe OD with adjustments for bells and spacers.
   q. Injection locations.
   r. Method of surveying or monitoring carrier pipe for movement during LDCC placement.
   s. Maximum LDCC age before set initiation.
   t. maximum injection pressures.
   u. Method for demonstrating that the conduits were not deformed by the exothermic reaction from the heat of hydration during curing of the LDCC.
   v. Sequence of placement and staging of backfill lifts and pumping method.
2. Submit Shop Drawings of bulkheads, grout pipes, vent pipes, and drain lines.
3. Pre-Placement Test Reports and Certifications: Proposed LDCC mix designs with mix data for the components, mix properties including air content and wet unit weight, and testing results including cured unit weight and compressive strength tests reports from a certified testing laboratory.

4. Daily reports and records of backfill grout placement, including but not limited to:
    a. Furnish the Contracting Officer delivery tickets with the information stated in Section 16 of ASTM C94 with each batch of concrete before unloading at the Site; except actual scale weights of materials.
    b. Submit to the Contracting Officer a printout of the actual scale weights for the loads batched at the end of each working day.
    c. Volumes placed and lift (stage) heights achieved.
    d. Stationing of LDCC placement.
    e. Injection locations and pressures.
    f. Unit weight and air content testing results.
    g. Time of placement.
    h. Internal temperature of the LDCC during the curing period.
    i. Internal wall temperature of conduits backfilled with LDCC during the curing period.
    j. Designation of cylinder samples prepared that day.
    k. Compressive strength tests reports from a certified testing laboratory.

B. Action Submittals:

1. Product Data:
    a. Submit mix designs for each LDCC mix proposed for use. Show the ingredients of the mix design and include:
        1) Type, brand, source, and amounts of cement, pozzolans, admixtures, and other additives.
        2) Source and amount of water.
        3) Combined grading of each mix design.
        4) Specific gravity of the materials.
        5) Results of required tests.
    b. Submit material specifications and instructions for use of any proposed concrete admixtures, including evidence from foam manufacturer that proposed admixtures are compatible with the foaming agent.
    c. Air content, unit weight, and compressive strength test results for proposed mix design.
2. Equipment:
    a. Submit the following for each type of LDCC proposed:
        1) Manufacturer’s specifications and operation instructions for conveyance equipment.
            a) Pump specifications.
            b) Grout and air-release hose, valve, and port sizes and specifications.
            c) Foam generators and ancillary equipment.

PART 2 PRODUCTS

2.01 MATERIALS

A. Cement: Portland cement, ASTM C150, Type I or Type II.

B. Fly Ash: Not permitted with LDCC mix in contact with galvanic cathodic protection systems. Otherwise, Type F, ASTM C618.

C. Water: Use potable water free from deleterious amounts of alkali, acid, and organic materials which would adversely affect the setting time or strength of the backfill grout.

D. Admixtures: Admixtures may only be used when specifically approved by foaming agent supplier in writing.

E. Foaming Agent: Comply with ASTM C869 when tested in accordance with ASTM C796.

2.02 MIX DESIGN

A. General: Design LDCC mix in accordance with the requirements of ACI 523.1R, ACI 523.3R, and the additional requirements herein. Adjust mixes in the field as necessary to meet the requirements of these Specifications. The foaming agent material manufacturer's field services representative shall approve changes to the mix designs.

B. Minimum 28-day Compressive Strength per ASTM C495: 100 psi.

C. Limiting Requirements:

1. Unless otherwise specified, design and control each LDCC mix within the following limits:
   a. Wet Density (Unit Weight): Wet density of the foam grout shall be not less than 50 pcf, at the point of placement.
   b. Preformed Foam: Generate preformed foam by combining controlled quantities of air, water, and foaming agent under pressure. Retain preformed foam stability until the cement sets to form a self-supporting matrix. The resulting LDCC shall have essentially closed cell and low water absorptive characteristics. The concentration of foam agent shall be in accordance with the foaming agent material manufacturer's recommendations.
   c. Admixtures: The admixture content, batching method, and time of introduction to the mix shall be in accordance with the manufacturer's recommendations for minimum shrinkage and for compliance with these Specifications. Admixtures may be used when specifically approved by foaming agent material

manufacturer and in accordance with their recommendations. No calcium chloride or admixture containing chloride from other than impurities from admixture ingredients will be acceptable.

d. Design and test a tentative mix in accordance with ASTM C796 for each consistency intended for use. These results will be compared with field test results to confirm consistent properties are obtained in the field. Test each mix as follows:

1) Two sets of compression test cylinders (3 inches by 6 inches), three cylinders per set, shall be made from each proposed backfill grout mix. One set of three cylinders shall be tested at an age of 7 days and the other set shall be tested at an age of 28 days. Foam grout specimens shall be made, cured, stored, and tested in conformity with ASTM C495.

2) Determine total air content of each proposed foam grout mix in accordance with ASTM C796.

e. Determine unit weight of each proposed foam grout mix in accordance with ASTM C567.

2.03 EQUIPMENT

A. General:

1. Use equipment for mixing and injecting foam grout, which is designed for underground backfill grouting service. Maintain equipment in good operating condition, capable of satisfactorily mixing, agitating, and forcing LDCC into injection ports at a uniform flow rate under the required constant pressure.
2. Configure backfill grouting equipment so flushing can be accomplished with grout intake valves closed, with water supply valve open, and with grout pump running at full speed.
3. Provide an adequate inventory of spare parts or backup equipment to ensure that operable backfill grouting equipment is available during the work. Maintain sufficient quantities of spare gauge savers, pressure gauges, stop valves, and other wear parts onsite.

B. Use a foam generator to produce a predetermined quantity of foam, which shall be injected into the mixer and blended with the cement slurry. The foam generator shall be timer-controlled to repetitively discharge a pre-selected quantity or to discharge continuously at a fixed rate. Test and calibrate foam generating equipment for dilution percentage, density, and volume output. Two types of foam generating systems, batch, and continuous generating, are acceptable.

1. A batch system consisting of a tank in which the foam liquid concentrate and water are first premixed. This dilute solution is then discharged from either a pressurized tank or by means of a mechanical

pump through a foam-making nozzle in which this solution is blended with compressed air in fixed proportions.

2. A continuous generating system container, which continuously draws the concentrate directly from its shipping container, automatically blends it with water and compressed air in fixed proportions, and forms the stable micro-bubbled foam.
3. Both types utilize foam refining columns or nozzles calibrated for foam quality and discharge rate. The foam nozzles may be timer-controlled to repetitively discharge any preselected quantities or to discharge continuously at a fixed rate.
4. Propose distances and volumes and provide batching, mixing and pumping equipment compatible and of sufficient size and capacity to place LDCC.
5. Provide graphical or digital printout records of batch scale readings, accurate to 1 pound of the dry mix ingredients before delivery to mixer.

C. Specially designed batch mixers may also be used in conjunction with surge hopper equipped pumps. Properly adjust the rates of mixing and pumping and obtain a continuous flow of foam grout at the point of placement.

D. Injection Hoses and Connections:

1. Use hose of proper type and diameter to withstand maximum injection pressures used.
2. At the point of injection, provide suitable valves and calibrated pressure gauges so that the pressure and grout flow at the grout hole may be regulated and monitored. Provide a meter to measure the total volume of LDCC pumped into each port. Provide at or very near the point of injection, a system of valves in the line transporting the grout that will allow easy access for collection of test specimens. Provide an automatic bypass valve set to the maximum pressure specified.
3. Provide injecting hoses and connections with a minimum of 1-1/2 inches and a maximum of 2-1/2 inches in diameter.
4. Provide suitable stop valves at collar of hole for use in maintaining pressure, as required, until LDCC has set.

2.04 QUALITY CONTROL

A. Qualifications:

1. Develop a mix design, and batching, mixing, handling, and placing LDCC under similar project conditions; have furnished and placed LDCC on at least three similar projects of the general type and the size specified herein which have been in successful operation; and have a record of experience and quality of work using foam grout that is satisfactory to the Contracting Officer.

2. May alternatively employ a manufacturer's representative to supervise supplying and placing of LDCC. The manufacturer's representative shall be capable of complying with the qualifications specified and shall be acceptable to the Contracting Officer. The manufacturer's representative shall supervise LDCC operations including training the Contractor's personnel, mixing designs, and placement of LDCC in the steel casing.
3. Personnel Qualifications: Be fully qualified to perform the Work. Provide a superintendent with previous experience under similar ground and project conditions, or the foam grout supplying and placing shall be under the supervision of the foaming agent supplier's representative.
4. Field Services: The foaming agent material manufacturer shall provide engineering field services to review the Project and the material application prior to any preparation; to approve the applicator, the material used, the equipment, and the procedure to be used; to approve setup before production of LDCC; and to observe during initial application. The field representative of the material manufacturer shall submit, in writing, approvals of proposed material, equipment, application procedures, applicator, and setup before production.

PART 3 EXECUTION

3.01 GENERAL

A. Install carrier pipe within casing and block or flood to prevent floatation in accordance with the requirements of Section 31 45 00, Installation of Carrier Pipe in Steel Casing.

B. Complete placement of LDCC prior to completing the connection to each end of carrier pipe to pipeline and prior to placement of any backfill against either end of the casing in the shafts.

C. Properly place LDCC as specified herein. Make the LDCC using preformed foam process equipment approved by the foaming agent material manufacturer.

D. Utilize methods for completely filling the annular space between carrier pipe and the casing in accordance with submittals that are reviewed and approved by the Contracting Officer. No standing water, soil, and debris will be allowed where LDCC is to be placed.

E. Utilize methods for protecting conduits from deformation in accordance with submittals that are reviewed and approved by the Contracting Officer.

F. Construct bulkheads at the end of each reach of pipe to be backfilled.

1. Seal ends with brick and mortar bulkheads or other appropriate nonmetallic material, as determined by the Contractor, to facilitate the placement of the LDCC backfill as required.
2. Construct bulkheads so the annular space will be completely backfilled.
3. Provide bulkheads that incorporate a minimum l-inch diameter drainpipe in the invert of the steel casing to facilitate drainage of water during LDCC backfilling. Securely cap and plug this pipe once LDCC begins to flow from the drain line.
4. Provide air release piping above the crown of the steel casing through the high side bulkhead to allow entrapped air to escape. Securely cap and plug this pipe once LDCC begins to flow from the air release piping.

G. Inform the Contracting Officer at least 24 hours in advance of the times and place where placement of LDCC is anticipated.

H. Do not place any backfill around the ends of the steel casing until backfill grouting has been completed in accordance with the Specifications.

3.02 BATCHING AND MIXING

A. General: Conform to the requirements of accepted submittals and the foaming agent manufacturer’s recommendations.

B. Mixing:

1. Mechanically mix LDCC to produce a uniform distribution of the materials with a suitable consistency and the specified limiting requirements. Avoid excessive mixing in order to reduce the possibility of changes in unit weight and consistency.
2. In batch mixing operations, follow the manufacturer’s recommendations concerning the order of charging the mixer with the various ingredients. Monitor the as-cast unit weight at the point of placement. Allowance should be made for any additional mixing that may result from the method of placement, such as mechanical or pneumatic pumping, and for any unit weight changes that may result from these methods.
3. Make provisions for continuous mixing operations for reasonably uniform and continuous rate of addition of mix components at appropriate positions in the mixing machine, and in the correct ratio, to assure uniformity and the specified limiting requirements at the point of placement.
4. Alternative methods for batching and mixing LDCC will be considered by and must be acceptable to the Contracting Officer.

3.03 PLACING LOW-DENSITY CELLULAR CONCRETE

A. General Requirements: Completely fill void space outside of the carrier pipe with LDCC. Provide air release piping in the crown of the bulkhead to allow displaced air and air lost from LDCC to escape and be replaced with LDCC. Place LDCC in accordance with approved submittals.

B. Accomplish backfilling of the annular space between the pipe and the casing by placing LDCC in one or more stages (lifts). Monolithic placements (one stage) may be acceptable, demonstrate that placement techniques will not induce movement of the pipe, pipe overstressing, pipe and/or pipe coating overheating, or excessive deformation. Place the LDCC through grout pipes installed within the annular space between the carrier pipe and casing. Install multiple grout pipes to provide redundancy.

C. Install gauge saver or diaphragm seal to protect pressure gauges from grout contamination.

D. Locate pressure gauges of appropriate range for monitoring the backfill grout injection pressures in the line transporting the LDCC at the point of injection. Maintain injection pressure low enough to prevent pipe movement and do not exceed 15 psi at the point of injection unless a request for higher injection pressure has been submitted and approved by the Contracting Officer.

E. Place backfill grout through approved grout port locations.

F. Provide positive venting to ensure complete grouting around the carrier pipe, particularly in the invert and crown.

G. Begin grouting at the low end of the steel casing and proceed to the high end so as to cause any water remaining in the invert to move ahead of, and not mix with or become trapped by, the backfill grout.

H. Provide means to allow water and thinned or contaminated grout at the leading edge of the lift to escape.

I. A witness port shall be placed at the top of the high end bulkhead. The grout return through the port shall constitute as the termination criteria.

J. Measure and record volume of LDCC injected and compare with the anticipated volume per foot of pipe backfilled.

K. Provide a means of direct communication between the injection point and the pump operator.

3.04 FIELD QUALITY CONTROL

A. General: Perform field control tests, including unit weight (wet density), air content tests, and compression tests, and submit the results submitted to the Contracting Officer.

1. The frequency specified herein for each field control test is approximate. A greater or lesser number of tests may be made, as required by the Contracting Officer.
2. Collect test specimens near the connection where the LDCC is being injected.
3. Assist the Contracting Officer in obtaining additional test cylinders. Supply materials necessary for fabricating the test cylinders.
4. Provide at or very near the point of injection, a system of valves in the line transporting the LDCC, which will allow easy access for collection of test specimens without disconnecting the line from the outlet. Submit the valve arrangement to the Contracting Officer for review at least 15 days prior to commencing LDCC backfilling operations.

B. Unit Weight: Make unit weight (wet density) tests from the first batch mixed each day, after a change in mix design, every 30 minutes during pumping, and from each batch of LDCC from which compression test cylinders are made. Determine unit weight in accordance with ASTM C567. Unit weight at the point of placement shall be within plus or minus 5 percent of the unit weight established for the mix design being placed. Adjust mix as required to obtain the specified wet density.

C. Air Content: Make an air content test from the first batch mixed each day, and from each batch of LDCC from which concrete compression test cylinders are made. Air content at the point of placement will be the difference between the wet density at the point of placement less the wet density at the point immediately before the addition of preformed foam. Determine air content in accordance with ASTM C138 except that vibration or rodding of the sample is not allowed.

D. Compression Tests: Make one set of four test cylinders (3 inches by 6 inches) for each shift when LDCC is placed. Make one additional set from each additional 200 cubic yards, or major fraction thereof, placed in any one shift. Test two cylinders from each set at an age of 28 days.

1. Compressive strength of LDCC will be considered satisfactory if both of the following requirements are met:
   a. Average of three consecutive compressive strength tests equal or exceed the specified unconfined compressive strength.

b. No individual compressive strength test (average of two cylinders) is below the specified unconfined compressive strength by more than 20 percent.

2. A strength test shall be the average of two compressive strengths of two cylinders made from the same concrete sample and tested at 28 days.
3. Make test cylinders in the field, cure and store in the laboratory, and test in accordance with ASTM C495.
4. Mark or tag each set of compression test cylinders with the date and time of day the cylinders were made, the location in the work where the LDCC represented by the cylinder was placed, batch number, unit weight (wet density), and the air content.

E. Temperature Monitoring: Measure and record daily internal temperature of LDCC and internal conduit wall during the curing period.

3.05 PROTECTION AND CLEAN UP

A. Utilize methods for protecting conduits from deformation in accordance with submittals that are reviewed and approved by the Contracting Officer.

B. Take necessary precautions to protect and preserve the carrier pipe from damage.

C. Minimize spills and clean up immediately. Repair damage to the pipe caused by or occurring during the backfilling operations by a method approved by the Contracting Officer.

END OF SECTION

SECTION 32 11 23
AGGREGATE BASE COURSE(S)

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C29, Standard Test Method for Bulk Density (Unit Weight) and Voids in Aggregate.
   b. C88, Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
   c. C117, Standard Method of Test for Materials Finer Than 7 µm (No. 200) Sieve in Mineral Aggregates by Washing.
   d. C131, Standard Specification for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
   e. C183, Standard Method of Test for Sieve Analysis of Fine and Coarse Aggregates.
   f. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lb/ft^3 (600 kN-m/m^3)).
   g. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lb/ft^3 (2700 kN-m/m^3)).
   h. D1883, Test Method for CBR (California Bearing Ratio) of Laboratory Compacted Soils.
   i. D2216, Standard Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
   j. D2419, Test Method for Sand Equivalent Value of Soils and Fine Aggregate.
   k. D2844, Standard Specification for Resistance R-Value and Expansion Pressure of Compacted Soils.
   l. D4318, Standard Test Methods for Liquid Limit, Plastic Limit and Plasticity Index of Soils.
   m. D4791, Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   n. D5195, Standard Test Methods for Density of Soil and Rock In-Place Below Surface by Nuclear Methods.
   o. D6938, Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

1.02 DEFINITIONS

A. Base Course: Crushed aggregate or similar as specified placed and compacted on prepared subgrade or subbase course.

B. Completed Course: Compacted, unyielding, free from irregularities, with smooth, tight, even surface, true to grade, line, and cross-section.

C. Completed Lift: Compacted with uniform cross-section thickness.

D. Gravel Surfacing: Aggregate used for construction of low-volume access and staging area that can be easily graded and compacted.

E. Leveling Course: Crushed aggregate placed and compacted on base course to be used for finish grading.

F. Subbase Course: Sandy, gravelly material placed and compacted on prepared subgrade.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Test Results on Source Materials: Submit copies from commercial testing laboratory 30 days prior to delivery of materials to Project showing materials meeting the physical qualities specified.
2. Certified results of in-place density tests from independent testing agency.

PART 2 PRODUCTS

2.01 BASE COURSE

A. Clean, hard durable, pit run gravel or crushed stone graded from coarse to fine containing enough fines to bind material when compacted.

B. Physical Qualities:

1. Abrasion, ASTM T 96: Not to exceed 50 percent maximum wear.
2. Two Fractured Face: AASHTO T 335, ASTM D5821: 50 percent minimum particles.
3. Liquid Limit, ASTM D4318, AASHTO T 89 and AASHTO 90: Non-plastic, Maximum 25 percent.
4. Plasticity Index, ASTM D4318, AASHTO T 89 and AASHTO 90: Non-plastic, Maximum 6 percent.
5. Aggregate Index, ASTM D2419: 50 percent minimum.
6. Resistance (R) Value, ASTM D2844: 75 minimum.

C. Gradation, ASTM C183 and ASTM C117, Based on U.S. Standard Sieves:

Table 1 Gradation Percent Passing by Weight		
Sieve Designation	**Material**	
(Square Opening)	**Aggregate Base Course**	**Gravel Surfacing**
1"	100	100
3/4"	85-90	
1/2”		70-80
1/4"	40-70	40-50
No. 10	30-55	35-40
No. 40		15-25
No. 200	6.0 – 15.0	8-14

2.02 PULVERIZED ASPHALT BASE COURSE

A. Pulverize existing asphalt base course to meet Base Course specifications. Contractor shall re-use all demolished roadway asphalt concrete pavement materials onsite as the Base Course under new asphalt concrete pavement and concrete pavement.

B. Asphalt on Abert’s Squirrel Loop, Black Bear Loops, Campground Road, and Coyote Loop shall be pulverized in place.

C. Asphalt removed from Entrance Road and Visitor Center Lot/Stonehouse Road shall be moved to a stockpile location to be used elsewhere on the Project as indicated. Remove any excess asphalt base course that is not needed for this Project from the Project Site.

D. At the pulverization site or the stockpile location crush the asphalt concrete pavement as required to meet Base Course requirements.

2.03 LEVELING COURSE AND GRAVEL SURFACING

A. Same as for base course. Clean, tough, uniform quality, durable fragments of crushed rock, free from flat, elongated, soft or disintegrated pieces, or other objectionable matter occurring either free or as coating on stone. Gradation as specified in Table 1.

B. Physical Qualities: Same as for base course.

2.04 SOURCE QUALITY CONTROL

A. Perform tests necessary to locate acceptable source of materials meeting specified requirements.

B. Final approval of aggregate material will be based on test results of installed materials.

C. Should separation of coarse from fine materials occur during processing or stockpiling, immediately change methods of handling materials to correct uniformity in grading.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. As specified in Section 31 23 13, Subgrade Preparation.

B. Obtain Contracting Officer's acceptance of subgrade before placing base course or surfacing material.

C. Do not place base course or surfacing materials in snow or on soft, muddy, or frozen subgrade.

3.02 EQUIPMENT

A. Compaction Equipment: Adequate in design and number to provide compaction and to obtain specified density for each layer.

3.03 HAULING AND SPREADING

A. Hauling Materials:

1. Do not haul over surfacing in process of construction.
2. Loads: Of uniform capacity.
3. Maintain consistent gradation of material delivered; loads of widely varying gradations will be cause for rejection.

B. Spreading Materials:

1. Distribute material to provide required density, depth, grade, and dimensions with allowance for subsequent lifts.
2. Produce even distribution of material upon roadway or prepared surface without segregation.

3. Should segregation of coarse from fine materials occur during placing, immediately change methods of handling materials to correct uniformity in grading.

3.04 CONSTRUCTION OF COURSES

A. Subbase Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Spread lift on prepared subgrade to required cross-section.
3. Water, grade, and roll surface until thoroughly compacted.
4. Blade or broom surface to maintain true line, grade, and cross-section.

B. Base Course:

1. Maximum Completed Lift Thickness: 6 inches.
2. Completed Course Total Thickness: As shown in Plans.
3. Spread lift on preceding course to required cross-section.
4. Lightly blade and roll surface until thoroughly compacted.
5. Add keystone to achieve compaction and as required when aggregate does not compact readily because of lack of fines or natural cementing properties, as follows:
   a. Use leveling course or surfacing material as keystone.
   b. Spread evenly on top of base course, using spreader boxes or chip spreaders.
   c. Roll surface until keystone is worked into interstices of base course without excessive displacement.
   d. Continue operation until course has become thoroughly keyed, compacted, and will not creep or move under roller.
6. Blade or broom surface to maintain true line, grade, and cross-section.

C. Gravel Surfacing:

1. Maximum Completed Lift Thickness: 8 inches.
2. Completed Course Total Thickness: Match existing, with a minimum of 4 inches, or as shown.
3. Spread on preceding course in accordance with cross-section shown.
4. Blade lightly and roll surface until material is thoroughly compacted.

3.05 ROLLING AND COMPACTION

A. Commence compaction of each layer of subbase and gravel surfacing after spreading operations and continue until density of 96 percent of maximum density has been achieved as determined by AASHTO T 180 (Modified Proctor), Method D (TCCP Modified).

B. Roll each layer of material until material does not creep under roller before succeeding layer is applied.

C. Commence rolling at outer edges and continue toward center; do not roll center of road first.

D. Apply water as needed to obtain specified densities.

E. Place and compact each lift to the required density before succeeding lift is placed.

F. Surface Defects: Remedy by loosening and rerolling. Reroll entire area, including surrounding surface, until thoroughly compacted.

G. Finished surface shall be true to grade and crown before proceeding with surfacing.

3.06 SURFACE TOLERANCES

A. Blade or otherwise work surfacing as necessary to maintain grade and cross-section at all times, and to keep surface smooth and thoroughly compacted.

B. Finished Surface of Untreated Aggregate Base Course: Within plus or minus 0.04 foot of grade shown at any individual point.

C. Gravel Surfacing: Within 0.04 foot from lower edge of 10-foot straightedge placed on finished surface, parallel to centerline.

D. Overall Average: Within plus or minus 0.01 foot from crown and grade specified.

3.07 DRIVEWAY RESURFACING

A. Replace gravel surfacing on driveways that were gravel surfaced prior to construction.

B. Provide compacted gravel surfacing to depth equal to original, but not less than 4 inches.

C. Leave each driveway in as good or better condition as it was before start of construction.

3.08 FIELD QUALITY CONTROL

A. In-Place Density Tests:

1. Show proof that areas meet specified requirements before identifying density test locations.
2. Refer to Table 2 for minimum sampling and testing requirements for aggregate base course and surfacing.

Table 2
Minimum Sampling and Testing Requirements

Property	Test Method	Frequency	Sampling Point
Gradation	ASTM C117and ASTM C183	One sample every 500 tons but at least every 4 hours of production	Roadbed after processing
Moisture Density (Maximum Density)	ASTM D1557 , Method D	One test for every aggregate grading produced	Production output or stockpile
In-Place Density and Moisture Content	ASTM D5195, ASTM D6938, and ASTM D2216 for moisture content	One for each 500 ton but at least every 10,000 sq ft of area	In-place completed, compacted area

3.09 CLEANING

A. Remove excess material from the Work area. Clean stockpile and staging areas of all excess aggregate.

END OF SECTION

SECTION 32 12 16
ASPHALT PAVING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M17, Standard Specification for Mineral Filler for Bituminous Paving Mixtures.
   b. M81, Standard Specification for Cut-Back Asphalt (Rapid Curing Type).
   c. M82, Standard Specification for Cut-Back Asphalt (Medium Curing Type).
   d. M140, Standard Specification for Emulsified Asphalt.
   e. M156, Standard Specification for Requirements for Mixing Plants for Hot-mixed, Hot-laid Bituminous Paving Mixes.
   f. M208, Standard Specification for Cationic Emulsified Asphalt.
   g. R35, Standard Practice for Superpave Volumetric Design for Hot Mix Asphalt.
   h. T166, Standard Method of Test for Bulk Specific Gravity (Gmb) of Compacted Hot Mix Asphalt (HMA) Mixtures Using Saturated Surface-Dry Specimens.
   i. T176 Standard Method of Test for Plastic Fines in Graded Aggregates and Soils by Use of the Sand Equivalent Test.
   j. T209, Standard Method of Test for Theoretical Maximum Specific Gravity (Gmm) and Density of Hot Mix Asphalt (HMA).
   k. T245, Standard Method of Test for Resistance to Plastic Flow of Asphalt Mixtures Using Marshall Apparatus.
   l. T246, Standard Method of Test for Resistance to Deformation and Cohesion of Hot Mix Asphalt (HMA) by Means of Hveem Apparatus.
   m. T247, Standard Method of Test for Preparation of Test Specimens of Hot Mix Asphalt (HMA) by Means of California Kneading Compactor.
   n. T283, Standard Method of Test for Resistance of Compacted Hot Mix Asphalt (HMA) to Moisture-Induced Damage.
   o. T304, Standard Method of Test for Uncompacted Void Content of Fine Aggregate.
   p. T312, Standard Method of Test for Preparing and Determining the Density of Hot Mix Asphalt (HMA) Specimens by Means of a Superpave Gyratory Compactor.

2. Asphalt Institute (AI):
   a. Manual Series No. 2 (MS-2), Mix Design Methods for Asphalt Concrete.
   b. Superpave Series No. 2 (SP-2), Superpave Mix Design.
3. ASTM International (ASTM):
   a. D75, Standard Method of Test for Sampling of Aggregates.
   b. D140, Standard Method of Test for Sampling Bituminous Materials.
   c. D979, Standard Method of Test for Sampling Bituminous Paving Mixtures.
   d. D2041, Standard Test Method for Theoretical Maximum Specific Gravity and Density of Bituminous Paving Mixtures.
   e. D2489, Standard Method of Test for Determining Degree of Particle Coating of Asphalt Mixtures.
   f. D4318, Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
   g. D4791, Standard Test Method for Flat Particles, Elongated Particles, or Flat and Elongated Particles in Coarse Aggregate.
   h. D5821, Standard Test Method for Determining the Percentage of Fractured Particles in Coarse Aggregate.
   i. E329 REV A, Standard Specification for Agencies Engaged in Construction Inspection Testing, or Special Inspection.

1.02 DEFINITIONS

A. Combined Aggregate: All mineral constituents of asphalt concrete mix, including mineral filler and separately sized aggregates.

B. Maximum Aggregate Size: One sieve size larger than the nominal aggregate size.

C. Nominal Aggregate Size: One sieve size larger than the first sieve that retains more than 10 percent aggregate.

D. Prime Coat: Low viscosity cutback or emulsified asphalt applied to granular base in preparation of paving to coat and bond loose materials, harden the surface, plug voids, prevent moisture migration, and provide adhesion.

E. Reclaimed asphalt pavement (RAP): Removed and/or processed pavement materials containing binder and aggregate.

F. Seal Coat: Term used for various applications of emulsified asphalt, with or without sand or aggregate, to protect the asphalt surface from aging due to wear, degradation from the sun, wind, and water. Also used to improve skid resistance and aesthetics. The term seal coat can be used to define fog seal, slurry seal, chip seal or sand seal, depending on application.

G. Tack Coat: Thin layer of emulsified asphalt applied to hard surfaces, including new pavement lifts, to promote adhesion and bonding.

H. Warm Mix Asphalt (WMA): Generic term used to describe reduction in production, paving and compaction temperatures achieved through application of one or combination of several WMA technologies. Technologies involve HMA plant foaming processes and equipment, mineral additives, or chemicals that allow reduction of mix production to temperatures between 185 degrees F to 275 degrees F.

1.03 DESIGN REQUIREMENTS

A. Design Criteria:

1. Superpave Method, AI SP-2, AASHTO R35:
   a. Design Gyrations, NDES: 75.
   b. Coarse Aggregate Angularity, ASTM D5821: One or more fractured faces 75 percent minimum.
   c. Fine Aggregate Angularity, AASHTO T304: 40 percent below 4 inches from surface and 40 percent above 4 inches from surface.
   d. Flat and Elongated Particles, ASTM D4791: 10 percent, maximum.
   e. Clay Content, AASHTO T176: Minimum sand equivalent of 45 percent.
   f. Voids in Mineral Aggregate: See Table 1.
   g. Voids Filled with Asphalt: 72 percent to 80 percent.
   h. Mixture Density as a Percentage of Theoretical Maximum Density at Initial Gyration Level: 90.5 percent, maximum.
   i. Mix Density at Maximum Number of Gyrations: Less than 98 percent of theoretical maximum density.
   j. Dust Proportion: 0.8 to 1.6.
   k. Air Voids: 4 percent.
   l. Tensile Strength Ratio, AASHTO T283: 80 percent, minimum.

Table 1
Voids in Mineral Aggregate (VMA) Criteria

Nominal Maximum Aggregate Size (mm)	Minimum VMA, Percent
3/8" (9.5)	15
1/2" (12.5)	14
3/4" (19.0)	13
1" (25.0)	12
1-1/2" (37.5)	11

B. Furnished Mix Tolerances:

1. Conform to asphalt concrete mix formula within the following, plus or minus:
   a. Aggregate Passing No. 4 and Larger Sieves: 5 percent.
   b. Aggregate Passing the No. 8 to No. 100 Sieves: 4 percent.
   c. Aggregate Passing the No. 200 Sieve: 2 percent.
   d. Bitumen Content: 0.3 percent of volume or batch weight of aggregate.
   e. Temperature Leaving Mixer: 20 degrees F.
   f. Temperature in Paving Machine Hopper: 20 degrees F.

1.04 WMA MIX CRITERIA

A. Meet all the requirements for HMA.

B. Binder grade shall be the same as for hot-mix asphalt (HMA) unless production temperatures are less than 100 degrees F lower than HMA, in which case a one-bump higher grade binder shall be used.

C. 95 percent coating of coarse aggregate as determined by ASTM D2489.

D. Gyration ratio of less than 1.25 by comparing number of gyrations to reach 92 percent relative density described below.

1. Relative Density shall be determined using AASHTO T166, AASHTO T209, and AASHTO T312.
2. Gyration Ratio (GR) is determined by the following equation:

GR = (N92)T-54/(N92)T

where: (N92)T-54 = gyrations to 92 percent relative density at 54 degrees F below the planned field compaction temperature
(N92) = gyrations to 92 percent relative density at the planned field compaction temperature.

1.05 SUBMITTALS

A. Informational Submittals:

1. Asphalt Concrete Job Mix Formula (JMF):
   a. Submit minimum of 21 days prior to start of production.
   b. The JMF shall have been approved by the local state department of transportation within the past 12 months. Submit a production certification conforming to the state department of transportation specifications.

c. Submittal to include the following information:
   1) Gradation and portion for each aggregate constituent used in mixture to produce a single gradation of aggregate within specified limits.
   2) Bulk specific gravity for each aggregate constituent.
   3) Measured maximum specific gravity of mix at optimum asphalt content determined in accordance with ASTM D2041.
   4) Properties as stated in this section for at least four different asphalt contents other than optimum, two below optimum, and two above optimum.
   5) Percent of asphalt lost due to absorption by aggregate.
   6) Index of Retained Strength (TSR) at optimum asphalt content as determined by AASHTO T283.
   7) Percentage of asphalt cement, to nearest 0.1 percent, to be added to mixture.
   8) Optimum mixing temperature.
   9) Optimum compaction temperature.
   10) Temperature-viscosity curve of asphalt cement to be used.
   11) Brand name of any additive to be used and percentage added to mixture.

2. Test Report for Asphalt Cement:
   a. Submit minimum 10 days prior to start of production.
   b. Show appropriate test method(s) for each material and the test results.
3. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, for the following materials:
   a. Aggregate: Gradation, source test results as defined in this section.
   b. Asphalt for Binder: Type, grade, and viscosity-temperature curve.
   c. Prime Coat: Type and grade of asphalt.
   d. Tack Coat: Type and grade of asphalt.
   e. Additives.
   f. Mix: Conforms to job-mix formula.
4. Statement of qualification for independent testing laboratory.
5. Test Results:
   a. Mix design.
   b. Asphalt concrete core.
   c. Gradation and asphalt content of uncompacted mix.
   d. Field density.
   e. Quality control.
6. WMA mix design information:
   a. All information required per AASHTO R35.
   b. WMA technology and/or WMA additives to be used.
   c. WMA technology manufacturer's established recommendations for usage.

d. WMA technology manufacturer's established target rate for water and additives, the acceptable variation for production, and documentation showing the impact of excessive production variation.
e. WMA technology Material Safety Data Sheets (MSDS).
f. Documentation of past WMA technology field applications including project type, project owner, tonnage, location, mix design, mixture volumetrics, field density, and performance;
g. Temperature range for mixing.
h. Temperature range for compaction.
i. Asphalt binder performance grade test data over the range of WMA additive percentages proposed for use.
j. Laboratory test data, sources of mix components, and asphalt binder viscosity-temperature relationships.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. Independent Testing Laboratory: In accordance with ASTM E329 REV A.
2. Asphalt concrete mix formula shall be prepared by approved certified independent laboratory under the supervision of a certified asphalt technician.
3. Asphalt testing shall be performed by technicians with at least 2 years' experience with relevant testing, and who are certified by NICET Level II or equivalent local state DOT certification program. All testing equipment shall be properly functioning, calibrated within 6 months of use, and certified to meet ASTM and AASHTO standards. Provide evidence of all certifications, accreditations, and calibrations.

B. Compaction Control Strip:

1. General:
   a. Construct to approximately 400 square yards in area and at location that will become a portion of completed paved area.
   b. Thickness: Typical of thickness to be paved on Project.
2. Rollers Used for Compaction:
   a. Steel Wheel Rollers: Minimum static weight 10 tons (9 mg).
   b. Pneumatic Rollers: Capable of exerting pressure of 80 psi on bituminous surface.
   c. Vibratory Rollers: Static weight minimum 6 tons, capable of applying a 10-ton impact force equipped with amplitude and frequency control specifically designed for compaction of bituminous mixtures.

3. Compaction:
    a. Compact bituminous mat, using a standard rolling pattern that covers entire control strip. Contractor shall perform final density test.
    b. Continue rolling until no further compaction can be obtained as determined by field density testing.
    c. Temperature and condition of bituminous mat shall be considered workable when further compaction can no longer be obtained.
4. Target Density Determination:
    a. Select test point near center of normal roller pass, but no closer than 2 feet from edge of mat and 50 feet from either end of control strip. Mat thickness at this point shall be at least depth of finished pavement.
    b. Point at which no further densification can be obtained.
5. Establish new target density if change is made in mix design, nominal depth of mat being placed, aggregate source, or material properties.

1.07 ENVIRONMENTAL REQUIREMENTS

A. Temperature: Do not apply asphalt materials or place asphalt mixes when ground temperature is lower than 50 degrees F or air temperature is lower than 40 degrees F. Measure ground and air temperature in shaded areas away from heat sources or wet surfaces.

B. WMA may be applied at temperatures ambient temperatures of 35 degrees F or higher and rising. Provide documentation demonstrating proposed WMA technology can successfully place and compact mix at site temperatures and perform control strip or initial production testing and verification.

C. Moisture: Do not apply asphalt materials or place asphalt mixes when application surface is wet.

PART 2 PRODUCTS

2.01 MATERIALS

A. Prime Coat:

1. Physical Characteristics: Cutback asphalt for Prime Coat.
2. Functional Characteristics: None.
3. Performance Characteristics: Cutback asphalt, Grade MC-70 conforming to AASHTO M82.

B. Tack Coat:

1. Physical Characteristics: Emulsified Asphalt for Tack Coat or Seal Coat.
2. Functional Characteristics: None.
3. Performance Characteristics: Emulsified Asphalt: Grade CSS-1, CSS-1h conforming to AASHTO M208.

C. Performance Grade (PG) Asphalt Cement:

1. Physical Characteristics: Performance Grade bitumen binder for Superpave asphalt concrete pavement.
2. Functional Characteristics: None.
3. Performance Characteristics: Performance Grade Bitumen 64-28 conforming to AASHTO M320.

D. Sand for Blotter Material or Sand Seal:

1. Physical Characteristics: Clean, dry, with 100 percent passing No. 4 sieve, and a maximum of 10 percent passing No. 200 sieve.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.02 ASPHALT CONCRETE MIX

A. General:

1. Mix formula shall not be modified except with written approval of Contracting Officer.
2. Source Changes:
   a. Should material source(s) change, establish new asphalt concrete mix formula before new material(s) is used.
   b. Perform check tests of properties of plant-mix bituminous materials on first day of production and as requested by Contracting Officer to confirm that properties are in compliance with design criteria.
   c. Make adjustments in gradation or asphalt content as necessary to meet design criteria.

B. Asphalt Concrete: Performance Grading 64-28.

C. Composition: Hot-plant mix of aggregate, mineral filler if required, and performance grade asphalt cement. The several aggregate fractions shall be sized, uniformly graded, and combined in such proportions that resulting mixture meets grading requirements of mix formula.

D. Aggregate:

1. General: RAP material may be used up to a maximum of 15 percent by total weight.
2. Coarse:
   a. Material retained on a No. 8 sieve.
   b. Minimum 75 percent by weight of individual pieces having two or more fractured faces, and 90 percent by weight having at least one fractured face.
3. Fine:
   a. Material passing a No. 8 sieve.
   b. Clean, sound, durable, angular shaped particles produced by crushing.
   c. Plasticity Index: Maximum 6.
   d. Liquid Limit: Maximum 25, when tested in accordance with ASTM D4318.
4. Natural Sand: May be used to a maximum of 15 percent by weight of total aggregate.

E. Mineral Filler: In accordance with AASHTO M17.

F. Asphalt Cement: Performance Grading 64-28.

G. WMA Information:

1. Anti-stripping additives, silicone additives, WMA additives, and WMA technologies used.
2. Comply with the manufacturer's recommendations for incorporating additives and WMA technologies into the mix.
3. Comply with manufacturer's recommendations regarding receiving, storage, and delivery of additives.
4. Maintain supplier recommendations on file at the asphalt mixing plant and make available for reference while producing WMA.

PART 3 EXECUTION

3.01 GENERAL

A. Traffic Control:

1. In accordance with Section 01 50 00, Temporary Facilities and Controls.
2. Minimize inconvenience to traffic, but keep vehicles off freshly treated or paved surfaces to avoid pickup and tracking of asphalt.

B. Driveways: Repave driveways from which pavement was removed. Leave driveways in as good or better condition than before start of construction.

3.02 LINE AND GRADE

A. Provide and maintain intermediate control of line and grade, independent of underlying base, to meet finish surface grades and minimum thickness.

B. Shoulders: Construct to line, grade, and cross-section shown.

3.03 PREPARATION

A. Prepaving Requirements: Prior to placing any WMA mix, produce a sufficient amount of mix to calibrate the plant and procedures using the approved mix design. Sample and test WMA mix for the following:

1. Voids in mineral aggregate (VMA).
2. Asphalt binder content.
3. Gradation.
4. Air voids.
5. Tensile strength ratio.

B. Heat WMA field samples, transported to the laboratory, to the field production temperature, or lower, when reheating is required for WMA mixture testing.

C. Prepare subgrade as specified in Section 31 23 13, Subgrade Preparation.

D. Existing Roadway:

1. Modify profile by grinding, milling, or overlay methods as approved, to provide meet lines and surfaces and to produce smooth riding connection to existing facility.
2. Remove existing material to a minimum depth of 1 inch.
3. Paint edges of meet line with tack coat prior to placing new pavement.

E. Thoroughly coat edges of contact surfaces (curbs, manhole frames) with emulsified asphalt or asphalt cement prior to laying new pavement. Prevent staining of adjacent surfaces.

3.04 PAVEMENT APPLICATION

A. General: Place asphalt concrete mixture on approved, prepared base in conformance with this section.

B. Prime Coat:

1. Heat cutback asphalt prior to application.
2. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.

3. Do not apply when moisture content of upper 3 inches of base exceeds optimum moisture content of base, or if free moisture is present.
4. Application Rate: 0.15 gallon to 0.50 gallon per square yard of surface area.
5. Remove or redistribute excess material.
6. Allow a minimum of 5 full days for curing of primed surface before placing asphalt concrete.

C. Tack Coat:

1. Apply uniformly to clean, dry surfaces avoiding overlapping of applications.
2. Do not apply more tack coat than necessary for the day's paving operation.
3. Touch up missed or lightly coated surfaces and remove excess material.
4. Application Rate: 0.05 gallon per square yard to 0.15 gallon per square yard of asphalt (residual if diluted emulsified asphalt).

D. Pavement Mix:

1. Prior to Paving:
   a. Sweep primed surface free of dirt, dust, or other foreign matter.
   b. Patch holes in primed surface with asphalt concrete pavement mix.
   c. Blot excess prime material with sand.
2. Place asphalt concrete pavement mix in one single lift if total thickness is 3 inches or less and two equal lifts if total thickness is over 3 inches.
3. Compacted Lift Thickness:
   a. Minimum: Twice maximum aggregate size, but in no case less than 1 inch.
   b. Maximum: 4 inches.
4. Total Compacted Thickness: As shown on the Drawings.
5. Sequence placement so that meet lines are straight and edges are vertical.
6. Collect and dispose of segregated aggregate from raking process. Do not scatter material over finished surface.
7. Joints:
   a. Offset edge of each layer a minimum of 6 inches so joints are not directly over those in underlying layer.
   b. Offset longitudinal joints in roadway pavements so longitudinal joints in wearing layer coincide with pavement centerlines and lane divider lines.
   c. Form transverse joints by cutting back on previous day's run to expose full vertical depth of layer.

8. Succeeding Lifts: Apply tack coat to pavement surface between each lift.
9. After placement of pavement, seal meet line by painting a minimum of 6 inches on each side of joint with cutback or emulsified asphalt. Cover immediately with sand.

E. Compaction:

1. Do not overcompact WMA mixtures above a density that will result in less than 3 percent air voids. Carefully monitor compaction procedures to establish rolling patterns and techniques to attain specified density without overcompaction.
2. Roll until roller marks are eliminated and density of 92 percent of measured maximum density determined in accordance with ASTM D2041 is obtained.
3. Measure the compaction process with nuclear density gauges calibrated according to the ASTM D2950 calibration section within 6 months before use. Check the standard and reference on each day of use according to the ASTM D2950 standardization and reference check sections.
4. Joint Compaction:
   a. Place top or wearing layer as continuously as possible.
   b. Pass roller over unprotected end of freshly laid mixture only when placing of mix is discontinued long enough to permit mixture to become chilled.
   c. Cut back previously compacted mixture when Work is resumed to produce slightly beveled edge for full thickness of layer.
   d. Cut away waste material and lay new mix against fresh cut.

F. Tolerances:

1. General: Conduct measurements for conformity with crown and grade immediately after initial compression. Correct variations immediately by removal or addition of materials and by continuous rolling.
2. Completed Surface or Wearing Layer Smoothness:
   a. Uniform texture, smooth, and uniform to crown and grade.
   b. Maximum Deviation: 1/8 inch (from lower edge of a 12-foot straightedge, measured continuously parallel and at right angle to centerline.
   c. If surface of completed pavement deviates by more than twice specified tolerances, remove and replace wearing surface.
3. Transverse Slope Maximum Deviation: (1/4 inch in 12 feet from rate of slope shown.

G. Seal Coat:

1. General: Apply seal coat of paving grade or emulsified asphalt to finished surface at longitudinal and transverse joints, joints at abutting pavements, areas where asphalt concrete was placed by hand, patched surfaces, and other areas as directed by Contracting Officer.
2. Preparation:
   a. Surfaces that are to be sealed shall be maintained free of holes, dry, and clean of dust and loose material.
   b. Seal in dry weather and when temperature is above 35 degrees F.
3. Application:
   a. Fill cracks over 1/16 inch in width with asphalt-sand slurry or approved crack sealer prior to sealing.
   b. When sealing patched surfaces and joints with existing pavements, extend minimum 6 inches beyond edges of patches.

3.05 PAVEMENT OVERLAY

A. Preparation:

1. Remove fatty asphalt, grease drippings, dust, and other deleterious matter.
2. Surface Depressions: Fill with asphalt concrete mix, and thoroughly compact.
3. Damaged Areas: Remove broken or deteriorated asphalt concrete and patch as specified in Article Patching.
4. Portland Cement Concrete Joints: Remove joint filler to minimum 1/2 inch below surface.

B. Application:

1. Tack Coat: As specified in this section.
2. Place and compact asphalt concrete as specified in Article Pavement Application.
3. Place first layer to include widening of pavement and leveling of irregularities in surface of existing pavement.
4. When leveling irregular surfaces and raising low areas, the actual compacted thickness of any one lift shall not exceed 2 inches.
5. Actual compacted thickness of intermittent areas of 120 square yards or less may exceed 2 inches, but not 4 inches.
6. Final wearing layer shall be of uniform thickness, and meet grade and cross-section as shown.

3.06 PATCHING

A. Preparation:

1. Remove damaged, broken, or unsound asphalt concrete adjacent to patches. Trim to straight lines exposing smooth, sound, vertical edges.
2. Prepare patch subgrade as specified in Section 31 23 13, Subgrade Preparation.

B. Application:

1. Patch Thickness: 4 inches or thickness of adjacent asphalt concrete, whichever is greater.
2. Place asphalt concrete mix across full width of patch in layers of equal thickness.
3. Spread and grade asphalt concrete with hand tools or mechanical spreader, depending on size of area to be patched.

C. Compaction:

1. Roll patches with power rollers capable of providing compression of 200 pounds per linear inch to 300 pounds per linear inch. Use hand tampers where rolling is impractical.
2. Begin rolling top course at edges of patches, lapping adjacent asphalt surface at least one-half the roller width. Progress toward center of patch overlapping each preceding track by at least one-half width of roller.
3. Make sufficient passes over entire area to remove roller marks and to produce desired finished surface.

D. Tolerances:

1. Finished surface shall be flush with and match grade, slope, and crown of adjacent surface.
2. Tolerance: Surface smoothness shall not deviate more than plus 1/4 inch or minus 0 inch when straightedge is laid across patched area between edges of new pavement and surface of old surfacing.

3.07 FIELD QUALITY CONTROL

A. General: Provide services of approved certified independent testing laboratory to conduct tests.

B. Field Density Tests:

1. Perform tests from cores or sawed samples in accordance with AASHTO T166.

2. Measure with properly operating and calibrated nuclear density gauge in accordance with ASTM D2950.
3. Maximum Density: In accordance with ASTM D2041, using sample of mix taken prior to compaction from same location as density test sample.

C. Testing Frequency:

1. Quality Control Tests:
   a. Asphalt Content, Aggregate Gradation: Once per every 500 tons of mix or once every 4 hours, whichever is greater.
   b. Mix Design Properties, Measured Maximum (Rice's) Specific Gravity: Once every 1,000 tons or once every 8 hours, whichever is greater.
2. Density Tests: Once every 500 tons of mix or once every 4 hours, whichever is greater.

END OF SECTION

SECTION 32 13 13
CONCRETE PAVING

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO).
   a. M6, Standard Specification for Fine Aggregate for Portland Cement Concrete.
   b. M80, Standard Specification for Coarse Aggregate for Portland Cement Concrete.
   c. M153, Standard Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
   d. M157, Standard Specification for Ready-Mixed Concrete.
   e. M213, Standard Specification for Preformed Expansion Joint Fillers for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
   f. M227/M227M, Standard Specification for Steel Bars, Carbon, Merchant Quality, Mechanical Properties.
2. American Concrete Institute (ACI):
   a. 305R, Hot Weather Concreting.
   b. 306R, Cold Weather Concreting.
   c. 308, Standard Practice for Curing Concrete.
   d. 318/318R, Building Code Requirements for Structural Concrete and Commentary.
   e. 325.9R, Guide for Construction of Concrete Pavements and Concrete Bases.
3. ASTM International (ASTM):
   a. A615/A615M, Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   b. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   c. C33, Specification for Concrete Aggregates.
   d. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   e. C42/C42M, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   f. C78, Test Method for Flexural Strength of Concrete (Using Simple Beam with Third-Point Loading).

g. C88, Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
h. C94/C94M, Standard Specification for Ready-Mixed Concrete.
i. C143/C143M, Standard Test Method for Slump of Hydraulic Cement Concrete.
j. C150, Specification for Portland Cement.
k. C172, Standard Practice for Sampling Freshly Mixed Concrete.
l. C231, Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
m. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
n. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
o. C494/C494M, Standard Specification for Chemical Admixtures for Concrete.
p. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use as a Mineral Admixture in Concrete.
q. C803/C803M, Test Method for Penetration Resistance of Hardened Concrete.
r. C1330, Specification for Cylindrical Seal Backing for Use With Cold Liquid Applied Sealants.
s. C805, Test Method for Rebound Number of Hardened Concrete.
t. C979/C979M, Standard Specification for Pigments for Integrally Colored Concrete.
u. D920, Standard Specification for Elastomeric Joint Seals.
v. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
w. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).
x. D1752, Specification for Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction.
y. D2628, Specification for Preformed Polychloroprene Elastomeric Joint Seals for Concrete.
z. D2828, Specification for Non-Bituminous Inserts for Contraction Joints in Portland Cement Concrete Airfield Pavements, Sawable Type.
aa. D3406, Specification for Joint Sealant, Hot-Applied, Elastomeric-Type, for Portland Cement Concrete Pavements.
bb. D3569, Specification for Joint Sealant, Hot-Applied, Elastomeric, Jet-Fuel-Resistant Type for Portland Cement Concrete Pavements.
cc. D3581, Specification for Joint Sealant, Hot-Applied, Jet-Fuel-Resistant-Type, for Portland Cement and Tar-Concrete Pavements.

dd. D5249, Specification for Backer Material for Use With Cold- and Hot-Applied Joint Sealants in Portland Cement Concrete and Asphalt Joints.
ee. D5893, Specification for Cold-Applied, Single Component, Chemically Curing Silicone Joint Sealant for Portland Cement Concrete Pavements.
ff. E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.

4. National Ready Mixed Concrete Association (NRMCA).

1.02 SUBMITTALS

A. Provide as required in Section 03 30 00, Cast-in-Place Concrete, and as noted in Paragraph Action Submittals and Article Informational Submittals.

B. Action Submittals:

1. Jointing Drawings: Identify location and spacing of each type of joint.
2. Colored concrete samples.
3. Admixtures: Color pigment product data including application rate and color chart.

C. Informational Submittals:

1. Manufacturers' Certificate of Compliance: Color pigment admixtures.

1.03 QUALITY ASSURANCE

A. Provide as required in Section 03 30 00, Cast-in-Place Concrete.

B. Prepaving Conference:

1. Held between Contractor, Subcontractor involved in concrete paving, and Contracting Officer.
2. To be conducted a minimum of 14 days prior to commencing paving.
3. Conference cannot be held until mix design and admixture Submittals have been received by Contracting Officer.
4. Items to discuss shall include, but not be limited to:
   a. Mix design.
   b. Method of placement.
   c. Curing.
   d. Finishing schedule.
   e. Traffic control.
   f. Protection of work.

C. Hot Weather Concreting: Conform to ACI 305R.

D. Cold Weather Concreting: Conform to ACI 306R.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Transporting of ready-mix concrete shall be in accordance with ASTM C94/C94M.

PART 2 PRODUCTS

2.01 CONCRETE MATERIALS

A. Cement:

1. Physical Characteristics: Cement for Concrete.
2. Functional Characteristics: None.
3. Performance Characteristics: Portland cement shall be blended hydraulic cement Type II in accordance with ASTM C150.
4. Pozzolan as specified in Section 03 30 00, Cast-in-Place Concrete.

B. Aggregates:

1. General:
   a. As specified in Section 03 30 00, Cast-in-Place Concrete.
   b. Aggregate for portland cement concrete mixture shall be 1-1/2-inch maximum size stone meeting requirements of AASHTO M6 and AASHTO M80.
   c. Material: Natural aggregates, free from deleterious coatings.
   d. Aggregates shall not be potentially reactive as defined in ASTM C33.
   e. Aggregates not in compliance with soundness and durability requirements of ASTM C33 may be used with prior approval of Contracting Officer; provided it can be shown by special testing or record of past performance that these aggregates produce concrete of adequate strength and durability. Aggregate soundness testing for fine and coarse aggregates shall be in accordance with ASTM C33 and ASTM C88.
2. Fine Aggregates:
   a. Must be graded coarse to fine within the following limits:

General Requirements	
Sieve Size Passing	**Percentages by Weight**
3/8"	100
No. 4	90-100

General Requirements	
Sieve Size Passing	**Percentages by Weight**
No. 8	55-85
No. 16	45-75
No. 30	25-55
No. 50	5-30
No. 100	0-8

b. Sand: Equivalent of not less than 68.
c. Materials finer than 200 sieve shall not exceed 4 percent.

3. Coarse Aggregate:
   a. Materials finer than 200 sieve shall not exceed 0.5 percent.
   b. Size: 1-1/2-inch to No. 4.

Grading Requirements		
Sieve Size Passing	**Separated Sizes 1-1/2 Inch to 3/4 Inch**	**Percentages (by Weight) 3/4 Inch to No. 4**
2"	100	
1-1/2"	90-100	
1"	30-65	100
3/4"	0-15	90-100
3/8"		20-50
No. 4		0-10

C. Physical Properties: Meet requirements of AASHTO M80 for Class A.

D. Water: ASTM C94/C94M.

E. Admixtures:

1. Add admixtures to mix at batch plant.
2. Air Entraining: ASTM C260.
3. Water Reducing:
   a. ASTM C494/C494M, Type A, normal or Type D, retarding type, containing no chlorides and compatible with air-entraining admixtures.
   b. Do not use calcium chloride, salt, or antifreeze agents.

2.02 ANCILLARY MATERIALS

A. Tie Bars:

1. Physical Characteristics: Deformed steel bars manufactured for use in concrete.
2. Functional Characteristics: None.
3. Performance Characteristics: Grade 40 deformed steel bars conforming to ASTM A615/A615M.

B. Dowels:

1. Physical Characteristics: Steel bars manufactured for use in concrete.
2. Functional Characteristics: None.
3. Performance Characteristics: Conform to requirements of AASHTO M227/M227M, Grade 70.

C. Joint Filler:

1. Physical Characteristics: Premolded expansion joint filler.
2. Functional Characteristics: None.
3. Performance Characteristics: Joint filler conforming to bituminous type ASTM D994 or ASTM D1751
4. Fillers furnished under AASHTO M213 shall be tested in accordance with ASTM D1751.

D. Joint Sealant:

1. Physical Characteristics: Preformed or hot poured elastomeric joint seal or cold-applied single component joint sealant for filling concrete expansion, contraction, and cold joints.
2. Functional Characteristics: None.
3. Performance Characteristics: Preformed elastomeric joint seal conforming to AASHTO M220 or hot-poured elastomeric joint seal conforming to AASHTO M282 or cold-applied single component joint sealant conforming to ASTM D5893. Elastomeric Joint sealants conforming to ASTM C920.

E. Backer Rod:

1. Physical Characteristics: Backer material for concrete expansion joints.
2. Functional Characteristics: None.
3. Performance Characteristics: Material conforming to ASTM D5249 or cylindrical sealant backing conforming to ASTM C1330.

F. Curing Compound:

1. Physical Characteristics: Sprayable curing compound for exposed concrete surfaces.
2. Functional Characteristics: None.
3. Performance Characteristics: Curing compound conforming to ASTM C309, Type 2, Class B, suitable for spray application.

G. Curing Membranes:

1. Physical Characteristics: White polyethylene sheeting or waterproof paper or cotton or jute mats.
2. Functional Characteristics: None.
3. Performance Characteristics: Retain moisture on the surface of the concrete during curing.

2.03 EQUIPMENT

A. Ready-Mix Concrete Batch Plants: Certified by NRMCA.

B. Batch Plants:

1. Bins shall have adequate separate compartments for fine aggregate, each separate size of coarse aggregate and cement. Bins and compartments shall be tight and ample to prevent spilling from one bin to another. Separate compartments, including weighting hoppers, shall discharge freely and efficiently.
2. Scales for weighing aggregates and cement may be either beam type or springless dial type. They shall be accurate within 0.5 percent under operating conditions throughout the range of use and, tested and adjusted as often as Contracting Officer may deem necessary to assure their continued accuracy.
3. Equipment for dispensing water and admixtures shall provide a separate feed, accurate quantity measurement, and shall inject water and admixture at a time in mixing process to ensure thorough and complete mixing throughout batch of portland cement concrete.
4. Automatically controlled batchers shall have automatically interlocked mechanisms providing the following:
   a. Positive weighing and discharge of cement and of each separate size of aggregate.
   b. Interlocking between weighing hoppers to prevent part of batch from being discharged until each separate hopper has been filled with correct proportion.
   c. Simultaneous discharge of hoppers.
   d. Lockable compartment containing time setting controls.
5. Equip mixers with a timing device that will not permit batch to be discharged until specified mixing time has elapsed. The means of

storing, measuring and introducing water into mixer shall provide positive control and accurate measurement.

C. Ready-Mix Concrete Trucks:

1. Agitator mixer type.
2. Equipped with operable electrically actuated drum revolution counters.
3. Use of nonagitator equipment will not be permitted.
4. Each mixer shall carry a clearly visible manufacturer's plate showing capacity of mixer and other pertinent operating rates and limits.
5. Provision shall be made at mixer for controlled addition of air-entraining admixtures or other special components of mix.
6. Mixing Speed: 70 to 100 revolutions at a mixing speed recommended by truck mixer manufacturer.

D. Hauling Equipment:

1. Hauling equipment shall conform to AASHTO M157, Paragraph 11.6 and Paragraph 12.
2. Upon delivery of each batch of concrete to Site, a trip ticket shall be submitted to Contracting Officer.

E. Concrete Saws:

1. Provide power driven concrete saws for sawing joints or finishing concrete, adequate in number of units and power to complete sawing at required rate.
2. Saws and related equipment shall be of proven adequacy and design to perform efficiently and shall be subject to immediate replacement, if specified results are not obtained.
3. Standby saw shall be available at Site.

F. Smoothness Testing Equipment: Supply two 12-foot straightedges for determining smoothness.

2.04 CONCRETE MIX DESIGN

A. As specified in Section 03 30 00, Cast-in-Place Concrete, with a minimum flexural strength of 650 psi.

B. Compressive strength of 4,000 psi minimum and flexural strength of 650 psi minimum, both at 28 days.

1. If the 650 psi flexural strength specification requires a compressive strength in excess of 4,000 psi the higher compressive value shall be used as a standard minimum for compressive strength cylinder tests taken during construction.

2. The relationship between compressive strength f_c and modulus of rupture f_r shall be:

$$f_r = k\sqrt{f_c}$$

with k derived from the tests results.

C. Concrete target strengths shall be in accordance with ACI 318/318R.

D. Color Pigment: Add color pigment to concrete mixture for all curbs, sidewalks, ramps, and concrete pavements according to manufacturer's written instructions and to result in hardened concrete color consistent with approved mockup. High purity, chemically inert, unfading, and alkali-fast synthetic pigment coloring material according to ASTM C979.

1. Color additive pigment shall be for integral coloration of the concrete mix. Use additive and sealers as recommended by manufacturer. A minimum of three test sections will be required for determining the exact amount of additive, as stated in this specification. Determine coloring agent batch amounts by weight, not volume. Use additional mixing time required as recommended by the manufacturer. The amount of coloring agent to be used will be determined by the Contracting Officer based on test section results.
2. The color of the concrete shall match existing on-site colored concrete and be similar to x (Davis color equivalent x – NPS to provide color for next submittal) for all exposed concrete paving, accessible ramps, curbs, and gutters. Similar colors provided by other manufacturers of concrete dye products are acceptable.

PART 3 EXECUTION

3.01 WEATHER LIMITATIONS

A. Concrete shall not be placed:

1. Until the air temperature in the shade is 35 degrees F and rising and is forecast to remain above 35 degrees F.
2. On frozen ground.
3. During periods of rain or snow.

B. Concrete placement shall not continue when air temperature drops below 40 degrees F.

C. Protect concrete pavement from inclement weather for 7 days after it has been placed, when rain is imminent, and when air temperature drops or is forecast to drop below 35 degrees F.

3.02 PREPARATION

A. Prepare base as specified in Section 32 11 23, Aggregate Base Course(s).

B. Dampen base thoroughly prior to concrete placement; standing water will not be permitted.

C. Formwork shall be complete prior to placement of concrete. Area in which concrete is to be placed, shall be smooth and free of ruts, projections, debris, spilled concrete, mud, sloughed soil, standing water, organic and other objectionable materials.

D. Construction Joints: Inspect prior to placement of concrete.

E. Protect existing exposed surfaces such as grates, catch basins, air valves, manholes, and cleanout lids from splattered and spilled concrete during concrete placement by use of durable waterproof paper.

F. Furnish operable backup vibrator on Site prior to concrete placement.

3.03 SLIP FORM PAVING

A. Deliver from hauling vehicles to paving machine hopper.

B. Contractor’s equipment hauling portland cement concrete or reinforcement will not be permitted on subgrade, but will be allowed on base, with turns or other maneuvering kept to a minimum. Damage to subgrade or base shall be corrected to satisfaction of Contracting Officer.

C. Place in final position uniformly in one layer, so a minimum of finishing will be necessary to provide a dense, homogenous pavement conforming to true grade and cross-section.

1. Coordinate mixing, delivering, and spreading portland cement concrete to provide uniform progress.

D. While placing portland cement concrete, provision shall be made for constructing joints, placing dowels, tie bars, and other devices as called for by the Drawings and as provided in Article Joints.

E. Portland cement concrete shall be rejected if it:

1. Is not in place within 1 hour after being mixed.
2. Has begun to take an initial set prior to placement.
3. Has been retempered with water.

F. If necessary, supplemental hand spreading and distributing shall be with shovels. Rakes will not be permitted.

G. Portland cement concrete shall not be fouled with foreign matter.

H. Use vibrators to consolidate portland cement concrete pavement at least 6 feet each side of construction joints and expansion joints.

I. Defects:

1. Fill areas of minor honeycomb or other minor defect in composition of portland cement concrete along exposed edges of portland cement concrete with a stiff mortar of cement and fine aggregate. Apply to moistened portland cement concrete to satisfaction of Contracting Officer.
2. Area showing serious defects in composition of concrete shall be removed and replaced with pavement of specified quality for full width of strip between longitudinal joints or edges and for a length not less than between the nearest transverse joints.

3.04 JOINTS

A. General:

1. Referred to as contraction or construction, either of which may be transverse or longitudinal, as called for by the Drawings or as approved by Contracting Officer.
2. Joints, backer material, joint filler and joint sealants shall extend to pavement edges or to each other, as the case may be, and shall be constructed perpendicular to surface of pavement.
3. Joints shall not vary from specified or indicated line by more than 1/4 inch.
4. Contractor shall submit jointing plan and details to Contracting Officer for approval. Take into consideration placement of joints in curb and gutter, at catch basins, and position of manholes and other large structures, as well as other limitations herein mentioned.
5. Place manhole or similar large structure in line of joint, or if impractical, isolate structure from pavement with premolded joint filler, 1/2-inch wide, conforming to AASHTO M213 and ASTM D1751.

B. Contraction Joints:

1. Sawed Type with Poured Filler:
   a. Sawing shall be to a depth as shown on the Drawings with a maximum width of 1/4 inch and a minimum width of 1/8 inch, in straight lines as shown or as approved by Contracting Officer.
   b. Perform saw cuts as soon as portland cement concrete has set enough to permit sawing without tearing or raveling, before

uncontrolled cracking results, and within 24 hours of placing portland cement concrete.

c. Saws may be single or tandem, as Contractor may elect, and shall be controlled by guides to true line.

d. Clean joints thoroughly of foreign matter before pouring approved rubber asphalt filler.

e. Tops of joint filler shall be true to pavement cross-section within 1/8 inch and shall be protected from damage by portland cement concrete operations.

f. Areas containing uncontrolled cracks shall be removed and replaced.

g. Restore curing agents broken or damaged by sawing operations.

2. Space longitudinal joints as shown on the Drawings and at intervals between 12 feet to 16 feet.

3. Transverse joints shall be as shown on the Drawings or as approved by Contracting Officer, with intervals of 12 feet to 16 feet.

C. Construction Joints:

1. Construct when there is an interruption of longer 45 minutes in portland cement concrete placing operations or where specified.

2. Place parallel with intended contraction joint.

3. Tool both free edges of joints with 1/8 inch radius rounder to remove laitance and mortar resulting from finishing operations and to provide clean rounded edge. Tooling shall not form ridges on surface of concrete.

4. New portland cement concrete placed contiguous to joint shall conform to proportions and consistency of previously placed concrete.

5. Longitudinal Construction Joint:

a. Tied type using No. 5 by 36-inch deformed tie bars at 12-inch centers.

b. Tie Bars:

1) Not required at construction joint between portland cement concrete pavement and gutter, except where shown on the Drawings and mentioned above.

2) Placement:

a) Plastic Portland Cement Concrete: Insert before vibrating and finishing portland cement concrete; or

b) Hardened Concrete:

(1) Drill hole, insert, and grout tie bars into place.

(2) Drill holes large and deep enough to allow tie bars to be inserted with grout.

(3) Perform any time after portland cement concrete has attained enough strength to resist any damage caused by drilling.

(4) Tie bars shall be grouted a maximum of 3 hours prior to placement of adjacent portland cement concrete.

3) Replace loose tie bars by drilling and grouting as described.

D. Scored Joints:

1. Configuration: 1/4-inch wide by 1/4-inch deep at locations indicated on the Drawings formed by tooling of concrete while it is still fresh.
2. Do not fill or seal.
3. Layout of joints shall be straight and true and shall not vary from indicated line by more than 1/4 inch.

3.05 SURFACE FINISHING

A. Use temporary screeds. Wet screeding and jitterbugging shall not be permitted.

B. Pavement shall have surface tolerance of 1/4 inch in 10 feet in accordance with ACI 325.9R.

C. Salting, spreading of cement or cement and sand mixture to speed up hardening shall not be permitted.

D. Exposed pavement edges shall be edged to a 1/2-inch radius and construction joints shall be edged to 1/8-inch radius after finishing. Edging shall not form ridges on pavement surface.

E. Pavement shall be treated and protected by use of evaporation retardant applied in accordance with manufacturer’s written instructions. Flat surfaces shall be treated immediately after screeding and floating or if time period greater than 15 minutes occurs between finishing operations.

F. Pavement shall be screeded, floated, and given heavy nylon bristle-broomed skid-resistant surface.

1. Broomed surface with hand broom or mechanical broom device to produce 1/16-inch to 1/8-inch deep striations oriented perpendicular to the direction of travel.

3.06 CURING OF PORTLAND CEMENT CONCRETE

A. Immediately after the final floating, surface finishing, and edging has been completed, and while portland cement concrete surface is still moist, cover

and cure entire exposed surface for at least 72 hours in accordance with one of the following provisions:

1. Liquid Membrane-Forming Compounds: Apply compound uniformly to portland cement concrete by pressure spray methods at a rate which will form an impervious membrane, but at least at a rate of 1 gallon per 150 square feet.
2. Other Membranes:
   a. Apply to damp portland cement concrete as soon as it can be placed without marring surface.
   b. Place in contact with surface, extend beyond sides or edges of slabs or forms, and fasten down to hold it in position as a waterproof and moistureproof covering.
   c. Laps shall be sufficient to maintain tightness equivalent to sheeting.
   d. Transverse laps for waterproof paper shall be at least 18 inches, and longitudinal seams shall be cemented.
   e. Cotton or jute mats shall be saturated with water prior to placing and kept fully wetted during curing period.

B. Concrete shall be cured by use of curing compound, for minimum of 7 days after concrete placement, in accordance with ACI 308. Curing compounds shall be applied in accordance with manufacturer's written instructions.

C. Exposed surfaces shall be sprayed with curing compound immediately after free surface water has disappeared from finished surface.

D. Concrete temperature shall be maintained in accordance with ACI 306R.

E. Curing compounds shall not come in contact with hardened concrete that is to be concreted against.

3.07 FIELD QUALITY CONTROL

A. Retain independent testing or inspection agency to perform inspection, sampling, and testing.

B. Concrete Sampling: In accordance with ASTM C172. Take sample not less than every 5,000 square feet or fraction thereof of concrete placed each day.

C. Perform following tests on each sampling:

1. Slump: ASTM C143/C143M.
2. Air Content: ASTM C231.
3. Compressive Strength: ASTM C39/C39M.
4. Flexural Strength: ASTM C78.

D. Strength Tests:

1. Make and cure cylinders and beams in accordance with ASTM C31/C31M.
2. Cylinders: Make four, standard 6-inch diameter by 12 inches high. Cure one in field and three in laboratory.
3. Beams: Make three, standard 6 inches by 6 inches by 21 inches. Cure in field.
4. Compressive: Test one field-cured cylinder at 7 days and two laboratory-cured cylinders at 28 days. Test last cylinder at 56 days if 28-day cylinder is below specified strength.
5. Flexural: Test one beam at 7 days and two beams at 28 days.

E. Acceptance of concrete shall be in accordance with ACI 318/318R.

F. Concrete with compressive strength less than specified, as evidenced by cylinder tested at 56 days, shall be additionally tested as follows:

1. Less Than 500 psi Low in Compression or Less Than 75 psi Low in Flexure:
   a. Penetration Resistance Test: ASTM C803.
   b. Rebound Hammer Test: ASTM C805.
   c. Perform tests within 24 hours of noncomplying strength tests.
2. More Than 500 psi Low in Compression or More Than 75 psi Low in Flexure:
   a. Concrete Coring: Take three standard cores from concrete representing original specimens.
   b. Take and prepare cores in accordance with ASTM C42/C42M.
   c. Test cores in accordance with ASTM C39/C39M.
   d. Take cores within 24 hours of noncomplying strength test.

G. Pay Factor:

1. Portland cement concrete shall be accepted according to average compressive strengths of four or more cylinders taken for 28-day tests for each 500 cubic yards placed.

2. Whenever percentage of specified compressive strength falls below the level of 80 percent, Contracting Officer may require the portland cement concrete be removed and replaced to meet required Specifications.
3. If the compressive strength, f_c, to comply with the flexural strength requirement is greater than 4,000 psi, then the specified strength shall be multiplied by:

$$\frac{F_c}{4000}$$

3.08 CLEANING

A. Clean concrete splatter from exposed surfaces.

B. Thoroughly broom and wash concrete surfaces before opening to traffic.

3.09 PROTECTION OF CONCRETE

A. Do not operate construction equipment or allow traffic on newly placed portland cement concrete until the following requirements are met:

1. Joints have been filled as per Article Joints.
2. Concrete has attained a compressive strength of at least 4,000 pounds per square inch.

B. Protect new concrete from construction operations, mechanical disturbances, water flow, and soiling until open for traffic.

C. Erect and maintain suitable barriers to protect concrete from traffic or other detrimental trespass until pavement is opened to traffic.

D. Maintain watchmen after normal working hours for at least a 24-hour period to ensure barriers are not removed or destroyed, and that trespass and vandalism upon pavement does not occur.

E. Wherever it is necessary that traffic, including Contractor's vehicles and equipment, be carried from one side of pavement to the other, construct suitable bridges over pavement, and maintain them in good condition as long as they may be required. Leaving gaps in pavement to facilitate movement of traffic will not be allowed, unless prior written permission is obtained from Contracting Officer.

F. Protect new concrete from dirt, asphalt, and other deleterious substances that may be tracked onto new pavement from construction activities.

G. Pavement damaged by traffic or damaged from any other cause, prior to its official acceptance, shall be repaired or replaced to the satisfaction of Contracting Officer.

END OF SECTION

SECTION 32 16 00
CURBS AND GUTTERS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T 99, Standard Specification for the Moisture-Density Relations of Soils Using a 2.5 kg (5.5 pound) Rammer and a 305 mm (12 in.) Drop.
2. American Concrete Institute (ACI): 304R, Guide for Measuring, Mixing, Transporting, and Placing Concrete.
3. ASTM International (ASTM):
   a. C94, Standard Specification for Ready-Mixed Concrete.
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   c. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).

1.02 SUBMITTALS

A. Action Submittals:

1. Form Material: Information on metal forms, if used, including type, condition, surface finish, and intended function.
2. Complete data on concrete mix, including aggregate gradations and admixtures in accordance with requirements of ASTM C94.

B. Informational Submittals:

1. Curing Compound: Manufacturer’s Certificate of Compliance and application instructions.
2. Ready-mix delivery ticket for each truck in accordance with ASTM C94.

1.03 QUALITY ASSURANCE

A. Form and construct curb and gutters using skilled concrete workers with a minimum of 5 years’ experience in curb and gutter construction.

PART 2 PRODUCTS

2.01 EXPANSION JOINT FILLER

A. Preformed asphalt-impregnated, expansion joint material meeting ASTM D994, 1/2 inch thick.

2.02 CONCRETE

A. As specified in Section 03 30 00, Cast-in-Place Concrete.

B. Maximum Aggregate Size: 1-1/2 inch.

C. Slump: 2 inches to 4 inches.

2.03 CURING COMPOUND

A. Liquid membrane forming, clear or translucent, suitable for spray application and meeting ASTM C309, Type 1.

PART 3 EXECUTION

3.01 FORMWORK

A. Lumber Materials:

1. 2-inch dressed dimension lumber, or metal of equal strength, straight, free from defects that would impair appearance or structural quality of completed curb and sidewalk.
2. 1-inch dressed lumber or plywood may be used where short-radius forms are required.

B. Metals: Steel in new undamaged condition.

C. Setting Forms:

1. Construct forms to shape, lines, grades, and dimensions.
2. Stake securely in place.

D. Bracing:

1. Brace forms to prevent change of shape or movement resulting from placement.
2. Construct short-radius curved forms to exact radius.

E. Tolerances:

1. Do not vary tops of forms from gradeline more than 1/8 inch when checked with 10-foot straightedge.
2. Do not vary alignment of straight sections more than 1/8 inch in 10 feet.

3.02 PLACING CONCRETE

A. Prior to placing concrete, remove water from excavation and debris and foreign material from forms.

B. Place concrete as soon as possible, and within 1-1/2 hours after adding cement to mix without segregation or loss of ingredients, and without splashing.

C. Place, process, finish, and cure concrete in accordance with applicable requirements of ACI 304, and this section. Wherever requirements differ, the more stringent shall govern.

D. To compact, vibrate until concrete becomes uniformly plastic.

3.03 CURB CONSTRUCTION

A. Construct ramps at pedestrian crossings and accessible parking spaces.

B. Expansion Joints: Place at maximum 75 foot intervals and at the beginning and end of curved portions of curb, and at connections to existing curbs. Install expansion joint filler at each joint.

C. Curb Facing: Do not allow horizontal joints within 7 inches from top of curb.

D. Contraction Joints:

1. Maximum 15-foot intervals in curb.
2. Provide open joint type by inserting thin, oiled steel sheet vertically in fresh concrete to force coarse aggregate away from joint.
3. Insert steel sheet to full depth of curb.
4. Remove steel sheet with sawing motion after initial set has occurred in concrete and prior to removing front curb form.
5. Finish top of curb with steel trowel and finish edges with steel edging tool.

E. Front Face:

1. Remove front form and finish exposed surfaces when concrete has set sufficiently to support its own weight.
2. Finish formed face by rubbing with burlap sack or similar device to produce uniformly textured surface, free of form marks, honeycomb, and other defects.

3. Remove and replace defective concrete.
4. Apply curing compound to exposed surfaces of curb upon completion of finishing.
5. Continue curing for minimum of 5 days.

F. Backfill curb with earth upon completion of curing period, but not before 7 days has elapsed since placing concrete.

1. Backfill shall be free from rocks 2 inches and larger and other foreign material.
2. Compact backfill firmly.

3.04 SIDEWALK CONSTRUCTION

A. Thickness:

1. 4 inches in walk areas.
2. 6 inches in driveway areas.

B. Connection to Existing Sidewalk:

1. Remove old concrete back to an existing contraction joint.
2. Clean the surface.
3. Apply a neat cement paste immediately prior to placing new sidewalk.

C. Expansion Joints: Place in adjacent curb, where sidewalk ends at curb, and around posts, poles, or other objects penetrating sidewalk. Install expansion joint filler at each joint.

D. Contraction Joints:

1. Provide transversely to walks at locations opposite contraction joints in curb.
2. Dimensions: 3/16-inch by 1-inch weakened plane joints.
3. Construct straight and at right angles to surface of walk.

E. Finish:

1. Broom surface with fine-hair broom at right angles to length of walk and tool at edges, joints, and markings.
2. Mark walks transversely at 5-foot intervals with jointing tool; finish edges with rounded steel edging tool.
3. Apply curing compound to exposed surfaces upon completion of finishing.
4. Protect sidewalk from damage and allow to cure for at least 7 days.

END OF SECTION

SECTION 32 17 23
PAVEMENT MARKINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO):
   a. M247, Standard Specification for Glass Beads Used in Traffic Paint.
   b. M248, Standard Specification for Ready-Mixed White and Yellow Traffic Paints.
2. Federal Specifications (FS):
   a. A-A-2886A, Paint, Traffic, Solvent Based.
   b. TT-B-1325C, Beads (Glass Spheres); Retroreflective.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Paint.
      2) Epoxies, resins, and primers to be used.
   b. Glass Beads: Proposed gradation.

B. Informational Submittals:

1. Description of proposed methods for removal of drips, overspray, improper markings, paint and thermoplastic material tracked by traffic, and existing markings.
2. Equipment List: Proposed equipment to be used, including descriptive data.
3. Manufacturer’s Instructions:
   a. Application of portland cement concrete primer.
   b. Application of glass beads.

PART 2 PRODUCTS

2.01 PAINT

A. Waterborne Traffic Paint:

1. Physical Characteristics: Paint used for traffic marking on asphalt and concrete pavements.
2. Functional Characteristics: None.
3. Performance Characteristics: Acrylic water-based, ready-mixed traffic paint composed of resin solids of 100 percent acrylic polymer in accordance with AASHTO M248, Type F or Type N.
   a. Pigment: ASTM D3723, 45 percent to 55 percent by mass.
   b. Lead, chromium, cadmium, or cobalt, ASTM D3335 and ASTM D3718, 0 percent by mass.
   c. Volatile Organic Compounds: EPA Method 24, 20 ounces per gallon maximum.
   d. Density of Paint: ASTM D1475, 12 pounds per gallon minimum.
   e. Viscosity: ASTM D562, 75–90 Krebs units.
   f. Drying Time to No Track: ASTM D713, 90 seconds maximum.
   g. Flexibility: ASTM D522, using the 1/4-inch cylindrical method, no cracking or flacking.
   h. Dry Opacity: ASTM D2805, contrast ratio at 319 square feet per gallon spreading rate, 0.96 minimum.
   i. Daylight Reflectance (without glass beads): ASTM E1347, white, 84 percent, and yellow 55 percent relative to magnesium oxide standard.
   j. Freeze-thaw Stability: ASTM D2243, plus or minus 5 Krebs units maximum.
4. Color: ASTM D1729, White, yellow, or blue.
5. Homogeneous, easily stirred to smooth consistency, with no hard settlement or other objectionable characteristics during storage period of 6 months.

2.02 GLASS BEADS

A. Glass Beads:

1. Physical Characteristics: Reflective Beads used in Traffic Marking Paint.
2. Functional Characteristics: None.
3. Performance Characteristics: Glass Beads in accordance with AASHTO M247, Type I.

PART 3 EXECUTION

3.01 SURFACE PREPARATION

A. Cleaning:

1. Thoroughly clean surfaces to be marked before application of pavement marking material.
2. Remove dust, dirt, and other granular surface deposits by sweeping, blowing with compressed air, rinsing with water or a combination of these methods.
3. Completely remove rubber deposits, surface laitance, existing paint markings, and other coatings adhering to pavement with scrapers, wire brushes, sandblasting, approved chemicals, or mechanical abrasion.
4. Scrub areas of old pavement affected with oil or grease with several applications of trisodium phosphate solution or other approved detergent or degreaser, and rinse thoroughly after each application.
5. Surfaces shall be completely free of dirt and ice, and dry of water at the time of application of materials specified herein.
6. Oil-Soaked Areas: After cleaning, seal with cut shellac to prevent bleeding through the new paint.
7. Reclean surfaces when the Work has been stopped due to rain.
8. Existing Pavement Markings:
   a. Remove existing pavement markings that may interfere or conflict with newly applied marking patterns, or that may result in a misleading or confusing traffic pattern.
   b. Perform grinding, scraping, sandblasting or other operations so finished pavement surface is not damaged.

B. Pretreatment for Early Painting: Where painting is required prior to 30 days after paving rigid pavements, pretreat with an aqueous solution containing 3 percent phosphoric acid and 2 percent zinc chloride.

C. New Concrete Pavement (ABA parking spaces):

1. Allow a minimum cure time of 30 days before cleaning and marking.
2. Clean by either sandblasting or water blasting to the following results:
   a. No visible evidence of curing compound on peaks of textured concrete surface.
   b. No heavy puddled deposits of curing compound in valleys of textured concrete surface.
   c. Remaining curing compound is intact, with loose and flaking material completely removed.
   d. Peaks of textured pavement surface are rounded in profile and free of sharp edges and irregularities.

3. Allow a minimum drying time of 24 hours after water blasting before applying thermoplastic markings.

D. New Asphalt Pavement: Allow a minimum pavement cure time of 30 days before applying paint.

3.02 PAINT APPLICATION

A. General:

1. Thoroughly mix pigment and vehicle together prior to application, and keep thoroughly agitated during application.
2. Do not add thinner.
3. Apply only when air and pavement temperatures are above 40 degrees F, and less than 95 degrees F. Maintain paint temperature within these same limits.
4. Apply only when surface is dry.
5. Do not apply when conditions are windy to the point of causing overspray or fuzzy line edges.
6. Provide guidelines and templates to control paint application.
7. Take special precautions in marking numbers, letters, and symbols.
8. Sharply outline edges of markings and apply without running or spattering.
9. Establish control points at 100-foot intervals on tangent and at 50-foot intervals on curves.
10. Maintain the line within 2 inches of the established control points and mark the roadway between control points as needed.
11. Maintain the line dimension within 10 percent of the width and length dimensions defined in Standard Drawings.

B. Rate of Application:

1. Reflective Markings: Apply evenly,105 plus or minus 5 square feet per gallon.
2. Glass Bead Application:
   a. Apply immediately following application of paint.
   b. Use evenly distributed drop-on application method.
   c. Rate: 8 pounds per gallon of paint.
   d. Glass beads are not required on parking lot markings or symbols.
3. Nonreflective Markings: Apply paint evenly to pavement surface at a rate of 105 plus or minus 5 square feet per gallon.
4. On new pavement or new asphalt surface treatments, apply two coats of paint at a uniform rate of 210 square feet per gallon.

C. Drying:

1. Provide maximum drying time to prevent undue softening of bitumen and pickup, displacement, or discoloration by traffic.
2. If drying is abnormally slow, discontinue painting operations until cause is determined and corrected.

D. Protection:

1. Protect markings from traffic until paint is thoroughly dry.
2. Protect surfaces from disfiguration by paint spatters, splashes, spills, or drips.

E. Cleanup: Remove paint spatters, splashes, spills, or drips from the Work and staging areas including areas outside the immediate Work area where spills occur.

1. Broken Centerlines: As shown.

END OF SECTION

SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. A121, Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
   b. A313/A313M, Standard Specification for Stainless Steel Spring Wire.
   c. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
   d. A491, Standard Specification for Aluminum-Coated Steel Chain-Link Fence Fabric.
   e. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   f. A615/A615M, Standard Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
   g. A780, Standard Specification for Repair of Damaged and Uncoated Areas of Hot-Dipped Galvanized Coatings.
   h. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain Link Fence.
   i. A1011/A1011M, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy and High-Strength Low-Alloy with Improved Formability.
   j. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   k. C150, Standard Specification for Portland Cement.
   l. C387, Standard Specifications for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. F552, Standard Terminology Relating to Chain Link Fencing.
   n. F567, Standard Practice for Installation of Chain-Link Fence.
   o. F626, Standard Specification for Fence Fittings.
   p. F668, Standard Specification for Polyvinyl Chloride (PVC) and Other Organic Polymer-Coated Steel Chain-Link Fence Fabric.
   q. F900, Standard Specification for Industrial and Commercial Swing Gates.
   r. F934, Standard Specification for Standard Colors for Polymer-Coated Chain Link Fence Materials.
   s. F1043, Standard Specification for Strength and Protective Coatings on Metal Industrial Chain Link Fence Framework.

t. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
u. F1183, Standard Specifications for Aluminum Alloy Chain Link Fence Fabric.
v. F1184, Standard Specifications for Industrial and Commercial Horizontal Slide Gates.
w. F1379, Standard Terminology Relating to Barbed Tape.
x. F1911, Standard Practice for Installation of Barbed Tape.
y. F1916, Standard Specification for Selecting Chain Link Barrier Systems with Coated Chain Link Fence Fabric and Round Posts for Detention Applications.

2. Institute of Electrical and Electronic Engineers (IEEE), Inc.: C2, National Electrical Safety Code.
3. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 volts max.).

1.02 DEFINITIONS

A. Terms as defined in ASTM F552.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data: Include construction details, material descriptions, dimensions of individual components, and finishes for chain link fences.
      1) Fence, rails, and fittings.
      2) Chain link fabric.
      3) Hardware.
2. Samples:
   a. Chain Link Fabric: Approximately 6 inches square.
   b. Posts, Rails, Braces, Wire, and Ties: Approximately 6 inches long.
   c. Fittings: 1 each.

B. Informational Submittals:

1. Manufacturer’s recommended installation instructions.
2. Evidence of Supplier and installer qualifications.

1.04 QUALITY ASSURANCE

A. Design, supply of equipment and components, installation, and on-call service shall be product of individual company with record of installations meeting requirements specified.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to Site in undamaged condition. Store materials off the ground to provide protection against oxidation caused by ground contact.

1.06 SCHEDULING AND SEQUENCING

A. Complete necessary Site preparation and grading before installing chain link fence.

B. Interruption of Existing Utility Service: Notify Contracting Officer of utility 72 hours prior to interruption of utility services. Do not proceed with interruption of utility service without written permission from utility owner.

PART 2 PRODUCTS

2.01 GENERAL

A. Match style, finish, and color of each fence component with that of other fence components and with the existing fencing at the following site:

1. Hwy 4 water storage tank (Blue Tank).

B. Physical Characteristics:

1. Chain Link Fence Fabric:
   a. Galvanized fabric conforming to ASTM A392, Type II, Class 2, 2 ounces per square foot, galvanized after weaving.
   b. Height: 72 inches or existing site fence height, whichever is greater.
   c. Core Wire Gauge: No. 9.
   d. Pattern: 2-inch diamond-mesh.
   e. Diamond Count: Manufacturer’s standard and consistent for fabric furnished of same height.
   f. Loops of Knuckled Selvages: Closed or nearly closed with space not exceeding diameter of wire.
   g. Wires of Twisted Selvages:
      1) Twisted in a closed helix three full turns.
      2) Cut at an angle to provide sharp barbs that extend minimum 1/4 inch beyond twist.
2. Posts:
   a. General:
      1) Strength and Stiffness Requirements: ASTM F1043, heavy industrial fence except as modified in this section.
      2) Round Steel Pipe, Schedule 40: ASTM F1083.

3) Roll-Formed Steel Shapes: Roll-formed from ASTM A1011/A1011M, Grade 45, High-Strength Low-Alloy steel.
4) Lengths: Manufacturer's standard with allowance for minimum embedment below finished grade of 34 inches.
5) Protective Coatings:
a) Zinc Coating: ASTM F1043, Type A external and internal coating.

b. Line Posts:
1) Round Steel Pipe:
a) Outside Diameter: 2.375 inches.
b) Weight: 3.65 pounds per foot.

c. End, Corner, Angle, and Pull Posts:
1) Round Steel Pipe:
a) Outside Diameter: 2.875 inches.
b) Weight: 5.79 pounds per foot.

d. Posts for Removable Fence Panels: As specified for end, corner, angle, and pull posts.

3. Top and Brace Rails:
a. Galvanized Round Steel Pipe:
1) ASTM F1083.
2) Outside Diameter: 1.66 inches.
3) Weight: 2.27 pounds per foot.

b. Galvanized Roll-Formed Steel C Shapes:
1) Roll formed from ASTM A1011/A1011M, Grade 45.
2) Outside Dimensions: 1.625 inches by 1.25 inches.
3) Weight: 1.40 pounds per foot.

c. Protective Coatings: As specified for posts.

d. Strength and Stiffness Requirements: ASTM F1043, top rail, heavy or industrial fence.

4. Fence Fittings:
a. General: In conformance with ASTM F626, except as modified by this article.

b. Post and Line Caps: Designed to accommodate passage of top rail through cap, where top rail required.

c. Tension and Brace Bands: No exceptions to ASTM F626.

d. Tension Bars:
1) One-piece.
2) Length not less than 2 inches shorter than full height of chain link fabric.
3) Provide one bar for each gate and end post, and two for each corner and pull post.

e. Truss Rod Assembly: 3/8-inch diameter, steel, hot-dip galvanized after threading rod and turnbuckle or other means of adjustment.

f. Tie Wires, Clips, and Fasteners: According to ASTM F626.

5. Tensions Wire: Zinc-coated steel marcelled tension wire conforming to ASTM A824 Type II, Class 2.
6. Barbed Wire:
   a. Zinc-Coated Barbed Wire: ASTM A121, Chain Link Fence Grade.
   b. Aluminum-Coated Steel Barbed Wire: ASTM A121, Type II.
      1) Line Wire: Two strands of No. 12-1/2 gauge.
      2) Barbs:
         a) Number of Points: Two.
         b) Length: 3/8 inch minimum.
         c) Shape: Round.
         d) Diameter: No. 14 gauge.
         e) Spacing: 5 inches.

C. Functional Characteristics:

1. Prevent intrusion and provide protection of infrastructure within fenced boundary.
2. Withstand degradation from environmental factors including ultraviolet and precipitation.

D. Performance Characteristics: None.

2.02 CONCRETE

A. Provide as specified in Section 03 30 00, Cast-in-Place Concrete.

2.03 CONCRETE

A. Mix: ASTM C94/C94M, Option A.

1. Cement: ASTM C150, Type I.
2. Coarse Aggregate Size: 3/4 inch.

B. Mixing: In a clean metal container, mix package of dry materials by hand or machine. Following manufacturer's instructions, add clean water in sufficient quantity to produce a slump of 2 inches to 3 inches.

PART 3 EXECUTION

3.01 GENERAL

A. Install chain link fences in accordance with ASTM F567, except as modified in this section, and in accordance with fence manufacturer's recommendations, as approved by Contracting Officer. Erect fencing in straight lines between angle points.

B. Provide necessary hardware for complete fence installation.

C. Any damage to galvanized surfaces, including welding, shall be repaired with paint containing zinc dust in accordance with ASTM A780.

3.02 PREPARATION

A. Clear area on either side of fence to the extent specified in Section 31 10 00, Site Clearing. Eliminate ground surface irregularities along fence line to the extent necessary to maintain a 2-inch clearance between bottom of fabric and finish grade.

B. Stake locations of fence lines and terminal posts. Do not exceed intervals of 500 feet or line of sight between stakes. Indicate locations of utilities, lawn sprinkler system, underground structures, benchmarks, and property monuments.

3.03 POST SETTING

A. Drill or hand-excavate holes for posts to diameters and spacing indicated, in firm, undisturbed soil. Driven posts are not acceptable. Postholes shall be clear of loose materials. Waste materials from postholes shall be removed from Site or regraded into slopes on Site.

B. Posthole Depth:

1. Minimum 3 feet below finished grade.
2. 2 inches deeper than post embedment depth below finish grade.

C. Set posts with minimum embedment below finished grade of 34 inches and with top rail at proper height above finished grade. Verify posts are set plumb, aligned, and at correct height and spacing. Brace posts, as necessary, to maintain correct position and plumbness until concrete sets.

D. Backfill postholes with concrete to 2 inches above finished grade. Vibrate or tamp concrete for consolidation. Protect above ground portion of posts from concrete splatter.

E. Before concrete sets, crown and finish top of concrete to readily shed water.

F. Terminal Posts: Locate terminal end, corner, and gate posts per ASTM F567 and terminal pull posts at changes in horizontal or vertical alignment of 15 degrees or more.

G. Line Posts: Space line posts uniformly at 10 feet on centers between terminal end, corner, and gate posts.

3.04 POST BRACING

A. Install according to ASTM F567, maintaining plumb position, and alignment of fencing. Install braces at gate, end, pull, and corner posts diagonally to adjacent line posts to ensure stability. Install braces on both sides of corner and pull posts.

1. Locate horizontal braces at mid-height of fabric or higher, on fences with top rail, and 2/3-fabric height on fences without top rail. Install so posts are plumb when diagonal truss rod assembly is under proper tension.

3.05 TOP RAILS

A. Install according to ASTM F567, maintaining plumb position and alignment of fencing. Run rail continuously through line post caps and terminating into rail end attached to posts or posts caps fabricated to receive rail at terminal posts. Install top rail sleeves with springs at 105 feet maximum spacing to permit expansion in rail.

3.06 BARBED WIRE SUPPORTING ARMS

A. Barbed wire supporting arms shall be installed as indicated and as recommended by manufacturer. Bolt or rivet supporting arm to top of post in a manner to prevent easy removal with hand tools. Angle single arms to outside of fence.

3.07 TENSION WIRE

A. Install according to ASTM F567 and ASTM F1916, maintaining plumb position and alignment of fencing. Pull wire taut, without sags. Fasten fabric to tension wire with tie wires at a maximum spacing of 24 inches on center.

B. Install tension wire within 6 inches of bottom of fabric and tie to each post with not less than same diameter and type of wire.

3.08 CHAIN LINK FABRIC

A. Do not install fabric until concrete has cured minimum 7 days.

B. Apply fabric to outside of enclosing framework. Pull fabric taut to provide a smooth and uniform appearance free from sag, without permanently distorting fabric diamond or reducing fabric height. Tie fabric to posts, rails, and tension wires. Anchor to framework so fabric remains under tension after pulling force is released.

C. Splicing shall be accomplished according to ASTM F1916 by weaving a single picket into the ends of the rolls to be joined.

D. Leave 2 inches between finish grade or surface and bottom selvage, unless otherwise indicated.

E. Tension or Stretcher Bars: Thread through fabric and secure to end, corner, pull, and gate posts with tension bands spaced not more than 15 inches on center.

F. Tie Wires: Fasten ties to wrap a full 360 degrees around rail or post and a minimum of one complete diamond of fabric. Twist ends of tie wire three full twists, and cut off protruding ends to preclude untwisting by hand.

1. Maximum Spacing: Tie fabric to line posts at 12 inches on center and to brace and top rails at 24 inches on center.

3.09 FIELD QUALITY CONTROL

A. Post and Fabric Testing: Test fabric tension and line post rigidity according to ASTM F1916.

3.10 CLEANUP

A. Remove excess fencing materials and other debris from Site.

END OF SECTION

SECTION 32 91 13
SOIL PREPARATION

PART 1 GENERAL

1.01 WORK INCLUDED

A. The extent of Work is to prepare and stabilize the disturbed areas for revegetation.

B. Vegetative surface restoration to be performed by NPS staff.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ASTM International (ASTM):
   a. C33/C33M, Standard Specification for Concrete Aggregates.
   b. C602, Standard Specification for Agricultural Liming Materials.
   c. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
   d. D5268, Standard Specification for Topsoil Used for Landscaping Purposes.

1.03 SUBMITTALS

A. Informational Submittals:

1. Certified Topsoil Analysis Reports: Indicate quantities of materials necessary to bring onsite topsoil into compliance with textural/gradation requirements.

1.04 SEQUENCING AND SCHEDULING

A. Rough grade areas to be planted or seeded prior to performing Work specified under this section.

PART 2 PRODUCTS

2.01 TOPSOIL

A. General: Natural, friable, sandy loam, obtained from well-drained areas, free from objects larger than 1-1/2 inches maximum dimension, and free of subsoil, roots, grass, other foreign matter, hazardous or toxic substances, and deleterious material that may be harmful to plant growth or may hinder grading, planting, or maintenance.

B. Composition: In general accordance with ASTM D5268.

1. Gravel-Sized Fraction: Maximum 5 percent by weight retained on a No. 10 sieve.
2. Sand-Sized Fraction: Minimum 20 percent to 60 percent passing No. 10 sieve.
3. Silt and Clay-Sized Fraction: Minimum 35 percent to 70 percent.

C. Organic Matter: Minimum 1.5 percent by dry weight as determined in accordance with ASTM D2974.

D. pH: Range 5.0 to 7.0.

E. Textural Amendments: Amend as necessary to conform to required composition by incorporating sand, peat, manure, or sawdust.

F. Source: Stockpile material onsite, in accordance with Section 31 10 00, Site Clearing. Import topsoil if onsite material is insufficient in quantity.

PART 3 EXECUTION

3.01 SUBGRADE PREPARATION

A. Scarify subgrade to minimum depth of 6 inches where topsoil is to be placed.

B. Remove stones over 2-1/2 inches in any dimension, sticks, roots, rubbish, and other extraneous material.

C. Limit preparation to areas which will receive topsoil within 2 days after preparation.

3.02 TOPSOIL PLACEMENT

A. Do not place topsoil when subsoil or topsoil is frozen, excessively wet, or otherwise detrimental to the Work.

B. Mix soil amendments, lime, and other soil additives, identified in analysis reports with topsoil before placement or spread on topsoil surface and mix thoroughly into entire depth of topsoil before planting or seeding. Delay mixing of fertilizer if planting or seeding will not occur within 3 days.

C. Place one-half of the total depth of topsoil and work into top 4 inches of subgrade soil to create a transition layer. Place remainder of topsoil to depth where seeding and planting are scheduled.

D. Uniformly distribute to within 1/2 inch of final grades. Fine grade topsoil eliminating rough or low areas and maintaining levels, profiles, and contours of subgrade.

E. Remove stones exceeding 1-1/2-inch diameter, roots, sticks, debris, and foreign matter during and after topsoil placement.

F. Remove surplus subsoil and topsoil from Site. Grade stockpile area as necessary and place in condition acceptable for planting or seeding.

END OF SECTION

SECTION 32 93 00
PLANTS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of Nurserymen (AAN): Z60.1, Nursery Stock.
2. Federal Housing Administration (FHA), Section 1103-103.
3. Hortus Third, Liberty Hyde Bailey, Hortorium, 1976.

1.02 DEFINITIONS

A. Measurement:

1. In size grading Balled and Burlapped (B & B), caliper takes precedence over height.
2. Take trunk caliper 6 inches above the ground level (up to and including 4-inch caliper size) and 12 inches above the ground level for larger trees.
3. Measure size of container-grown stock by height and width of plant.

1.03 SUBMITTALS

A. Action Submittals:

1. Plant materials source list.
2. Representative photos of plant species from the nursery source.
3. Product Data on Manufactured Products: Antidesiccant.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Cover plants during shipment with a tarpaulin or other suitable covering to minimize drying.

B. Balled and Burlapped Plants: Wrap each ball firmly with burlap and securely bind with twine, cord, or wire for shipment and handling. Drum-lace balls with a diameter of 30 inches or more.

1.05 SCHEDULING AND SEQUENCING

A. Plant Deliveries: Notify Cultural Resources Park Manager at least 7 working days in advance of each delivery.

B. Planting Season: Plant only between July 1 and August 31 rainy season. Submit for approval by Cultural Resources Park Manager for times outside the rainy season.

C. Plant trees after final grades are established.

PART 2 PRODUCTS

2.01 PLANT MATERIALS

A. Provide quantity, size, genus, species, and variety of trees indicated; comply with applicable requirements of AAN Z60.1.

B. Nomenclature (Names of Plants): In accordance with “Hortus Third.”

C. Quality and Size:

1. Nursery-grown, habit of growth normal for species.
2. Sound, healthy, vigorous, and free from insects, diseases, and injuries.
3. Equal to or exceeding measurements specified in plant list. Measure plants before pruning with branches in normal position.
4. Root System of Container-Grown Plants: Well developed and well distributed throughout the container, such that the roots visibly extend to the inside face of the growing container.
5. Sizes: 6-foot height minimum.
6. Balled and Burlapped Plants: Firm, intact ball of earth encompassing enough of the fibrous and feeding root system to enable full plant recovery.
   a. Ball Size: AAN Z60.1.
7. Container-Grown Plants: Self-established root systems, sufficient to hold earth together after removal from container, without being root bound.
   a. Stock: Grown in delivery containers for at least 6 months but not over 2 years.
8. Label at least one tree of each variety with securely attached waterproof tag bearing legible designation of botanical and common name.

D. Plant List:

Plant Listing				
Quantity	**Size**	**Genus**	**Species**	**Common Name**
TBD*	6-foot ht. minimum	Juniperus	monosperma	One seed juniper
TBD*	6-foot ht. minimum	Pinus	edulis	Pinyon pine
*Contractor to replace removed or damaged trees. Consult Cultural Resources Park Manager for quantity of each tree species.				

E. Replacement Trees: Same species, size, and quality as specified for plant being replaced or as determined by Cultural Resources Park Manager.

2.02 ANTIDESICCANT

A. Provide transpiration retarding material to be used where any plant material is moved during the growing season.

B. Products:

1. Foliguard.
2. Wiltpruf.
3. Or approved equal.

2.03 MULCH

A. Free from noxious weed seed and foreign material harmful to plant growth.

B. Barkdust: Medium grind, fir, pine, or hemlock; maximum 3/4-inch particle size. Guaranteed free of weed, noxious and invasive seed

2.04 PLANTING SOIL MIX

A. Soil stripping from the top 6 inches of the existing soil horizon, stockpiled for reuse and free of stones over 1 inch and vegetative matter.

2.05 SOURCE QUALITY CONTROL

A. Top Soil Analysis/Testing: Per Cultural Resources Park Manager’s direction should on-site topsoil stripping be deemed unsuitable or contaminated with subsurface soils.

PART 3 EXECUTION

3.01 PERCOLATION TESTS

A. Fill each planting pit with water for Cultural Resources Park Manager's review. Monitor water drainage in the pit, report to Cultural Resources Park Manager's results of test and proposed remedy if water does not dissipate within 24 hours.

B. Test Hole Depth: 30 inches.

3.02 LOCATION OF PLANTS

A. Locate new planting and stake positions as determined by Cultural Resources Park Manager.

3.03 PREPARATION

A. Planting Soil: Confirm location and quality of stripped topsoil prior to backfilling tree pits.

B. Plants: Place on undisturbed existing soil or well-compacted backfill.

C. Trees and Shrubs:

1. Pits: Excavate with vertical and scarified sides.
2. B & B Trees: Make excavations at least twice as wide as root ball.
3. Container-Grown Stock: Excavate as specified for B & B stock, adjust for size of container width and depth.
4. Fill excavations with water and allow to percolate out prior to planting. Notify Cultural Resources Park Manager if water does not percolate out in 24 hours.

3.04 PLANTING

A. Plant trees, adjust plants with most desirable side facing toward the public's prominent view.

B. B & B Plants: Place in pit by lifting and carrying by its ball (do not lift by branches or trunk). Lower into pit. Set straight and in pit center with tip of rootball 1 to 2 inches above adjacent finish grade.

3.05 BACKFILLING

A. Backfill with existing salvaged planting soil.

B. B & B Plants:

1. Partially backfill pit to support plant. Remove burlap and binding from sides and tops of B & B plants, do not pull burlap from under balls.
2. When excavation is approximately 2/3 full, water thoroughly before placing remainder of backfill to eliminate air pockets even if it is raining. Finish backfilling pit sides.
3. Never cover top of rootball with soil. Form a saucer above existing grade, completely around the outer rim of the plant pit.

3.06 MULCHING

A. Cover planting area of saucer around each plant with 2-inch thick layer of mulch within 2 days after planting. Saturate planting area with water.

3.07 PRUNING AND REPAIR

A. Prune only after planting and in accordance with standard horticultural practice to preserve natural character of the plant. Perform in presence of Cultural Resources Park Manager. Remove all dead wood, suckers, and broken or badly bruised branches. Use only clean, sharp tools. Do not cut lead shoot.

END OF SECTION

SECTION 33 05 01
CONVEYANCE PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Concrete Institute (ACI): 301, Specifications for Structural Concrete.
2. American Water Works Association (AWWA):
   a. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   b. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
   c. C207, Steel Pipe Flanges for Waterworks Service - Sizes 4 in. Through 144 in. (100 mm Through 3,600 mm).
   d. C210 Liquid-Epoxy Coating Systems for the Interior and Exterior of Steel Water Pipelines.
   e. C213, Fusion-Bonded Epoxy Coating for the Interior and Exterior of Steel Water Pipelines.
   f. C217, Petrolatum and Petroleum Wax Tape Coatings for the Exterior of Connections and Fittings for Steel Water Pipelines.
   g. C219, Bolted, Sleeve-Type Couplings for Plain-End Pipe.
   h. C221, Fabricated Steel Mechanical Slip-Type Expansion Joints.
   i. C606, Grooved and Shouldered Joints.
3. ASTM International (ASTM):
   a. A497/A497M, Standard Specification for Steel Welded Wire Reinforcement, Deformed, for Concrete.
   b. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   d. C150/C150M, Standard Specification for Portland Cement.
   e. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings.
2. Product Data.

B. Informational Submittals: Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements.

1.03 DELIVERY, STORAGE, AND HANDLING

A. In accordance with manufacturer's recommendations.

B. Pipe, specials, and fittings received at Project Site in damaged condition will not be accepted.

C. Gasket Storage: Store rubber gaskets in cool, well ventilated place, and do not expose to direct rays of sun. Do not allow contact with oils, fuels, petroleum, or solvents.

D. Store and support pipe securely to prevent accidental rolling and to avoid contact with mud, water, or other deleterious materials.

E. Handling:

1. Pipe shall be handled with proper equipment in a manner to prevent distortion or damage. Use of hooks, chains, wire ropes, or clamps that could damage pipe, damage coating or lining, or kink and bend pipe ends is not permitted.
2. Use heavy canvas, or nylon slings of suitable strength for lifting and supporting materials.
3. Lifting pipe during unloading or lifting into trench shall be done using two slings placed at quarter point of pipe section. Pipe may be lifted using one sling near center of pipe, provided pipe is guided to prevent uncontrolled swinging and no damage will result to pipe or harm to workers. Slings shall bear uniformly against pipe.
4. Pipe and fittings shall not be stored on rocks or gravel, or other hard material that might damage pipe. This includes storage area and along pipe trench.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other

applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 PIPE

A. As specified in the individual specification(s) following this section.

2.03 JOINTS

A. As specified in the individual specification(s) following this section.

2.04 COUPLINGS

A. Physical Characteristics:

1. Coupling linings for use in potable water systems shall be in conformance with NSF/ANSI 61.
2. For Pipe with Plain-Ends:
   a. Bolted, sleeve-type coupling, in accordance with AWWA C219.
   b. Manufacturer of couplings shall observe same quality control requirements as specified in AWWA C221 for fabrication of pipe expansion joints.
   c. Unless thrust restraint is provided by other means, bolted, sleeve-type couplings shall be harnessed. Harness details shall be in accordance with requirements of appropriate reference standard or as shown on the Drawings.
3. Bolting Materials for Couplings: As recommended by coupling manufacturer for specified conditions.

B. Functional Characteristics: To prevent separation of joined pipelines and to minimize damage from surge events.

C. Performance Characteristics: Couplings shall be rated for appropriate operating pressure and hydrostatic test pressure.

2.05 SERVICE SADDLES

A. Refer to Section 33 12 13, Water Service Connections.

2.06 SLAB, FLOOR, WALL, AND ROOF PENETRATIONS

A. Modular Mechanical Seal:

1. Physical Characteristics:
   a. Type: Interconnected synthetic rubber links shaped and sized to continuously fill annular space between pipe and wall sleeve opening.
   b. Assemble interconnected rubber links with Type 316 stainless steel bolts, nuts, and pressure plates.
   c. Size modular mechanical seals according to manufacturer's instructions for the size of pipes shown to provide a watertight seal between pipe and wall sleeve opening.
2. Functional Characteristics: Provide seal around pipe penetration through wall or ceiling.
3. Performance Characteristics: None.

B. Wall Sleeves:

1. Physical Characteristics:
   a. Diameter, ends, and length shall be as shown on the Drawings.
   b. Include integral seep ring.
2. Functional Characteristics: Minimize seepage between metal sleeve and concrete.
3. Performance Characteristics: None.

C. Wall Couplings:

1. Physical Characteristics:
   a. Diameter, ends, and length shall be as shown on the Drawings.
   b. Body and end rings shall be coated with fusion bonded epoxy.
   c. Body shall include integral seep ring.
   d. Shall comply with AWWA C219.
2. Functional Characteristics: Provide flexible mechanical joint.
3. Performance Characteristics: None.

D. If core drilling is required for penetrations of existing concrete walls or slabs, locations of drilling shall be determined by radiograph to avoid damage to reinforcing steel and conduits.

2.07 FLANGES, FLANGE GASKETS, AND BOLTING MATERIALS

A. As specified in individual specifications following this section.

B. Flanges, bolting materials, and flange gaskets for steel flanges shall conform to AWWA C207.

C. Flanges, bolting materials, and flange gaskets for ductile iron flanges shall conform to AWWA C110 and AWWA C115.

D. Stainless steel bolting material shall conform to ASTM F593, Type 304 stainless steel, Group 1, Condition SH1, 2, 3, or 4.

E. If the flanges are coated, provide two washers for each bolt on each side of the flange to minimize damage to the coating as the nuts are tightened. Provide bolts of the proper length to accommodate the washers.

2.08 PIPE LOCATING TAPE

A. As specified in Section 31 23 23.15, Trench Backfill.

2.09 PIPE BEDDING AND PIPE ZONE MATERIAL

A. Granular material or controlled low strength material as specified in Section 31 23 23.15, Trench Backfill.

2.10 TRENCH STABILIZATION MATERIAL

A. As specified in Section 31 23 23.15, Trench Backfill.

2.11 TRACER WIRE

A. Manufacturer and Products:

1. Copperhead Industries.
2. Or equal.

B. Physical Characteristics:

1. Trenched Installation: 12 AWG high strength copper clad steel wire with 450-pound break load minimum and 30-mil HDPE insulation thickness minimum. Blue color to indicate water piping.
2. Directional Drilling Installation: 12 AWG high strength copper clad steel wire with 1,150-pound break load minimum and 45-mil HDPE insulation thickness minimum shall be used. Blue color to indicate water piping.
3. Install direct buried connectors as needed and tracer wire test station every 2,000 feet.

C. Functional Characteristics:

1. To facilitate magnetic detection of wire for utility locating.
2. Tracer wire shall be installed to be able to properly trace all pipelines and appurtenances without loss or deterioration of signal.

D. Performance Characteristics:

1. Magnesium grounding anode to be direct buried.
2. Install tracer wire magnesium grounding anode rated for direct burial, 30 volts with 21 percent, 450-pound break load.

2.12 WATER QUALITY SAMPLING STATION

A. Manufacturers and Products:

1. Mueller hydro-guard sampling station.
2. Or equal.

B. Physical Characteristics:

1. Above ground sampling station with internal curb stop drain freeze protection, self supporting with self locking enclosure.
2. Powder coated aluminum lockable support frame with powder coating for corrosion resistance.

C. Functional Characteristics: Provide sanitary station for collecting water samples for analysis.

D. Performance Characteristics: None.

2.13 PRV ENCLOSURE

A. Manufacturers and Products:

1. Hubbell Hot Box.
2. Or equal.

B. Physical Characteristics:

1. Heated, fiberglass hot box valve enclosure.
2. Color: Beige.
3. Aboveground on concrete pad.

C. Functional Characteristics: Provide aboveground protected enclosure to house valves and piping that can be easily accessed without confined entry.

D. Performance Characteristics: None.

2.14 WATER BOTTLE FILLING STATION

A. Manufacturers and Products:

1. Elkay outdoor ezH20
2. Or equal.

B. Physical Characteristics:

1. Type 316 stainless steel heavy duty vandal resistant.
2. ADA compliant.
3. Suitable for outdoor installation, freeze proof.
4. Free-standing.
5. NSF 61 and NSF 372 compliant.

C. Functional Characteristics: Provide safe drinking water for human consumption with varying physical abilities.

D. Performance Characteristics: None.

PART 3 EXECUTION

3.01 GENERAL

A. Notify Contracting Officer at least 2 weeks prior to field fabrication of pipe or fittings.

B. Furnish feeler gauges of proper size, type, and shape for use during installation for each type of pipe furnished.

C. Distributing Materials: Place materials along trench only as will be used each day, unless otherwise approved by Contracting Officer. Placement of materials shall not be hazardous to traffic or to general public, obstruct access to adjacent property, or obstruct others working in area.

3.02 EXAMINATION

A. Verify size, material, joint types, elevation, and horizontal location of existing pipeline to be connected to new pipeline or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

C. Damaged Coatings and Linings: Repair using coating and lining materials in accordance with manufacturer’s instructions.

3.03 PREPARATION OF TRENCH

A. Prepare trench as specified in Section 31 23 16, Excavation.

B. Unless otherwise permitted by Contracting Officer, maximum length of open trench shall not exceed 50 feet.

3.04 INSTALLATION

A. General:

1. Join pipe and fittings in accordance with manufacturer's instructions, unless otherwise shown or specified.
2. Install individual pipe lengths in accordance with approved lay diagram. Misplaced pipe shall be removed and replaced.
3. Inspect pipe and fittings before installation, clean ends thoroughly, remove foreign matter and dirt from inside.
4. Flanged Joints:
   a. Install perpendicular to pipe centerline.
   b. Bolt Holes: Straddle vertical centerline, aligned with connecting equipment flanges or as shown on the Drawings.
   c. Use torque-limiting wrenches to provide uniform bearing and proper bolt tightness.
   d. Flange Type: Use flat-faced flange when joining with flat-faced ductile or cast iron flange.
5. Couplings:
   a. Install in accordance with manufacturer's written instructions.
   b. Before coupling, clean pipe holdback area of oil, scale, rust, and dirt.
   c. Do not remove pipe coating. If damaged, repair before joint is made.
   d. Clean gaskets before installation.
   e. If necessary, lubricate with gasket lubricant for installation on pipe ends.
   f. Tighten coupling bolts progressively, drawing up bolts on opposite sides gradually until bolts have uniform tightness.

B. Buried Pressure Pipe:

1. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown on the Drawings.
2. Placement:
   a. Keep trench dry until pipe laying and joining is completed.
   b. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
   c. Measure for grade at pipe invert, not at top of pipe.

d. Excavate trench bottom and sides of ample dimensions to permit proper joining, welding, visual inspection, and testing of entire joint.
e. Prevent foreign material from entering pipe during placement.
f. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
g. In general, lay pipe upgrade with bell ends pointing in direction of laying.
h. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
    1) Shorter pipe lengths.
    2) Special mitered joints.
    3) Standard or special fabricated bends.
i. Check gasket position with feeler gauge to assure proper seating.
j. After joint has been made, check pipe alignment and grade.
k. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
l. Prevent uplift and floating of pipe prior to backfilling.

3. Tolerances:
    a. Deflection From Horizontal Line: Maximum 2 inches.
    b. Deflection From Vertical Line: Maximum 1 inch.
    c. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
    d. Horizontal position of pipe centerline on alignment around curves maximum variation of 1 foot from position shown.
4. Cover Over Top of Pipe: Minimum 4 feet, unless otherwise shown.
5. Disposal of Excess Excavated Material: As specified in Section 31 23 16, Excavation.

3.05 THRUST RESTRAINT

A. Location: At pipeline tees, plugs, caps, bends, and locations where unbalanced forces exist.

B. Thrust Blocking:

1. Place only where shown on the Drawings.
2. Quantity of Concrete: Sufficient to cover bearing area of pipe and provide required soil bearing area as shown on the Drawings.
3. Place blocking so pipe and fitting joints are accessible for repairs.
4. Place concrete in accordance with Section 03 30 00, Cast-in-Place Concrete.

3.06 CORROSION PROTECTION

A. Buried Pipe: As specified in the individual specifications following this section.

B. Notify Contracting Officer at least 3 days prior to start of surface preparation, coating application, and corrosion protection work.

3.07 TRACER WIRE INSTALLATION AND TESTING

A. Install tracer wire continuously along centerline of nonmetallic buried piping.

B. Attach wire to top of pipe using tape at maximum of 10-foot intervals. In areas where depth of cover is excessive for allowing detection of tracer wire with electronic pipe locator, install tracer wire within pipe backfill directly above pipe centerline at a minimum depth of 3 feet.

C. Install splices in accordance with manufacturer's instructions for direct bury applications. Tie ends of wire to be joined in a knot as required to reduce tension on splice.

D. Bring tracer wire to surface at each valve box, curb box, vault, air valve, blowoff valve, and hydrant. Tracer wire shall be brought to surface at least every 1,000 feet. If distance between pipe appurtenances exceeds 1,000 feet, install valve box to allow access to tracer wire. Mark valve box cover with the word "TRACER". Coil enough excess tracer wire at each appurtenance to extend wire 12 inches above ground.

E. Test continuity of tracer wire using electronic pipe locator in presence of Contracting Officer prior to paving.

3.08 SAMPLING STATION

A. Install sampling station as shown on details on the Drawings.

3.09 PLACEMENT OF PIPE LOCATING TAPE

A. Place pipe locating tape in accordance with Section 31 23 23.15, Trench Backfill.

3.10 PIPE BEDDING AND ZONE MATERIAL

A. Place pipe bedding and pipe zone material in accordance with Section 31 23 23.15, Trench Backfill.

3.11 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in the individual specification(s) following this section.

3.12 CLEANING AND DISINFECTION

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines with water at 2.5 fps minimum flushing velocity until foreign matter is removed. Dispose of water and flushed foreign matter.

B. If impractical to flush large diameter pipe at 2.5 fps, clean pipe by use of pipe pig as approved by Contracting Officer. Multiple passes of pipe pig may be required to adequately clean line.

C. Remove accumulated debris through blowoffs 2 inches and larger or by removing spools and valves from piping.

D. Disinfection: As specified in Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

END OF SECTION

SECTION 33 05 01.02
DUCTILE IRON PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): T99, Standard Method of Test for the Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
2. American Society of Mechanical Engineers (ASME):
   a. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   b. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
3. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Fittings.
   f. C116/A21.16, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile-Iron and Gray-Iron Fittings for Water Supply Service.
   g. C150/A21.50, Thickness Design of Ductile-Iron Pipe.
   h. C151/A21.51, Ductile-Iron Pipe. Centrifugally Cast, for Water.
   i. C153/A21.53, Ductile-Iron Compact Fittings for Water Service.
   j. C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
   k. C606, Grooved and Shouldered Joints.
4. ASTM International (ASTM):
   a. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   b. A563, Standard Specification for Carbons and Alloy Steel Nuts.
   c. D882, Standard Test Method for Tensile Properties of Thin Plastic Sheeting.
   d. D1330, Standard Specification for Rubber Sheet Gaskets.
   e. D1922, Standard Test Method for Propagation Tear Resistance of Plastic Film and Thin Sheeting by Pendulum Method.

f. D2000, Standard Classification System for Rubber Products in Automotive Applications.
g. D4976, Standard Specification for Polyethylene Plastics Molding and Extrusion Materials.

5. International Organization for Standardization (ISO): 9001, Quality Management Systems – Requirements.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings: Marking plan and details of standard pipe section showing dimensions, pipe joints, fitting and special fitting pressure rating and thickness, size, coating, and lining data.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, stating that inspections and specified tests have been made and that results thereby comply with requirements of Article Source Quality Control.
2. Manufacturer shall furnish sworn certificates that pipe and fittings have been manufactured, tested, and inspected in accordance with this and all applicable Specifications.
3. Field Hydrostatic Testing Plan:
   a. Submit at least 15 days prior to testing and at minimum, include the following:
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Method of isolation.
      4) Method of conveying water from source to system being tested.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.
4. Certifications of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
5. Test documentation form and results.

1.03 QUALITY ASSURANCE

A. Pipe manufacturer shall be ISO 9001 registered or provide the services of an independent inspection agency.

B. Prior to start of manufacturing, manufacturer not meeting or having ISO registration requirements shall submit name of at least two independent inspection agencies for approval.

1. Independent inspection agency shall be responsible, on a daily basis, for sample monitoring of chemical and mechanical tests, sample visual inspection of quality assurance tests performed on in-process pipe and fittings, and sample visual and dimensional inspection on finished products.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers and Products:

1. U.S. Pipe; TR Flex and HP Lok.
2. Or equal.

B. General:

1. Ductile iron pipe shall be manufactured, lined, coated, and tested domestically in the United States of America.
2. Ductile iron fittings shall be manufactured, lined, coated, and tested domestically in the United States of America.
3. Pipe and fittings shall be new and recently manufactured. Refurbished pipe and fittings shall not be provided.
4. Pipe manufacturer shall certify source manufacturing facility has been producing ductile iron pipe of the specified diameters, pressure, dimensions and standards for a period of not less than 10 years.
5. Ductile iron pipe and fitting shall be supplied by a single manufacturer.
6. Mixing of components and sources is not permitted.

C. Physical Characteristics:

1. Pipe:
   a. Lined and coated as specified.
   b. Centrifugally cast, grade 60-42-10 iron.
2. Fittings:
   a. Mechanical, Push-on, Flanged, or Restrained Joint ductile iron fittings.
   b. Rubber Gasket Joints.
   c. Lining: Cement mortar.
   d. Coating: Manufacturer’s Standard Bitumastic and Polyethylene Encasement.
3. Coating: Asphaltic type, 1 mil thick.

4. Polyethylene Encasement:
   a. Film: 0.008 inch (8 mil) thick, minimum.
      1) Number of Film Layers: Two.
5. Bolting:
   a. Flanged Connection Bolts: Carbon steel.
   b. Grooved End Connections Bolts: Manufacturer's standard.

D. Functional Characteristics: None.

E. Performance Characteristics:

1. Pipe:
   a. Meet requirements of AWWA C150/A21.50, AWWA C151/A21.51, and AWWA C111/A21.11.
   b. Pressure rating of pipe from 4 inches to 24 inches in diameter shall be 350 psi.
   c. Pipe wall thickness of threaded pipe for a flanged pipe end shall be minimum special thickness Class 53 from 12-inch to 54-inch diameter pipe in accordance with AWWA C115/A21.15.
   d. Grooved end pipe shall be minimum Special Class 53.
2. Joints:
   a. Push-On Joint: Rated at minimum working pressure equal to pipe material design.
   b. Restrained Joint: Manufactured proprietary joint that mechanically restrains pipe to adjoining pipe.
   c. Mechanical Wedge Action Type Joint:
      1) Use only in areas where adjoining to fixed points where laying length is determined in field.
      2) Prior to purchase and installation, type and application of this joint shall be approved by Contracting Officer.
   d. Use of set screws for restraint or field-lock gaskets shall not be allowed.
3. Fittings:
   a. Mechanical, Push-On, Flanged, or Restrained Joint:
      1) In accordance with the following table:

Minimum Pressure Ratings for AWWA C110/A21.10 and C115/A21.15 Ductile Iron Fittings		
Diameter (inches)	**Rubber Gasket Joints (Push-on, Mechanical, Restrained) (psi)**	**Flanged Joints (psi)**
3 to 24	350	250
30 to 48	250	250

Minimum Pressure Ratings for AWWA C153/A21.53 Ductile Iron Fittings		
Diameter (inches)	**Rubber Gasket Joints (Push-on, Mechanical, Restrained) (psi)**	**Flanged Joints**
3 to 24	350	Not included in C153/A21.53 (refer to the C110/A21.10 Standard)
30 to 48	250	Not included in C153/A21.53 (refer to the C110/A21.10 Standard)
54 to 64	150	150 psi

b. Rubber Gasket Joints Including Mechanical Joints, Push-On Joints, and Flanged Joints: In accordance with AWWA C111/A21.11.
c. Mechanical Joint Fittings: In accordance with AWWA C110/A21.10 and AWWA C153/A21.53.
d. Must meet requirements of NSF 61.

4. Welded Outlet: Only weld to pipe in manufacturer's shop.
5. Lining: Pipe and fittings for clean water applications shall be cement-lined and asphaltic seal coated in accordance with AWWA C104/A21.4.
6. Coating: Asphaltic type, in accordance with AWWA C151/A21.51, AWWA C115/A21.15, AWWA C110/A21.10, and AWWA C153/A21.53.
7. Polyethylene Encasement:
   a. Virgin polyethylene raw material conforming to requirements of ASTM D4976.
   b. Elongation: 800 percent, minimum, in machine and transverse direction (ASTM D882).
   c. Tensile Strength: 3,600 psi, minimum.
   d. Dielectric Strength: 800V per mil-thickness, minimum.
   e. Propagation Tear Resistance: 2,550-gram force (gf), minimum, in machine and transverse direction (ASTM D1922).
   f. Tube Form: Conform to AWWA C105/A21.5.
8. Bolting:
   a. Flanged Connection Bolts: Carbon steel, ASTM A307, Grade A hex bolts and ASTM A563, Grade A hex head nuts.
   b. Grooved End Connections Bolts: Manufacturer's standard.

9. Gaskets:
    a. Flat Faced Flange Gaskets:
        1) Pipe Smaller than 54 Inches: Rated for working pressure 150 psi to 250 psi, 1/8-inch thick, red rubber (SBR), hardness 80 (Shore A), rated to 200 degrees F, conforming to ASME B16.21, AWWA C207, and ASTM D1330, Grade 1 and Grade 2.
        2) Grooved End Joint Gaskets: Halogenated butyl, conforming to ASTM D2000 and AWWA C606.

2.02 SOURCE QUALITY CONTROL

A. Factory Tests:

1. General:
    a. Tests shall be performed on pipe with metal thickness equal to that specified.
    b. Only pipe that passes leak test shall be shipped.
2. Hydrostatic Proof Test:
    a. All Pipe: Perform at 500 psi for a minimum duration of 10 seconds.
    b. Pipe 30 Inches and Larger: Additionally test to 75 percent of minimum yield strength during test duration which shall not be less than 15 seconds.
    c. Record each test cycle on a strip chart.
    d. Each test cycle for 30-inch and larger pipe shall be marked by pipe number.
    e. Inspect each pipe during testing for leaks.
    f. Pipe which shows evidence of leaks shall be scrapped.
    g. Repair welding of leaks is not permitted.
3. Perform a 15-psi air test on welded-on outlet pipe.
4. Pipe ends (spigot end, bell and socket) shall be gauged with suitable gauges at sufficiently frequent intervals to ensure compliance to standard dimensions of AWWA C151/A21.51.
    a. In addition, each socket and spigot shall be inspected in a well lighted area for injurious defects which could affect the joint performance.
    b. Remove defects by cutting of pipe ends.
    c. Pipe with injurious defects in the bell shall be scrapped.
    d. Manufacturer shall have a recommended ovality tolerance for pipes 18 inches inch and larger.
    e. Each end of each 18-inch and larger pipe shall be measured and approved by manufacturer’s quality assurance inspector to meet tolerances.

5. Submit a certified inspection report from the independent agency of witnessed tests within 10 days of the inspection.
    a. Test results shall show restrained joints in the sizes specified have been successfully tested to at least twice the specified pressure rating of the joint without leakage or failure.
6. In accordance with AWWA C104/A21.4, AWWA C110/A21.10, AWWA C111/A21.11, AWWA C115/A21.15, AWWA C151/A21.51, AWWA C153/A21.53, and AWWA C606.

PART 3 EXECUTION

3.01 EXAMINATION

A. Inspect pipe and fittings to ensure no cracked, broken, or otherwise defective materials are being used.

3.02 PREPARATION

A. Trench Grade:

1. When specified, grade bottom of trench by hand to specified line and grade with proper allowance for pipe thickness and pipe base. Trench bottom shall form a continuous and uniform bearing and support for pipe between bell holes.
2. Before laying each section of pipe, check grade and correct irregularities found. Grade may be disturbed for removal of lifting tackle.

B. Pipe Bedding:

1. Place and compact pipe bedding material as follows:
    a. Install to full width of trench, from the following depths below bottom to springline of pipe:
        1) Pipe 12-Inch Diameter: 4 inches to 6 inches.
        2) Pipe Larger than 12-Inch Diameter: 6 inches to 8 inches.
    b. Compact to at least 95 percent of its maximum density as determined by AASHTO T99.
    c. Ensure that no unfilled or uncompacted areas occur beneath pipe.

C. Bell (Joint) Holes: At each joint, dig bell holes of ample dimensions in bottom of trench, and at sides where necessary, to permit joint to be made properly and to permit easy visual inspection of entire joint.

3.03 INSTALLATION

A. General:

1. Provide and use proper implements, tools, and facilities for safe and proper prosecution of the Work.
2. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of a crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings and linings.
3. Do not drop or dump pipe materials into trench.

B. Cleaning Pipe and Fittings:

1. Remove lumps, blisters, and excess coal tar coating from bell and spigot ends of each pipe. Wire brush outside of spigot and inside of bell and wipe clean, dry, and free from oil and grease before pipe is laid.
2. Wipe ends of mechanical joint pipe and fittings and of rubber gasket joint pipe and fittings clean of dirt, grease, and foreign matter.

C. Laying Pipe:

1. Direction of Laying: Lay pipe with bell end facing in direction of laying. For lines on an appreciable slope, face bells upgrade at discretion of Contracting Officer.
2. Mechanical Joint, Push-On Joint, and Restrained Joint Pipe: After first length of pipe is installed in trench, secure pipe in place with approved backfill material tamped under and along sides to prevent movement. Keep ends clear of backfill. After each section is jointed, place backfill as specified to prevent movement.
3. Take precautions necessary to prevent floating of pipe prior to completion of backfill operation.
4. When using movable trench shield, take necessary precautions to prevent pipe joints from pulling apart when moving shield ahead.
5. Do not allow foreign material to enter pipe while it is being placed in trench.
6. Close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints when laying operations are not in progress, at close of day’s work, or whenever workers are absent from job.

D. Joining Push-On Joint Pipe and Mechanical Joint Fittings:

1. Join pipe with push-on joints and mechanical joint fittings in accordance with manufacturer’s recommendations.
2. Provide special tools and devices, such as, special jacks, chokers, and similar items required for installation.

3. Lubricate pipe gaskets using lubricant furnished by pipe manufacturer. No substitutes will be permitted.
4. Clean ends of fittings of dirt, mud, and foreign matter by washing with water and scrubbing with a wire brush, after which, slip gland and gasket on plain end of pipe. If necessary, lubricate end of pipe to facilitate sliding gasket in place, then guide fitting onto spigot of pipe previously laid.

E. Ball Joint Pipe:

1. Assemble and install in accordance with manufacturer's recommendations.
2. Hydrostatic Test:
   a. Conduct on ball joint pipe independent of other pipe systems/type being installed.
   b. Conduct test in accordance with requirements of these Specifications and manufacturer's recommendations.

F. Cutting Pipe:

1. General: Cut pipe for inserting valves, fittings, or closure pieces in a neat and workmanlike manner without damaging pipe or lining and so as to leave a smooth end, at right angles to axis of pipe.
2. Pipe: Cut pipe with milling type cutter or saw. Do not flame cut.
3. Dressing Cut Ends: Dress cut end of mechanical joint pipe to remove sharp edges or projections, which may damage rubber gasket. Dress cut ends of push-on joint pipe by beveling, as recommended by manufacturer.

G. Field Welding:

1. Use of field welded outlets will not be allowed. Welding for outlets shall be performed only in pipe manufacturer's shop.
2. Field installed outlets may be installed with saddle approved by Contracting Officer. Opening in pipe shall be machined cut and not with cutting torch.
3. Field welding of bars for restrained joint systems will not be allowed unless approved by Contracting Officer. Welding shall be performed in pipe manufacturer's shop.

H. Line and Grade:

1. Minimum Pipe Cover: 3 feet, unless otherwise indicated.
2. No high points will be allowed between air valves.
3. Maintain pipe grade between invert elevations to provide minimum clearance at air valve locations of 4 feet from existing ground surface to top of pipe.

4. Install air valves as shown and field verify intervening low points. When field conditions warrant, exceptions may be made upon approval of Contracting Officer.
5. Deviations exceeding 6 inches from specified line or 1 inch from specified grade will not be allowed without express approval of Contracting Officer.
6. Pipeline sections that are not installed to elevations shown or installed as approved by Contracting Officer shall be reinstalled to proper elevation.

I. Thrust Restraint: Primary method of restraint shall be through use of restrained joint pipe. Thrust blocking shall be used where detailed on the Drawings and as approved by Contracting Officer.

J. Backfill for Pipe Zone:

1. Place and compact pipe zone material in accordance with Section 31 23 23.15, Trench Backfill, and as follows:
   a. After pipe bedding is in place, place imported granular material at approximately same rate on each side of pipe.
   b. Place such that backfill elevation of is approximately equal on each side of pipe at all times.
   c. Place to the following depths:
      1) 12-Inch Diameter Pipe: 4 inches to 6 inches above top of pipe barrel.
      2) Pipe Larger than 12 Inches in Diameter: 6 inches to 12 inches above top of pipe barrel.
   d. Compact material to top of pipe zone in 6-inch lifts, to at least 95 percent of its maximum density, as determined by AASHTO T99.

K. Polyethylene Encasement:

1. Encase pipe, fittings, and valves where specified in accordance with AWWA C105/A21.5, Method A.
2. Cut polyethylene tube approximately 2 feet longer than pipe length.
3. Slip tube around pipe, centering to provide 1-foot overlap on each adjacent section.
4. Pull encasement to take out slack and wrap snug around pipe.
5. Secure overlap in place and fold at quarter points of pipe length.
6. Wrap and tape encasement snug around fittings and valves.

3.04 HYDROSTATIC TESTING

A. Pipeline Hydrostatic Test:

1. General:
   a. Notify Contracting Officer in writing 5 days in advance of testing. Perform testing in presence of Contracting Officer.
   b. Test newly installed pipelines. Using water as test medium, pipes shall successfully pass a leakage test prior to acceptance.
   c. Furnish testing equipment and perform tests in manner satisfactory to Contracting Officer. Testing equipment shall provide observable and accurate measurements of leakage under specified conditions.
   d. Isolate new pipelines that are connected to existing pipelines.
   e. Conduct tests on entire pipeline after trench has been backfilled. Testing may be done prior to placement of asphaltic concrete or roadway structural section.
   f. Contractor may, if field conditions permit and as determined by Contracting Officer, partially backfill trench and leave joints open for inspection and conduct an initial service leak test. Hydrostatic test shall not, however, be conducted until backfilling has been completed.
   g. Supply of temporary water shall be as stated in Section 01 50 00, Temporary Facilities and Controls.
   h. Dispose of water used in testing.
2. Procedure:
   a. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on the full area of pipe.
   b. Expel air from pipe system during filling. Expel air through air release valve or through corporation stop installed at high points and other strategic points.
   c. Test pressure shall be 100 psi above system operating pressure.
   d. Test pressure shall be 125 percent of system operating pressure.
   e. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
   f. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional make-up water only as necessary to restore test pressure.
   g. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
   h. If measured leakage exceeds allowable leakage or if leaks are visible, repair defective pipe section and repeat hydrostatic test.
3. Allowable Leakage: Allowable leakage is zero, except as approved by the Contracting Officer.

END OF SECTION

SECTION 33 05 01.09
POLYVINYL CHLORIDE (PVC) PRESSURE PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C110, Ductile-Iron and Gray-Iron Fittings.
   b. C153, Ductile-Iron Compact Fittings, for Water Service.
   c. C605, Underground Installation of Polyvinyl Chloride (PVC) and Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe and Fittings.
   d. C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 Inches Through 12 Inches (100 mm Through 300 mm), for Water Transmission and Distribution.
   e. C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 Inches through 48 Inches (350 mm through 1,200 mm) for Water Transmission and Distribution.
   f. C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 Inches through 12 Inches (100 mm Through 300 mm), for Water, Wastewater, and Reclaimed Water Service.
2. ASTM International (ASTM):
   a. D2241, Standard Specification for Polyvinyl Chloride (PVC) Pressure-Rated Pipe (SDR Series).
   b. D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.
   c. D2466, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 40.
   d. D2467, Standard Specification for Polyvinyl Chloride (PVC) Plastic Pipe Fittings, Schedule 80.
   e. D2672, Standard Specification for Joints for IPS PVC Pipe Using Solvent Cement.
   f. D2855, Standard Practice for Making Solvent-Cemented Joints with Polyvinyl Chloride (PVC) Pipe and Fittings.
   g. D3139, Standard Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
3. NSF International (NSF).

1.02 SUBMITTALS

A. Action Submittals: Shop Drawings showing pipe diameter, allowable deflection angle, pipe class, dimension ratio (DR), and fitting details.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements.
2. Hydrostatic Testing Plan: Submit at least 15 days prior to testing and at minimum, include the following:
   a. Testing dates.
   b. Piping systems and section(s) to be tested.
   c. Method of isolation.
   d. Method of conveying water from source to system being tested.
   e. Method of disposing of test water.
   f. Calculation of maximum allowable leakage for piping section(s) to be tested.
3. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
4. Test report documentation.

1.03 DELIVERY, STORAGE, AND HANDLING

A. Solvent Cement: Store in accordance with ASTM D2855.

PART 2 PRODUCTS

2.01 MATERIALS

A. Manufacturers and Products:

1. Pipe:
   a. JM Eagle Blue Brute.
   b. Or equal.
2. Fittings: As specified in Ductile Iron Pipe and Fittings Specification, Section 33 05 01.02, Ductile Iron Pipe and Fittings.
3. Restrained Mechanical Joints at Fittings:
   a. Restrain mechanical joint fittings with a restraint designed specifically for PVC pipe.
      1) Sizes 4 Inches to 36 Inches:
         a) EBAA IRON, Series 2000PV Megalug.
         b) Or equal.

4. Restraints at Push-On Pipe Joints: Restrain push-on gasketed joints with a restraint harness designed specifically for PVC pipe.
    a. Sizes 4 Inches to 12 Inches:
        1) EBAA IRON, Series 1900 Restraint Harness.
        2) Or equal.
    b. Sizes 14 Inches to 36 Inches:
        1) EBAA IRON, Series 2800 Restraint Harness.
        2) Or equal.

B. Physical Characteristics:

1. Pipe:
    a. PVC.
    b. DR shall be 18, unless otherwise shown on the Drawings.
    c. Must be blue in color.
2. Joints: Rubber gasketed.
3. Fittings: As specified in ductile iron pipe and fittings specification, Section 33 05 01.02, Ductile Iron Pipe and Fittings.
4. Service Saddles: See Section 33 12 13, Water Service Connections.
5. Restrained Joints:
    a. Mechanical Joint:
        1) Nominal pipe sizes 3 inches through 36 inches shall consist of multiple gripping wedges incorporated into a follower gland.
        2) Gland body, wedges and wedge actuating components shall be cast from Grade 65-45-12 ductile iron material and coated.
    b. Push-on Joint:
        1) A restraint ring, incorporating a plurality of individually-actuating gripping surfaces, shall be used to grip the pipe, and a sufficient number of bolts shall be used to connect the bell ring and the gripping ring.
        2) A split serrated ring shall be used to grip the plain-end of the pipe. A split serrated ring shall also be used to grip the barrel of the pipe behind the PVC bell.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Pipe:
    a. Conforming to requirements of AWWA C900.
    b. Pipe to be used for potable water conveyance shall meet the requirements of NSF 61.
2. Joints: Conform to AWWA C900.

3. Fittings:
   a. Ductile iron mechanical joint, as specified in ductile iron pipe and fittings specification, Section 33 05 01.02, Ductile Iron Pipe and Fittings and designed for thrust restraint with wedge and gland follower per the following requirements.
   b. Shall meet NSF 61 requirements.
4. Service Saddles: See Section 33 12 13, Water Service Connections.
5. Restrained Joints:
   a. Provide pipe restraint, where indicated on the Drawings, by system designed specifically for use with PVC pipe using wedges. Do not use systems with set screws, gripper rings, or gripper gaskets.
   b. Mechanical joint restraint consisting of multiple gripping wedges, incorporated into a follower gland meeting applicable requirements of AWWA C110 and in accordance with ASTM A536.
   c. Minimum Pressure Rating:
      1) Pipe Sizes 4 Inches to 16 Inches: 235 psi.
      2) Pipe Sizes 18 Inches and Larger: 200 psi.
   d. Coating: All wedge assemblies and related parts shall be processed through a phosphate wash, rinse, and drying operation prior to coating application. The coating shall consist of a minimum of two coats of liquid thermoset epoxy coating with heat cure to follow each coat.
   e. All casting bodies shall be surface pretreated with a phosphate wash, rinse, and sealer before drying. The coating shall be electrostatically applied, and heat cured. The coating shall be a polyester based powder to provide corrosion, impact, and UV resistance.

PART 3 EXECUTION

3.01 INSTALLATION

A. In accordance with AWWA C605 and AWWA Manual 23.

B. Solvent cement used for joints as recommended by pipe manufacturer.

C. Joints:

1. Rubber Gasketed: In accordance with manufacturer’s written instructions.
2. Solvent Cemented: In accordance with ASTM D2855.
3. Restrained Joint Systems: In accordance with manufacturer’s written instructions.

D. Pipe Bending for Horizontal or Vertical Curves:

1. Bending of pipe barrels larger than 12 inches in diameter is not allowed.
2. Radius of curves shall not exceed 75 percent of manufacturer's recommended values.
3. Use blocks or braces at pipe joints to ensure axial deflection in gasketed or mechanical joints does not exceed allowable deflection.

E. Maximum Joint Deflection:

1. Deflect PVC pipe alignment at locations indicated on the Drawings.
2. Use solid sleeve or high deflection stop couplings for changes in alignment up to 5 degrees. Bell-spigot joints may be deflected up to 75 percent of the manufacturer's allowable deflection angle, if one is included on the print line of the pipe. Longitudinal bending of the pipe is not permitted.

3.02 INSPECTION AND HYDROSTATIC TESTING

A. General:

1. Notify Contracting Officer in writing at least 5 days in advance of testing. Perform testing in presence of Contracting Officer.
2. Using water as test medium, all newly installed pipelines must successfully pass hydrostatic leakage test prior to acceptance.
3. Conduct field hydrostatic test on buried piping after trench has been completely backfilled and compacted. Testing may, as approved by Contracting Officer, be done prior to placement of asphaltic concrete or roadway structural section.
4. Contractor may, if field conditions permit and as approved by Contracting Officer, partially backfill trench and leave joints open for inspection and conduct an initial informal service leak test. Final field hydrostatic test shall not, however, be conducted until backfilling has been completed as specified above.
5. Supply of Temporary Water: In accordance with Section 01 50 00, Temporary Facilities and Controls.
6. Dispose of water used in testing in accordance with federal, state, and local requirements.
7. Install temporary thrust blocking or other restraint as necessary to prevent movement of pipe and protect adjacent piping or equipment. Make necessary taps in piping prior to testing.
8. Wait a minimum of 5 days after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.

9. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
10. New Piping Connected to Existing Piping:
    a. Isolate new piping with grooved-end pipe caps, blind flanges, or other means as acceptable to Contracting Officer.
    b. Provide appropriate thrust blocking.

B. Hydrostatic Testing Procedure:

1. Furnish testing equipment, as approved by Contracting Officer, which provides observable and accurate measurements of leakage under specified conditions.
2. Maximum Filling Velocity: 0.25 foot per second calculated based on full area of pipe.
3. Expel air from piping system during filling.
4. Test Pressure: 125 percent of system operating pressure. Operating pressure between Blue Tank to Entrance Rd Tank is 146 psi and between Entrance Rd Tank to Visitor Center Canyon Area is 162 psi.
5. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
6. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding make-up water only as necessary to restore test pressure to within 5 psi of specified hydrostatic test pressure.
7. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

C. Maximum Allowable Leakage:

$$L = \frac{ND(P)^{1/2}}{7400}$$

where:

L = Allowable leakage, in gallons per hour.
N = Number of joints in tested line.
D = Nominal diameter of pipe, in inches.
P = Average test pressure during leakage test, in pounds per square inch.

END OF SECTION

SECTION 33 05 01.12
GRAVITY SEWER PIPE AND FITTINGS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C105, Polyethylene Encasement for Ductile Iron Pipe Systems.
   b. C110, Ductile-Iron and Gray-Iron Fittings.
   c. C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   d. C205, Cement-Mortar Protective Lining and Coating for Steel Water Pipe - 4 in. (100 mm) and Larger - Shop Applied.
   e. C208, Dimensions for Fabricated Steel Water Pipe Fittings.
   f. C302, Reinforced Concrete Pressure Pipe, Noncylinder Type.
2. ASTM International (ASTM):
   a. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   b. A746, Standard Specification for Ductile Iron Gravity Sewer Pipe.
   c. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
   d. C150, Standard Specification for Portland Cement.
   e. C361, Standard Specification for Reinforced Concrete Low-Head Pressure Pipe.
   f. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
   g. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
   h. C596, Test Method for Drying Shrinkage of Mortar Containing Hydraulic Cement.
   i. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
   j. D16, Standard Terminology for Paint, Related Coatings, Materials, and Applications.
   k. D1248, Standard Specification for Polyethylene Plastics Extrusion Materials for Wire and Cable.
   l. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
   m. D2241, Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series).

n. D2412, Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading.
o. D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
p. D3212, Standard Specification for Joints For Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
q. D3262, Standard Specification for “Fiberglass” (Glass-Fiber Reinforced Thermosetting-Resin) Sewer Pipe.
r. D4161, Standard Specification for “Fiberglass” (Glass-Fiber Reinforced Thermosetting-Resin) Pipe Joints using Flexible Elastomeric Seals.
s. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special inspection.
t. F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
u. F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.

1.02 DEFINITIONS

A. CCTV: Closed-Circuit Television.

B. DIP: Ductile Iron Pipe.

C. GRP: Glass-Fiber-Reinforced Thermosetting-Resin Pipe.

D. Pipe Stiffness Classification: Referred to as SN.

E. Pressure Class: Referred to as PN.

F. PVC: Polyvinyl Chloride Pipe.

G. RCP: Reinforced Concrete Pipe.

H. SDR: Standard Dimension Ratio.

I. VCP: Vitrified Clay Pipe.

1.03 SUBMITTALS

A. Action Submittals: Shop Drawings showing pipe diameter, pipe class, dimension ratio (DR), gasket polymer properties, and fitting details.

B. Informational Submittals:

1. Certificates:
   a. Manufacturer's Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements, that products furnished meet requirements of this section.
   b. Certification of Calibration: Approved testing laboratory certificate if pressure gauge for hydrostatic test has been previously used. If pressure gauge is new, no certificate is required.
   c. Certified statement from manufacturer of gaskets, setting forth that basic polymer used in gaskets and test results of physical properties of compound are in accordance with ASTM F477 for PVC pipe.
2. Manufacturer's written recommendations for pipe handling and installation.
3. Field Leakage Testing Plan:
   a. Submit at least 15 days in advance of testing and include at least the following:
      1) Testing dates.
      2) Piping systems and sections to be tested.
      3) Test type.
      4) Method of isolation.
      5) Method of conveying water from source to system being tested.
      6) Calculation of maximum allowable leakage for piping section(s) to be tested.
      7) Method for disposal of test water, if applicable.
4. CCTV inspection equipment in accordance with this section.
5. Leakage test results.
6. Pipe deflection test results.
7. CCTV inspection in accordance with this section.

1.04 QUALIFICATIONS

A. In accordance with this section.

PART 2 PRODUCTS

2.01 PIPING

A. Physical Characteristics:

1. 15 inch Diameter and Under: ASTM D3034, SDR 26 except that cell classification shall be 12454-B or 12454-C as defined in ASTM D1784.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.02 JOINTS

A. Physical Characteristics: Integral bell and spigot, in accordance with ASTM D3212.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.03 GASKETS

A. Physical Characteristics: ASTM F477 factory fabricated rubber compression type with solid cross section.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.04 GASKET LUBRICANT

A. Physical Characteristics: Lubricant shall be supplied by pipe manufacturer.

B. Functional Characteristics: Lubricant shall reduce friction and prevent premature wear of sealing components.

C. Performance Characteristics: Lubricant shall be chemically compatible with gasket material and adjacent joining pipe.

2.05 PLUGS

A. Removable. Removal shall provide a socket suitable for making a flexible jointed lateral connection or extension.

2.06 LATERAL SERVICE CONNECTION PIPE AND FITTINGS

A. As specified on Piping Data Sheet located at the end of this section as Supplement.

B. Manufacturers and Products:

1. Harrington Corp.
2. Or equal.

C. Physical Characteristics:

1. Shall conform to the requirements of ASTM D3034, ASTM F1336, ASTM D3212, ASTM F477 and ASTM F679, as applicable.
2. New service laterals to new sewer main connection: Gasketed SDR 26 PVC wyes.
3. New service lateral to existing sewer main connection: Gasketed SDR 26 PVC wye saddle with SS straps.
4. Use one type of service connection pipe material throughout. No interchanging of pipe and fittings allowed.
5. Size as shown on the Drawings.

D. Functional Characteristics: Provide sealed connection between sewer service lateral and sewer main collection system.

E. Performance Characteristics: None.

2.07 PIPE FOR WATERLINE CROSSINGS

A. PVC Pressure Pipe: Conform to AWWA C900 or AWWA C905 (DR18). See Section 33 05 01.09, Polyvinyl Chloride Pressure Pipe and Fittings.

2.08 PIPE TO MANHOLE CONNECTOR

A. As specified in Section 33 05 13, Manholes.

2.09 FLEXIBLE COMPRESSION COLLAR

A. Manufacturers and Products:

1. Fernco Inc.
2. Or equal.

B. Physical Characteristics: Mechanical joint coupling with No. 305 stainless steel bands.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.10 CONCRETE ANCHOR

A. Where the slope of a sewer line is in excess of 20 percent, provide push-on or mechanical joint ductile iron pipe with concrete anchors at each joint.

PART 3 EXECUTION

3.01 EXAMINATION

A. Notify Contracting Officer immediately of manufacturing imperfections or damage caused by improper handling.

B. Verify size, pipe condition, and pipe class prior to installation of pipe.

C. Repairs to RCP pipe section will be allowed only if approved, in writing, by Contracting Officer. Damaged pipe which, in opinion of Contracting Officer, cannot be repaired, will be rejected and removed from Project Site.

3.02 PREPARATION

A. Pipe Distribution: Do not distribute more than 1 week's supply of materials in advance of laying, unless otherwise approved by Contracting Officer.

B. Inspect pipe and fittings prior to lowering into trench to ensure no cracked, broken, or otherwise defective materials are being used.

C. Remove foreign matter and dirt from inside of pipe and fittings and keep clean during and after laying. Wash ends of section clean with wet brush prior to joining sections of pipe.

3.03 INSTALLATION

A. General:

1. Install pipe sections in accordance with manufacturer's recommendations.
2. Provide and use proper implements, tools, and facilities for safe and proper prosecution of Work.
3. Lower pipe, fittings, and appurtenances into trench, piece by piece, by means of crane, slings, or other suitable tools and equipment, in such a manner as to prevent damage to pipe materials, protective coatings, and linings. Do not drop or dump pipe into trenches.

B. Line and Grade:

1. Establish line and grade for pipe by use of lasers.
2. Measure for grade at pipe invert, not at top of pipe.
3. Do not deviate from line or grade, as shown on the Drawings, more than 1/2 inch, provided that such variation does not result in a level or reverse sloping invert.

C. Laying and Jointing:

1. Use gasket lubricant as recommended by gasket manufacturer.
2. Lay pipe upgrade with bell ends pointing in direction of laying.
3. When field cutting or machining pipe is necessary, use only tools and methods recommended by pipe manufacturer and approved by Contracting Officer.
4. After section of pipe has been placed in its approximate position for jointing, clean end of pipe to be joined, inside of joint, and rubber ring immediately before joining pipe.
5. Assemble joint in accordance with recommendations of manufacturer.
6. Apply sufficient pressure in making joint to assure that joint is correctly assembled as defined in standard installation instructions provided by pipe manufacturer. Inside joint space shall not exceed 50 percent of pipe manufacturer's recommended maximum allowance.
7. Place pipe to specified line and grade to form smooth flow line.
8. Ensure that bottom of pipe is in contact with bottom of trench for full length of each section.
9. Check for alignment and grade after joint has been made.
10. Place sufficient pipe bedding material to secure pipe from movement before next joint is installed.
11. When pipe is laid within movable trench shield, take precautions to prevent pipe joints from pulling apart when moving shield ahead.
12. When laying operations are not in progress, and at close of day's work close and block open end of last laid section of pipe to prevent entry of foreign material or creep of gasketed joints.
13. Take precautions to prevent "uplift" or floating of line prior to completion of backfill operation.
14. Connections between one pipe material and another shall be by means of flexible compression collar, installed in accordance with manufacturer's recommendations, or concrete closure collar.

D. Gasketed Joint Protection:

1. Point interior joints with openings greater than 3/8 inch on 24-inch and larger concrete pipe. Point (fill with joint cement mortar) 360 degrees of circumference. Quick setting grout may be substituted for joint cement mortar when approved by Contracting Officer.
   a. Thoroughly clean joint of lubricant materials and dirt.
   b. Prewet joint before applying mortar.
   c. Pointing shall be done in such a manner that there are no bulges, ridges, or other irregularities.
   d. Pointing shall be flush with interior of pipe.
   e. Do not point joints closer than three pipe joints from next pipe section to be placed.

E. Connection to Structure or Manhole:

1. Locate standard pipe joint within 1.5 feet of outside face of structure for pipe 18 inches and smaller and within one pipe diameter for pipe 21 inches and larger.
2. Plug or close off pipe stubbed with watertight plug.
3. Connect pipe to manhole with pipe to manhole connector in accordance with manufacturer's recommendations.

F. Crossing Waterlines: Where sewer crosses less than 18 inches below waterline, use ductile iron or PVC pressure pipe for crossing or encase in concrete envelope for a minimum distance of 9 feet on each side of waterline.

G. Ductile Iron Pipe:

1. Cutting and Dressing of Ductile Iron Pipe Ends:
   a. Cut at right angles to centerline of pipe to leave smooth end, without damage to pipe.
   b. Use only approved mechanical cutter.
   c. Taper cut end of pipe to be used with rubber gasket joints by grinding or filing 1/8 inch back at an angle of approximately 30 degrees with centerline of pipe.
   d. Remove sharp or rough edges.
   e. Abrade cut ends with grinding wheel and apply lining repair material. Use only compatible repair materials provided by pipe lining manufacturer. Allow repair lining to harden and cure before installation.
2. Polyethylene Wrap:
   a. Before installing wrap, clean pipe exterior of foreign material.
   b. Cut wrap approximately 2 feet longer than pipe section.
   c. Overlap wrap approximately 1 foot; seal joints with adhesive tape.
   d. Tape entire circumference of pipe at 3-foot intervals along pipe.
   e. Repair rips, punctures, or other damage to polyethylene with adhesive tape.
   f. When fittings cannot be practically wrapped in a tube, use a flat sheet or split tube of polyethylene. Securely tape seams.

3.04 CONCRETE CLOSURE COLLAR

A. Use only when approved by Contracting Officer, and then only to make connections between dissimilar pipe or where standard rubber gasketed joints or flexible compression collars are impractical or unavailable.

B. Procedure:

1. Remove water from excavation. Placement of concrete in standing water will not be allowed.

2. Wash pipe to remove loose material.
3. Wrap and securely fasten light gauge sheet metal or building felt around pipe joint to ensure that concrete does not enter line.
4. Wet nonmetallic pipe thoroughly prior to concrete placement.
5. Placement shall be monolithic for each collar.
6. Place to minimum 6 inch thickness around outside diameter of pipe.
7. Extend concrete minimum of 12 inches on each side of joint.
8. Cure concrete, after initial set, by covering with well moistened earth.

3.05 SERVICE CONNECTION TEES

A. Install prior to leakage testing.

B. Install caps or plugs on tees.

C. Install approved tee outlets with gasketed type joint or adapter to join service connection pipe.

D. Concrete encase tees in trenches deeper than 12 feet. Do not encase joints at ends of tee fitting.

E. Install services to right-of-way line or as shown on the Drawings.

3.06 SERVICE CONNECTION INSTALLATION

A. In general, service connections shall extend to street or alley right-of-way line, easement line, or as directed by Contracting Officer.

B. Minimum Slope: 1/4 inch per foot.

C. Progress of Construction: Unless otherwise approved by Contracting Officer, install service connection not more than 5 days after backfilling of sewer trench in block or equivalent 400-foot section of sewer.

D. Laying and Jointing of Service Connection Pipe and Fittings:

1. Maximum deflection permissible with any one fitting shall not exceed 45 degrees, except by permission of Contracting Officer.
2. Make service connection to sewer system at manhole when directed by Contracting Officer. Where service connection pipe is connected to manhole or concrete structure, make connection so standard pipe joint is located not more than 1.5 feet from structure unless PVC is used.
3. Provide end of service connection line and fittings with standard watertight plug, cap, and stopper, suitably braced to prevent blow-off during hydrostatic or air testing.

E. First length of pipe out from tee on lateral or main shall not be greater than 3 feet in length unless PVC pipe is used.

F. Line and Grade for Service Connection Pipe and Fittings:

1. Contracting Officer will set stake for location and depth to invert at right-of-way or easement line end of service connection for each tract of land to be serviced by sewer system.
2. Install sewer tee so as to locate connection pipe within horizontal distance of 1 foot either side of staked location.
3. When possible, lay pipe uniformly between tee or top of riser section and end of service connection. If a field conflict prevents uniform installation, propose an alternative method of installation to Contracting Officer for approval. Where minimum slopes are used, confirm accuracy of pipe grade with a good quality builder's level not less than 24 inches long.

G. Existing Service Connections:

1. Locate by potholing prior to constructing tee in new sewer pipeline.
2. Disconnect from existing pipelines to be abandoned and reconnect them to new sewer pipeline.

3.07 CLEANING

A. Clean each section of completed sewer pipeline prior to testing.

B. Place screen or dam in downstream manhole of section being cleaned to catch debris.

C. Remove material from each manhole section before cleaning next section downstream.

D. Method: High velocity hydro-cleaning equipment.

E. Dispose of cleaning water in a manner that will not damage or interfere with adjacent property and in a manner acceptable with Contracting Officer and regulatory agencies.

3.08 TESTING

A. General:

1. Notify Contracting Officer in writing 5 days in advance of testing. Perform testing in presence of Contracting Officer.

2. Test pipe 18 inches in diameter and smaller for leakage using Hydrostatic Exfiltration or Pneumatic Test Methods at Contractor's option.
3. Test pipe over 18 inches in diameter for leakage using Hydrostatic Exfiltration Test Method.
4. Individual joints may be tested on pipe 36 inches in diameter and larger at Contractor's option.
5. Pipe shall successfully pass leakage test prior to acceptance.
6. Test sections of constructed sewer between stations only after service connections, manholes, and backfilling are completed.
7. Isolate new pipelines that are connected to existing pipelines for testing. Install pipe plugs as required to allow section of new pipe to be pressure tested.
8. Furnish testing equipment and perform tests as approved by Contracting Officer. Testing equipment shall provide observable and accurate measurement of test pressure and amount of water needed to maintain specified conditions.
9. Supply of Temporary Water: As stated in Section 01 50 00, Temporary Facilities and Controls.
10. Dispose of water used in testing in accordance with federal, state, and local requirements.

B. Hydrostatic Exfiltration Test:

1. If groundwater is present and is 4 feet and above the top of pipe for the segment being tested, conduct an infiltration test.
2. For VCP and RCP pipe, fill pipe test section 24 hours prior to time of testing, if desired, to permit normal absorption into pipe walls.
3. Procedure:
   a. Maximum filling velocity shall not exceed 0.25 foot per second, calculated based on full area of pipe.
   b. Expel air from piping system during filling.
   c. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
   d. Maintain hydrostatic test pressure continuously for 2 hours minimum, adding additional water only as necessary to maintain test pressure.
   e. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.
4. Measurement Accuracy: Plus or minus 1/8 gallon of water leakage under specified conditions.
5. PVC Pipe and Joints: Maximum allowable water loss is 0.8 gallon per inch diameter per 1,000 feet of pipe, including service connections within test section per 2 hours. Modify allowable leakage as stated below if hydrostatic head is other than 6 feet.

6. Clay and Concrete Pipe and Joints: Maximum allowable water loss is 1.5 gallons per inch diameter per 1,000 feet of pipe, including service connections within test section per 2 hours. Modify allowable leakage as stated below if hydrostatic head is other than 6 feet.
7. Hydrostatic Head:
    a. At least 2 feet above maximum estimated groundwater level in section being tested, but no less than 6 feet above inside top of highest section of pipe in test section, including service connections.
    b. In every case, determine height of water table at time of test by exploratory holes or such other methods approved by Contracting Officer. Contracting Officer will make final decision regarding test height for water in pipe section being tested.
    c. If hydrostatic head is other than 6 feet, adjust allowable leakage as computed by criteria above by dividing square root of actual head by square root of 6 and multiplying result by allowable leakage stated above.
8. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 16 feet of water column. In no case shall length be greater than 700 feet or distance between manholes when greater than 700 feet.
9. Dispose of test water in a manner that will not damage or interfere with adjacent property and in a manner acceptable with Contracting Officer and regulatory agencies.

C. Pneumatic Testing for 18-inch and Smaller Diameter Pipe:

1. Equipment:
    a. Calibrate gauges with standardized test gauge provided by Contractor at start of each testing day.
    b. Install compressor, air piping manifolds, gauges, and valves at ground surface.
    c. Provide pressure release device, such as rupture disc or pressure relief valve, to relieve pressure at 6 psi or less.
    d. Restrain plugs used to close sewer lines to prevent blowoff.
2. Procedure:
    a. No person shall enter manhole or structure, or occupy area above opening of manhole or structure where pipe is under pressure.
    b. Determine height of groundwater table at time of test.
    c. Slowly introduce air into pipe section until internal air pressure reaches 4 psi greater than average backpressure of groundwater submerging pipe.
    d. Allow 2 minutes minimum for air temperature to stabilize.

e. Allowable leakage for sewers constructed of air-permeable materials, such a concrete or clay:
   1) When pressure is decreased to 3.5 psig, air pressure test shall begin.
   2) Test shall consist of measuring time in seconds for pressure in pipe to drop from 3.5 psig to 2.5 psig.
   3) Pipe leakage shall be considered acceptable if time in seconds for pressure drop is equal to or greater than required time as calculated below:

$$K = 0.0111d^2L$$
$$C = 0.000392dL$$

If C_t is less than or equal to 1.0, then time = K_t
If C_t is between 1.0 and 1.75, then time = K_t/C_t
If C_t is greater than or equal to 1.75, then time = $K_t/1.75$

   a) Where: d = pipe diameter in inches
      L = pipe length in feet
      K = value for each length of pipe of a specific diameter
      C = value for each length of pipe of a specific diameter
      K_t = Sum of all K values
      C_t = Sum of all C values

f. This method is based on allowable air loss rate of 0.003 cubic foot per minute (cfm) per square foot of internal pipe surface, with total air loss rate not less than 2.0 cfm nor greater than 3.5 cfm.
g. Allowable leakage for sewers constructed of nonair-permeable materials such as ductile iron, and polyvinyl chloride (PVC).
   1) When nonair-permeable pipe is subjected to low pressure air test, time in seconds for pressure drop shall be equal to or greater than three times required time calculated using procedure above.
   2) Defective Piping Sections: Replace and retest as specified.

D. Hydrostatic Joint Testing:

1. If pipe fails to pass hydrostatic test and location of leak cannot be readily identified, conduct individual joint tests. After leaking joints have been located and repaired, retest pipeline.
2. Conduct testing prior to installing PVC liner patch at joints.
3. Provide device specifically designed for testing of pipe joints and consisting of a metal cylinder, seal ring on each side of joint, and method of applying pressure to joint.

4. Measurement Accuracy: Plus or minus 0.05 gallon of water leakage under specified conditions.
5. Determine height of groundwater table at time of test.
6. Minimum Pressure, Each Joint: 2.5 psi above backpressure of groundwater.
7. Minimum Test Duration, Each Joint:
   a. 20 minutes for 60-inch diameter pipe and smaller.
   b. 10 minutes for pipe larger than 60-inch diameter.
8. Maximum Leakage Per Joint: 0.0008 gallon per hour per inch-diameter times length of distance between pipe joints.

E. Infiltration Test:

1. Where groundwater is 4 feet above top of a section of pipe, measure flow of water in pipe and rates of infiltration using a calibrated weir. Leave weir in line until flow rate has stabilized. Verify groundwater elevation.
   a. Maximum Acceptable Total Infiltration of Groundwater as Determined by Test: 50 gallons per 24 hours per inch-mile of pipe.
   b. Make infiltration tests on all sewer construction before placing lines in service and before making any connections to other sewers.
   c. If amount of infiltration into sewer(s) is in excess of maximum quantity specified above, repair joints, relay sewer (if necessary), or perform other remedial construction as required.
   d. Repeat test until each sewer meets specified infiltration amount.

F. Test Report Documentation:

1. Test date.
2. Pipe section tested.
3. Test method.
4. Test pressure.
5. Length of test.
6. Pressure or water loss.
7. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
8. Signed by Contractor and Contracting Officer to represent that test has been satisfactorily completed.

G. Subsequent Failure: Visible infiltration of groundwater following successful test shall be considered evidence that original test was in error or that subsequent failure of pipeline has occurred.

H. PVC Pipe Deflection Test:

1. Contractor is responsible for providing all labor and equipment for deflection testing.
2. Test deflection of pipe by manually pulling, with twine, a one-piece, nine-arm, go/no-go mandrel (sized in accordance with ASTM D3034) through pipe. Within 24 hours after compaction of backfill is complete, line shall be tested using 5 percent deflection mandrel. If line is satisfactory, it shall be retested using 7.5 percent deflection mandrel no less than 30 days following completion of compaction.
3. Correcting Deficiencies or Obstructions:
   a. Excavate to springline of pipeline and replace and recompact pipe zone material.
   b. Internal pipe rerounding or vibration will not be allowed.
   c. If pipe does not pass mandrel test after replacement of pipe zone material and trench backfill, re-excavate and replace pipeline.

I. Pipeline Lamping Test:

1. Contractor is responsible for providing all labor and equipment for pipeline lamping testing.
2. Prior to beginning lamping work, schedule pre-startup meeting with Contracting Officer to review proposed lamping and inspection methods.
3. Identify manholes in same manner as specified on the Drawings.
   a. Number each photograph according to structure identification number, plus number of photograph for that structure (e.g., 150221, 150222, 150223).
      1) Minimum of two photos showing inlet and outlet pipes of structure.
      2) Additional photos to show major defects identified during inspection.
      3) Digital photographs shall be submitted to Contracting Officer at end of each week.
4. Perform lamping operation by shining light at one end of each pipe section between manholes; observe light at other end; reject pipe not installed with uniform line and grade.
5. Remove and reinstall rejected pipe sections; re-clean and re-lamp.
6. Final Report:
   a. List of Structures.
   b. Provide evidence of satisfactory installation and lamping results
   c. Submit final report within 2 weeks after completion of field work.

3.09 INSPECTION

A. Television Pipeline Inspection:

1. General:
   a. Internally inspect sewer pipelines by closed circuit television (CCTV) after completion of pipeline cleaning and testing.
   b. Conduct inspection in presence of Contracting Officer.
2. Procedure:
   a. Provide complete and continuous taped record and written log of inspection.
   b. HD format.
   c. Television Camera Equipment:
      1) Rotating lens or pan and tilt.
      2) Resolution: Minimum 460 lines per inch.
      3) Focal Distance: Adjustable through a range of 6 inches to infinity.
      4) Remote-Reading Footage Counter: Accurate to less than 1 percent error.
      5) Lighting: Sufficient to provide clear, in-focus picture of entire inside periphery of pipe, and minimizes reflection.
   d. Pull camera at uniform rate, stopping to properly document defects. Maximum pull of camera shall not exceed 30 feet per minute.
3. Quality Standard:
   a. Provide clear, sharp image when played back on conventional television receiver.
   b. Neatly label HD showing contents, project title, HD number, pipe structure identification numbers, date HD was made, and inspection company.
   c. Tapes to Include:
      1) Opening Screen:
         a) Date of inspection.
         b) Pipe structure identification number.
         c) Upstream and downstream node identification numbers.
         d) Street address.
         e) Pipe size.
         f) Normal (upstream to downstream) or reverse (downstream to upstream) pull.
      2) Continuous View: Current distance along reach (tape counter footage).
   d. Log sheets to show time and date of inspection, location, upstream and downstream manholes, direction of pull, pipeline length, pipe size, pipe material, location of lateral connections, video tape number and detail of defects encountered.

e. Show sufficient detail to determine cracks in pipe, offset joints, leaking joints, sags, and other flaws in pipeline installation. Record location of deficiencies by distance from center of reference manhole.

f. Upon completion, playback video in presence of Contracting Officer. Any video not meeting quality standard will be rejected and videoing process repeated.

g. Correct deficiencies found as a result of video replay and repeat CCTV inspection.

B. Deficiencies Requiring Correction:

1. Variations in alignment greater than specified herein.
2. Joint separations greater than allowed by pipe manufacturer.
3. Visible infiltration.
4. Presence of debris or foreign objects.
5. Obvious damage or defects in pipeline.
6. Sags, bellies, or negative slopes.
7. Slope less than minimum allowable.

END OF SECTION

SECTION 33 05 13
MANHOLES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO): M198, Standard Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants.
2. ASTM International (ASTM):
   a. A36/A36M, Standard Specification for Carbon Structural Steel.
   b. A48/A48M, Standard Specification for Gray Iron Castings.
   c. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   d. A536, Standard Specification for Ductile Iron Castings.
   e. A615/A615M, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   f. B139/B139M, Standard Specification for Phosphor Bronze Rod, Bar, and Shapes.
   g. C14, Standard Specification for Nonreinforced Concrete Sewer, Storm Drain, and Culvert Pipe.
   h. C31/C31M, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
   i. C39/C39M, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   j. C150/C150M, Standard Specification for Portland Cement.
   k. C192/C192M, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   l. C387/C387M, Standard Specification for Packaged, Dry, Combined Materials for Mortar and Concrete.
   m. C443, Standard Specification for Joints for Concrete Pipe and Manholes Using Rubber Gaskets.
   n. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   o. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
   p. C990, Standard Specification for Joints in Concrete Pipe, Manholes, and Precast Box Sections using Preformed Flexible Joint Sealants.
   q. C1311, Standard Specification for Solvent Release Sealants.

r. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
s. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft3 (600 kN-m/m3)).
t. D4101, Standard Specification for Propylene Injection and Extrusion Materials.
u. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
v. F594, Standard Specification for Stainless Steel Nuts.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings including details of construction, reinforcing and joints, anchors, lifting, erection inserts, and other items cast into members.
2. Product Data:
   a. Concrete mix design.
   b. Manhole frame to structure seals.
   c. Manhole frame to structure anchor bolt.
   d. Rubber gaskets and sealants.
   e. External joint wrap.

B. Informational Submittals:

1. Experience Record:
   a. Precast concrete production capabilities.
   b. Evidence of current PCI plant certification.
2. Calculations: Proposed details and design calculations for stresses in precast concrete members for loading conditions including earth pressures and transportation, handling, and erection. Calculations shall be stamped by engineer registered in the same state as the Project.
3. Certificate of Compliance: Certify admixtures and concrete do not contain calcium chloride.
4. Test Reports:
   a. Precast manufacturer’s concrete test cylinders.
   b. Core compression test.
   c. Absorption test.
5. Certified load test data for precast manhole steps.
6. Manufacturer’s recommended installation instructions.
7. Field quality control report.

1.03 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Precast Concrete and Precast Prestressed Concrete: Product of manufacturer with 3 years' experience producing precast concrete products of quality specified.
2. Precast Plant: PCI certified plant with current certification.

PART 2 PRODUCTS

2.01 GENERAL

A. Characteristics listed below cover the materials of construction and service conditions for manholes:

1. Physical Characteristics:
   a. Structures:
      1) Ring: Custom made with openings to meet indicated pipe alignment conditions and invert elevations.
      2) Floor: Minimum 8 inches below pipe to provide clearance for grouting channels.
      3) Joint:
         a) Form joint contact services with machined castings.
         b) Surfaces shall be parallel with nominal 1/16-inch clearing and tongue equipped with recess for installation of O-ring rubber gasket.
2. Functional Characteristics:
   a. Gaskets:
      1) Internal and external seals shall be made of materials that have been proven to be resistant to the following exposures and conditions:
         a) Sanitary sewage.
         b) Corrosion or rotting under wet or dry conditions.
         c) Gaseous environment in sanitary sewers and at road surfaces including common levels of ozone, carbon monoxide, and other trace gases at installation site.
         d) Biological environment in soils and sanitary sewers.
         e) Chemical attack by road salts, road oil, and common street spillages or solvents used in street construction or maintenance.
         f) Temperature ranges, variations, and gradients in construction area.
         g) Variations in moisture conditions and humidity.
         h) Fatigue failure caused by a minimum of 30 freeze-thaw cycles per year.

i) Vibrations because of traffic loading.
j) Fatigue failure because of repeated variations of tensile, compressive and shear stresses, and repeated elongation and compression. Material shall remain flexible allowing repeated movement.

3. Performance Characteristics:
   a. General:
      1) Materials shall be compatible with each other and manhole materials.
      2) Designed to provide a 20-year service life.
   b. Screws, Bolts, or Nuts: Type 304 stainless steel conforming to ASTM F593 and ASTM F594.
   c. Structures:
      1) Shall meet requirements of ASTM C478, this specification and the following.
         a) Loading: AASHTO HS-20.
         b) Design: In accordance with ACI 301.
      2) Concrete:
         a) Cement: Meet requirements of ASTM C150/C150M.
         b) Compressive Strength:
            (1) Minimum 4,000 psi.
            (2) Minimum strength shall be confirmed at 7 days by making two standard cylinders per manhole for testing.
         c) Water/Cement Ratio by Weight:
            (1) 0.5 maximum.
            (2) 0.56 maximum, with addition of water reducing agent (in accordance with ASTM C494, Type A).
      3) Reinforcement: Grade 60, unless otherwise specified.
      4) Gasket: Meet requirements of ASTM C443.

2.02 PRECAST MANHOLES

A. Manufacturers and Products:

1. Joint Seal Manufacturers and Products:
   a. Butyl Gaskets:
      1) Hamilton Kent, Sparks, NV; Kent-Seal No. 2.
      2) Or equal.
   b. External Wrap:
      1) Sealing Systems, Inc., Loretto, MN; Gator Wrap.
      2) Or equal.

B. Physical Characteristics:

1. Riser Sections:
   a. Fabricate in accordance with ASTM C478.
   b. Diameter: Minimum 48 inches (or as shown).
   c. Wall Thickness: Minimum 4 inches or 1/12-times inside diameter, whichever is greater.
   d. Top and bottom surfaces shall be parallel.
   e. Joints: Tongue-and-groove and confined O-ring with rubber gaskets meeting ASTM C443.
2. Cone Sections:
   a. Eccentric.
   b. Same wall thickness and reinforcement as riser section.
   c. Top and bottom surfaces shall be parallel.
3. Base Sections and Base Slab: Base slab integral with sidewalls.
4. Manhole Extensions: Concrete grade rings; maximum 6 inches high.
5. Joint Seal:
   a. Butyl Gaskets:
      1) Butyl rubber with dense polymer structure.
      2) Tacky outer surface.
      3) Flexible rope.
   b. Confined Plastic or Rubber O-Ring: As recommended by precast manufacturer.
   c. External Wrap:
      1) EPDM Rubber.
      2) Non-hardening butyl adhesive.
6. Meets requirements.
7. Polypropylene Steps:
   a. Minimum Width: 13 inches, center-to-center of legs.
   b. Embedment: 3-1/2-inch minimum and 4-1/2-inch minimum projection from face of concrete at point of embedment to center of step.
   c. Cast in manhole sections by manufacturer.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Riser Sections: Fabricate in accordance with ASTM C478.
2. Base Sections and Base Slab: Fabricate in accordance with ASTM C478.
3. Manhole Extensions: Fabricate in accordance with ASTM C478.
4. Joint Seal:
   a. Butyl Gaskets:
      1) Conforms to ASTM C990 and AASHTO M-198.
      2) Resists vapor permeation through the joint.

3) Highly compressible, adhesive.
4) Temperature and aging resistant.

b. Confined Plastic or Rubber O-Ring:
1) As recommended by precasting manufacturer.
2) Meet requirements of ASTM C443.

c. External Wrap:
1) Provides and water-tight seal around manhole, catch basin, or concrete pipe joint.
2) Meets requirements of ASTM C877, Type III and ASTM C923.

5. Polypropylene Steps:
a. Fabricate from minimum 1/2 inch, Grade 60, steel bar meeting ASTM A615/A615M.
b. Polypropylene encasement shall conform to ASTM D4101.
c. Load Test: Capable of withstanding ASTM C478 vertical and horizontal load tests.

2.03 MANHOLE FRAMES AND COVER

A. Physical Characteristics:

1. Castings: Plane or grind bearing surfaces to ensure flat, true surfaces.
2. Cover: Contracting Officer's Standard. True and seat within ring at all points. With the word SEWER, WATER, STORM, or DRAIN in 2-inch raised letters.
3. Frames: Rated for AASHTOH-20 wheel loading.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. Castings:
a. Tough, close-grained gray iron, sound, smooth, clean, free from blisters, blowholes, shrinkage, cold shuts, and defects.
b. Cast Iron: ASTM A48/A48M Class 35B.
c. Ductile Iron: ASTM A536, Grade 60-40-12.
2. Capscrews for Watertight Covers: High temper phosphor bronze with 60,000 psi minimum tensile strength meeting ASTM B139/B139M and rated for AASHTO H-20 wheel loading.
3. Watertight Cover Gasket: Molded from high-quality rubber such as nitrile or EPDM.

2.04 MANHOLE FRAME CONNECTION TO STRUCTURE

A. Manufacturers and Products:

1. Butyl Sealant:
   a. A Tremco Commercial Sealants and Waterproofing, Beachwood, OH; Tremco Butyl Sealant.
   b. Or equal.
2. External Wrap:
   a. Sealing Systems, Inc., Loretto, MN; Infi-Shield.
   b. Or equal.
3. Internal Wrap or Sealing Membrane:
   a. Sealing Systems, Inc., Loretto, MN; Flex-Seal Utility Sealant.
   b. Or equal.
4. Frame to Structure Anchor Bolts:
   a. Hilti; HVA Capsules Adhesive Anchoring System.
   b. Or equal.

B. Physical Characteristics:

1. Butyl Sealant: Trowelable or cartridge applied.
2. External Wrap:
   a. Thickness: Minimum 60 mils.
   b. Consist of a top and bottom section and be sealed to structure, frame top, and bottom with mastic as applicable.
   c. Length: Extend from manhole frame and extension ring to cone section.
   d. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
3. Internal Wrap or Sealing Membrane:
   a. Minimum internal thickness of 3/16 inch or as recommended by manufacturer for installation climate.
   b. Width: Minimum 8 inches.
   c. Bands: If required, constructed of minimum 16-gauge sheet if channeled, or 5/16-inch diameter if round.
   d. Wrap shall not restrict access to manhole.
4. Frame to Structure Anchor Bolts: 3/4-inch-diameter HAS stainless steel bolts; minimum 6-5/8-inch embedment.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Butyl Sealant: Conform to ASTM C1311, or AASHTO M198 and ASTM C990.
2. External Wrap:
   a. Meet requirements of ASTM C923.
   b. Construct of high-quality rubber that will provide flexible watertight seal around joint.
3. Internal Wrap or Sealing Membrane:
   a. Meet requirements of ASTM C923.
   b. Designed for application and have a demonstrated history of accommodating differential expansion between frame and concrete.
   c. Expansive type wraps shall be fabricated of high-quality rubber or urethane.

2.05 MORTAR

A. Standard premixed in accordance with ASTM C387/C387M, or proportion one part Portland cement to two parts clean, well-graded sand that will pass a 1/8-inch screen.

B. Admixtures:

1. May be included; do not exceed the following percentages of weight of cement:
   a. Hydrated Lime: 10 percent.
   b. Diatomaceous Earth or Other Inert Material: 5 percent.

C. Mix Consistency:

1. Tongue-and-Groove Type Joint: Such that mortar will readily adhere to pipe.
2. Confined Groove (Keylock) Joint: Such that excess mortar will be forced out of groove and support is not provided for section being placed.

2.06 BACKFILL AROUND AND UNDER MANHOLE

A. Structural fill as specified in Section 31 23 23, Fill and Backfill.

2.07 FLEXIBLE JOINTS FOR SEALING PIPES IN MANHOLE

A. Manufacturers and Products:

1. NPC, Inc., Milford, New Hampshire; Kor-N-Seal flexible rubber boot with stainless steel accessories.
2. Or equal.

B. Physical Characteristics:

1. Stainless steel pipe clamp.
2. Reinforced nylon wedge or cast wedge.
3. EPDM or polyisoprene rubber connector.

C. Functional Characteristics: None.

D. Performance Characteristics: Conforms to ASTM C923 and ASTM A167.

2.08 COLD-APPLIED ASPHALT EMULSION DAMPROOFING

A. Asphalt Emulsion:

1. Asphalt and water emulsion coating, formulated to penetrate substrate and build to moisture resistant coating: Nonfibrated type liquid asbestos-free emulsion; ASTM D1227, Type III.

2.09 CORROSION RESISTANT COATING (CRC) SYSTEM-2, EPOXY POLYMER, TROWEL OR SPRAY APPLIED

A. Physical Characteristics:

1. System-2, Epoxy Polymer
2. Surfacer/Filler: One coat of 100 percent solids, trowel applied epoxy surfacer, application rate as required to fill and level 100 percent of the concrete surface in preparation for coating, 1/16-inch minimum.
3. Primer: One coat of manufacturer’s recommended moisture-resistant epoxy primer, 2 MDFT. As required by CRC manufacturer.
4. Corrosion Barrier Lining: One coat of spray or trowel grade, 100 percent solids, chemical resistant amine-cured epoxy lining material, 125 MDFT.
5. Glaze Coat: Required for fiber-filled or aggregate-filled corrosion barrier lining products to provide a smooth surface. One coat of liquid applied, 100 percent solids, amine-cured chemical-resistant epoxy finish, 25 MDFT to 30 MDFT.

B. Functional Characteristics: Chemical resistant barrier lining suitable for application to new concrete hydraulic structures.

C. Performance Characteristics: Immersion and head space exposure to digested sludge and hydrogen sulfide and dilute sulfuric acid, pH of 1 to 3.

2.10 SOURCE QUALITY CONTROL

A. Prior to delivery of precast manhole sections to Site, yard permeability tests may be required at point of manufacture. Contracting Officer will select precast sections not to exceed 5 percent of the total project quantity to test from material which is to be supplied to Project. Test specimens shall be mat tested and meet permeability test requirements of ASTM C14.

B. Concrete Testing: Test two concrete test cylinders for each manhole. Compressive strength shall be tested in accordance with ASTM C31/C31M, ASTM C39/C39M, and ASTM C192/C192M.

C. Inspection:

1. Material Quality:
   a. Manufacturing process and finished sections shall be subject to inspection and approval by Contracting Officer.
      1) Inspections may take place at manufacturer's plant, at Site after delivery, or at both.
      2) Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
      3) Sections rejected after delivery shall be removed and replaced.
      4) Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Contracting Officer.
      5) If structure cannot be repaired, it shall be removed and replaced entirely at Contractor's expense.
2. At the time of inspection the sections will be carefully examined for compliance with ASTM C478 and with manufacturer's drawings. Sections will be inspected for general appearance, dimensions, scratch strength, blisters, cracks, roughness, and soundness. Surface shall be dense and close textured.
3. Imperfections may be repaired, subject to approval of Contracting Officer, after demonstration by manufacturer that strong and permanent repairs result.

PART 3 EXECUTION

3.01 GENERAL

A. Prior to installation inspect materials:

1. Sections not meeting requirements of this specification or that are determined to have defects which may affect durability of structure are subject to rejection.
2. Sections damaged after delivery will be rejected and if already installed shall be repaired to satisfaction of Contracting Officer.
3. Remove and replace structure that cannot be repaired.

B. If needed, dewater excavation during construction and testing operations.

3.02 EXCAVATION AND BACKFILL

A. Excavation: As specified in Section 31 23 16, Excavation.

B. Backfill:

1. As specified in Section 31 23 23, Fill and Backfill.
2. Place structural fill under manhole in 6-inch maximum lifts; minimum of 12 inches unless otherwise specified on the Drawings. Compact each lift to 98 percent relative compaction as determined in accordance with ASTM D698.

3.03 INSTALLATION OF PRECAST MANHOLES

A. Concrete Base:

1. Precast:
   a. Place on compacted structural fill.
   b. Properly locate, ensure firm bearing throughout, and plumb first section.
2. Cast-in-Place:
   a. Invert: Minimum 8 inches below lowest connecting pipe.
   b. First section of manhole shall be cast in concrete base.

B. Sections:

1. Inspect precast manhole sections to be joined.
2. Clean ends of sections to be joined.
3. Do not use sections with chips or cracks in tongue.
4. Locate precast steps in line with each other to provide continuous vertical ladder.

C. Preformed Plastic Gaskets or Rubber O-Ring:

1. Use only pipe primer furnished by gasket manufacturer.
2. Install gasket material in accordance with manufacturer's instructions.
3. Completed Manhole: Rigid and watertight.

D. Mortar Joints:

1. Thoroughly wet joint with water prior to placing mortar.
2. Place mortar on groove of lower section prior to section installation.
3. Fill joint completely with mortar of proper consistency.
4. Trowel interior and exterior surfaces smooth on standard tongue-and-groove joint.
5. Prevent mortar from drying out and cure by applying approved curing compound or comparable approved method.
6. Do not use mortar mixed for longer than 30 minutes.
7. Chip out and replace cracked or defective mortar.
8. Completed Manhole: Rigid and watertight.

E. External Joint Wraps: Install in accordance with manufacturer's instructions.

F. Extensions:

1. Provide on manholes in streets or other locations where change in existing grade may be likely.
2. Install to height not exceeding 12 inches.
3. Lay grade rings in mortar with sides plumb and tops level.
4. Seal joints with mortar as specified for sections and make watertight.

3.04 MANHOLE INVERT

A. Construct with smooth transitions to ensure unobstructed flow through manhole. Remove sharp edges or rough sections that tend to obstruct flow.

B. Where full section of pipe is laid through manhole, break out top section and cover exposed edge of pipe completely with mortar. Trowel mortar surfaces smooth.

3.05 MANHOLE FRAMES AND COVERS

A. Install concrete grade rings as required to set covers flush with surface of adjoining pavement or ground surface, unless otherwise shown or directed.

B. Set frames in three equally spaced beads of butyl sealant that run full circumference of frame.

C. Anchor frame to manhole with specified bolts.

D. Install exterior manhole frame to structure seals in accordance with manufacturer's instructions. Seal shall cover grade rings.

3.06 MANHOLE PIPING

A. Drop Assembly: See the Drawings for detail of installation requirements.

B. Flexible Joints:

1. Provide in pipe not more than 1-1/2 feet from manhole walls.
2. Where last joint of pipe is between 1-1/2 feet and 6 feet from manhole wall, provide flexible joint in manhole wall.

C. Stubouts for Future Connections:

1. Provide same type and class of pipe as specified for use in service connection, lateral, main, or trunk sewer construction. Where there are two different classes of pipe at manhole use higher strength pipe.
2. Grout pipe in precast walls or manhole base to provide watertight seal or use flexible joints as specified herein.
3. Maximum Length: 1-1/2 feet outside manhole wall.
4. Construct invert channels as shown.
5. Test Plugs:
   a. Install rubber-gasketed plugs in end of stubouts with gasket joints similar to sewer pipe being used.
   b. Plugs shall withstand internal or external pressures without leakage.
   c. Adequately brace plugs against hydrostatic or air test pressures.

D. Permanent Plugs:

1. Clean interior contact surfaces of pipes to be cut off or abandoned as shown, and construct plug as follows:
   a. Pipe 18 Inches or Less in Diameter: Concrete plug in end, minimum 2 feet long.
   b. Pipe 20 Inches and Larger: Concrete plug in end, minimum 4 feet long.
   c. Plugs shall be watertight and capable of withstanding internal and external pressures without leakage.

3.07 MANHOLES OVER EXISTING PIPING

A. Maintain flow through existing pipelines at all times.

B. Concrete Pipe: Apply bonding agent on surfaces in contact with concrete.

C. Construct base under existing piping.

D. Construct manhole as detailed on the Drawings.

E. Apply minimum of two complete wraps of hydrophilic waterstop centered on pipe in wall.

F. Place a minimum of 24 inches of concrete around each pipe penetration outside manhole against undisturbed soil or compacted aggregate unless otherwise detailed.

G. Grout channel through manhole.

H. Saw cut out or demolish existing pipe within new manhole using method approved by Contracting Officer.

I. Protect new concrete or grout for 7 days after placing concrete.

3.08 CONNECTIONS TO EXISTING MANHOLES

A. Core manhole bases and grouting, as necessary.

B. Seal pipe in manhole using flexible connector.

C. Regrout to provide smooth flow into and through manholes.

D. Provide diversion facilities and perform work necessary to maintain flow during connection.

3.09 FIELD QUALITY CONTROL

A. Conduct negative air pressure (vacuum) test on all manholes in accordance with ASTM C1244

B. Hydrostatic Testing:

1. When, in Contracting Officer’s opinion, groundwater table is too low to permit visual detection of infiltration leaks, hydrostatically test all manholes.
2. Procedure: Plug inlets and outlets and fill manhole with water to height determined by Contracting Officer.
3. Manhole may be filled 24 hours prior to time of testing, if desired, to permit normal absorption into pipe walls to take place.
4. Leakage in each manhole shall not exceed 0.1 gallon per hour per foot of head above invert.

5. Repair manholes that do not meet leakage test, or do not meet specified requirements from visual inspection.
6. If more than 25 percent of manholes tested fail the hydrostatic test, test all or as many manholes as Contracting Officer deems necessary.

END OF SECTION

SECTION 33 05 23.13
UTILITY HORIZONTAL DIRECTIONAL DRILLING

PART 1 GENERAL

1.01 WORK INCLUDED

A. This section specifies horizontal directional drilling and installation of product pipe for the crossing of Highway 4, furnishing all labor, materials, equipment and incidentals and all other related work necessary for horizontal directional drilling and installation of product pipe, complete.

1.02 REFERENCES

A. American Petroleum Institute (API):

1. 13A, Specification for Drilling Fluid Materials.
2. RP 13B-1, Standard Procedure for Field Testing Water-Based Drilling Fluids.

B. Occupational Safety and Health Administration (OSHA):

1. Code of Federal Regulations; Title 29 - Labor; Chapter XVII - Occupational Safety and Health Administration; Department of Labor (Parts 1900-1999), “Revised Excavation Standards” (29 CFR 1926.650 Subpart P).
2. Code of Federal Regulations; Title 29, Labor; Chapter XX - Occupational Safety and Health Administration; Department of Labor (Parts 2200-2499).

1.03 DEFINITIONS

A. Frac-out: Release of drilling fluid to ground surface, water ways or utilities as a result of drilling fluid pressure in excess of that pressure required to fracture or permeate the ground, which generally occurs at the weakest soil condition and cover combination.

B. Horizontal Directional Drilling: A trenchless, steerable installation method of using multi-axis drilling machine to bore a small diameter pilot hole. The pilot hole is bored by either controlled fluid jetting or fluid assisted mechanical cutting or combinations thereof. The pilot hole is reamed, as necessary, to accommodate the product pipe. The product pipe is pulled back into the reamed hole by the drilling machine. The installed product pipe is cleaned and prepared for testing and operation.

C. Spill: Release of drilling fluid to ground surface from entry or exit pits of from mixing, handling or hauling equipment.

1.04 SUBMITTALS

A. Action Submittals:

1. Description of how pilot hole drill will be steered and of how position and inclination of bore head will be monitored.
2. Installation plan, including detailed plan and profile of bore plotted at scale no smaller than 1 inch equals 20 feet horizontal and vertical.
3. Descriptions of HDD drill rig, drill rod and drill head and methods for steering pilot hole drill and monitoring the position and inclination of bore head. Include the type, operating range, and degree of accuracy of the tracking equipment. Surface (walkover) locating systems using sondes and wireline (with or without auxiliary surface grid) or magnetic steering tools are acceptable as appropriate to site conditions.

B. Contingency plan for the following potential situations:

1. Loss of drilling fluid circulation.
2. Hydrofracture (frac-out) spill cleanup method.
3. Obstruction encountered during drilling or reaming.
4. Broken drill pipe.
5. Collapsed or buckled product pipe.
6. HDD fails to advance or fails to respond to steering actions.
7. Failure to maintain grade and when alignment derivations are more than allowable limits.
8. Installation (pull back) forces reach 80 percent of the maximum allowable forces including manufacturer’s recommended allowable factor of safety (at least 2.0).

C. Frac-Out, Surface Spill, and Abandonment Contingency Plans: The Contractor shall prepare a Surface Spill and Frac-Out Contingency Prevention and Response Plan, and an Abandonment Contingency Plan. The Contractor shall follow all provisions of the approved plans.

D. Informational Submittals: Record drawing plan and profile showing as constructed position of pipeline.

1.05 QUALITY ASSURANCE

A. Perform all work in conformance with requirements of authorities having jurisdiction.

B. Provide key personnel with at least 5 years’ experience in directional drilling and associated pipe installation, including pipe at least as large as 6 inches in

diameter. Key personnel include field supervisor and operators of directional drilling equipment, including position monitoring and steering equipment.

C. Existing utilities are shown as based on available record information, field survey, and subsurface verification. The Contractor shall be responsible for selecting steering and guidance tools suitable to the situation taking into account the potential for signal loss and potential interferences.

1.06 SAFETY

A. The Contractor shall exercise appropriate care and caution during all phases of construction to ensure the safety of the nearby operations and avoid causing damage to adjacent properties and other facilities.

B. Horizontal directional drilling machine safety requirements shall include a common grounding system to prevent electrical shock in the event of a high voltage underground cable strike. The grounding system shall connect all pieces of interconnecting machinery including the drill, mud mixing system, drill power unit, drill rod trailer, operator's booth, worker grounding mats, and any other interconnected equipment to a common ground. The drill shall be equipped with an "electrical strike" audible and visual warning system that will notify the system operators of an electrical strike.

C. Operators of the drill shall conform to all OSHA, Company's, and utility owner(s) and facility safety regulations and shall wear electrical shock protection equipment and operate from common grounded mats as required.

PART 2 PRODUCTS

2.01 HDPE PIPE

A. As specified in Section 26 05 33, Raceways and Boxes for Electrical Systems.

PART 3 EXECUTION

3.01 GENERAL

A. Do not commence directional drilling until all required submittals have been provided, reviewed and approved by the Contracting Officer.

B. Notify the Contracting Officer in writing a minimum of 7 calendar days prior to commencing direction drilling operations.

C. Do not begin drilling until all pipe and special items for drilling have been delivered.

D. During performance of work, Contractor shall keep a reasonable degree of order by housekeeping at all Work Sites. The Job Site is to be free of trash and unsightly debris for the duration of the Work.

E. Provide freshwater, free of hazardous or toxic substances, for drilling and grouting purposes.

F. The Contracting Officer shall be provided access at all times to observe HDD operations.

3.02 PREPARATIONS

A. Locate positions of entry and exit pits, establish elevation and horizontal datum for bore head control, and lay out pipe assembly area. Entry and exit locations shall be surveyed by experienced survey personnel licensed in the State of New Mexico prior to the start of directional drilling.

B. Locate any other features that need to be precisely located as required for the Contractor's use.

C. The survey results shall be plotted on a drawing with a scale no smaller than that used for the Enlarged Plan and Profile Drawings in the Contract Documents, and submitted to the Contracting Officer for approval.

D. Any Contractor proposed changes to the alignment or profile shall be clearly shown.

3.03 DRILLING PILOT HOLE

A. Drill pilot hole from entrance point to exit point following the horizontal alignment shown.

B. As pilot hole is advanced, plot actual horizontal and vertical alignment of pilot hole at intervals not exceeding 50 feet. Provide Contracting Officer with position or inclination of pilot bore upon request.

C. Alignment Requirements:

1. Pilot hole exit point shall be within 5 feet horizontally of exit point location shown.
2. Throughout its alignment, pilot hole shall be within 5 feet of horizontal alignment shown, and no shallower than vertical alignment shown.
3. Alignment shall have no intermediate high points that might trap air in pipe after installation.
4. Curvature of completed pilot hole shall not exceed that which after pipe installation will result in pipe wall stresses greater than 0.50 of yield stress.

D. Acceptance: If pilot hole alignment fails to conform to specified requirements, drill new pilot hole with alignment meeting specified requirements.

3.04 REAMING PILOT HOLE AND PULLING PIPE

A. Obtain Contracting Officer's approval to proceed before enlarging pilot hole and pulling pipe into position.

B. While pulling pipe, enlarge pilot hole ahead of pipe to diameter sufficient for pulling pipe into position.

C. While pulling pipe, handle pipe in manner that does not overstress pipe. Limit radius of curvature along length of pipe during installation to minimum radius that will not result in wall stresses that exceed 50 percent of yield stress. If pipe buckles or is otherwise damaged, remove damaged section and replace it with new pipe.

D. Pull pipe so that minimum of 10 feet of pipe is exposed at both ends of bore.

3.05 CLEANING PIPE ENDS

A. After pulling pipe, clean exposed ends for installation of fittings.

3.06 HANDLING AND DISPOSAL OF DRILLING MUD AND CUTTINGS

A. Make adequate provisions for handling and containing muddy water, drilling mud, and cuttings during drilling operations. Do not discharge these contaminants into waterways.

B. Construct mud pits at entry and exit points in manner that completely contains mud and prevents its escape.

C. When onsite provisions for storing muddy water, drilling mud, or cuttings onsite are exceeded, haul contaminants away to suitable legal disposal site.

D. Conduct directional drilling operation in such manner that drilling mud is not forced into areas where it might be objectional.

3.07 PIPE ABANDONMENT

A. In event of failure to install pipe, retain possession of pipe and remove it from Site. Completely fill borehole with grout or sand so as to prevent future settlement.

B. If pipe cannot be withdrawn, cut pipe off at least 3 feet below ground surface and cap ends of pipe with blind flange. Fill annular space with grout.

3.08 NON-VEGETATIVE SURFACE RESTORATION

A. Restore the work area around entry and exit pits to pre-existing conditions, even if the site will be disturbed by other work.

END OF SECTION

SECTION 33 12 13
WATER SERVICE CONNECTIONS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Association of State Highway and Transportation Officials (AASHTO).
2. American Water Works Association (AWWA): C800, Underground Service Line Valves and Fittings.
3. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless
   b. B32, Standard Specification for Solder Metal.
   c. B88, Standard Specification for Seamless Copper Water Tube.
   d. D3350, Standard Specification for Polyethylene Plastics Pipe and Fittings Material.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product Data:
      1) Pipe material data.
      2) Materials of construction for corporation stops, curb stops, and meter stops.
      3) Fitting types.
   b. Details with dimensions and fabricating tolerances for component ends.
   c. Report of existing service line past the point of connection. Include addresses and existing pipe material and diameter in electronic format (Excel and PDF).
   d. Operating pressure and allowable test pressure for components making up the service connection.
   e. Allowable test pressure for connected components.

f. Proposed thrust restraint data for restraining joints including drawing details, materials, assembly ratings, and pipe attachment methods.
g. Factory test results of components.

B. Informational Submittals:

1. Manufacturer's Certificate of Compliance, in accordance with AWWA C800.
2. Manufacturer's Certificate of Compliance, in accordance with NSF/ANSI 61.
3. Statement of Qualifications:
   a. Piping manufacturer.
   b. Fitting and specials manufacturer.
4. Procedure for field testing water mains and service connections, including disinfection.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 SERVICE SADDLES

A. Manufacturers and Products:

1. Romac.
2. Or equal.

B. Physical Characteristics:

1. Provide in accordance with the following:

Mainline Material	Saddle Characteristics	Tap Size
PVC C900 or C905 Pipe	Double strap saddle with coated saddle and wide stainless steel straps	3/4" - 3"
Cast Iron/Ductile Iron	Double strap saddle with coated saddle and wide stainless steel straps	3/4" - 3"

2. Choose model number for each manufacturer based on pipe being saddled and corrosivity of surrounding soils.
3. Style:
   a. Double strap with minimum 2-inch wide straps for metal pipe.
   b. Straps: Type 304 stainless steel.
   c. One-piece, full-circle, single stainless body with double bolt for use on plastic pipe and cast iron/ductile iron pipe.
   d. Minimum Pressure Rating: 200 psi.
4. Saddle: Stainless steel.

C. Functional Characteristics: Provide sealed connection between service lateral and water main.

D. Performance Characteristics: None.

2.03 REPAIR SERVICE CLAMPS

A. Physical Characteristics:

1. IP threads.
2. Size: Application range and pressure encompassing that of existing pipe to be repaired.
3. Use full circle repair clamp only.
4. Compatible with pipe being repaired.
5. Resistant to surrounding soil corrosivity.
6. Clamps:
   a. Single- or double-sided bolts designed to accommodate anticipated operating pressures.
   b. Stainless steel body.
   c. Neoprene gaskets cemented in place.
   d. Length based on damage to main.
7. Service Size: As shown on the Drawings.
8. Connecting Piping: HDPE.

B. Functional Characteristics: Provide sealed connection between repaired service lateral and water main.

C. Performance Characteristics: None.

2.04 CORPORATION STOPS

A. Manufacturers and Products:

1. Mueller Co.
2. Or equal.

B. Physical Characteristics:

1. Accommodate piping being connected.
2. Resistant to soil corrosivity.
3. Service Size: 3/4 inch through 2 inch.
4. Connecting Piping: HDPE.

C. Functional Characteristics: Allows service lateral to be shut off at water main.

D. Performance Characteristics: None.

2.05 MISCELLANEOUS FITTINGS

A. Miscellaneous fittings, couplings, unions, reducers, and adapters.

B. Physical Characteristics:

1. Accommodate pipe being connected.
2. For use on water service connections.
3. Same nominal size as service.
4. Resistant to soil corrosivity.
5. Service Size: 3/4 inch through 2 inch.
6. Connecting Piping: HDPE.

C. Functional Characteristics: Used as needed to connect piping to service connections.

D. Performance Characteristics: None.

2.06 CURB STOPS

A. Manufacturers and Products:

1. Mueller Co.
2. Or equal.

B. Physical Characteristics:

1. Accommodate piping being connected.
2. Resistant to soil corrosivity.
3. Service Size: 3/4 inch through 2 inch.
4. Connecting Piping: HDPE.

C. Functional Characteristics: Allows service lateral to be shut off between the water meter and the water main.

D. Performance Characteristics: None.

2.07 METER BOXES, VAULTS, AND COVERS

A. Manufacturers and Products:

1. Old Castle Infrastructure.
2. Or equal.

B. Physical Characteristics:

1. Able to withstand AASHTO H20 loading characteristics.
2. Rectangular body.
3. Cast iron lid, removable for meter reading.
4. Products:

Service Size	Characteristics
3/4" through 2"	Rectangular concrete body and cast-iron lids; extensions as required
3/4" through 2"	Rectangular plastic body, cast-iron reading lid
3 inches, or 4 inches, or 6 inches	Precast sectional vault; 3/8-inch steel plate cover; two meter reading lids

C. Functional Characteristics: To house and protect water meters and valves for operator access.

D. Performance Characteristics: None.

2.08 METER YOKES

A. Manufacturers and Products:

1. Mueller Co.
2. Or equal.

B. Physical Characteristics:

1. Size to match associated service.
2. Service Size: 3/4 inch through 2 inch.
3. Connecting Piping: HDPE (new); Unknown (existing).
4. Resistant to soil corrosivity.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.09 ANGLE VALVES

A. Manufacturers and Products:

1. Mueller Co.
2. Or equal.

B. Physical Characteristics:

1. Size to match associated service.
2. Service Size: 3/4 inch through 2 inch.
3. Connecting Piping: HDPE.
4. Resistant to soil corrosivity.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.10 WATER METERS

A. Manufacturers and Products:
1. Meter:
   a. Neptune Technology Group.
   b. Or equal.
2. Dual Check Valve:
   a. Mueller Co.
   b. Or equal.

B. Physical Characteristics:

1. Size to match associated piping service and flow requirements.
2. Magnetic drive, positive displacement.
3. Factory equipped or installed with dual check valves.
4. Service Size: 3/4 inch through 2 inch.
5. Resistant to soil corrosivity.
6. NSF 61 compliant.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.11 HIGH DENSITY POLYETHYLENE PLASTIC PIPE

A. Manufacturers and Products:

1. Phillips Products Co.; Driscopipe 5100.
2. Or equal.

B. Physical Characteristics:

1. Manufactured from ultra-high molecular weight, high-density polyethylene.
2. Conforming to ASTM D3350 and NSF 61.
3. Working Pressure 200 psi.
4. Standard dimension ratio (SDR) of 11 or smaller.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.12 EXISTING CONNECTIONS

A. Reconnect all new services and meter to existing building service line, including all fittings, as necessary.

B. Provide a complete report of existing services including house address, existing pipe material, and diameter.

PART 3 EXECUTION

3.01 GENERAL

A. Install service connections, excluding meters, during or after construction of the main.

B. Install water meters after entire water system is ready for operation.

C. Depth of cover over the pipe shall be minimum 36 inches.

D. Install service connection in accordance with Standard Details on the Drawings.

E. Contractor to document the water service line material downstream of the water meters being replaced during construction. Provide this documentation to Contracting Officer.

3.02 TRENCH EXCAVATION AND BACKFILL

A. In accordance with Sections 31 23 16, Excavation, and Section 31 23 23.15, Trench Backfill.

3.03 CONNECTION TO MAIN

A. Clean exterior of main of dirt and other foreign matter that may impair the quality of the completed connection.

B. Place service clamp (saddle) at desired location.

C. Clamp by tightening alternate nuts progressively.

D. Do not place service clamp within 1 foot of pipe joint, or another clamp.

E. Make taps with adapters for the size main being tapped.

3.04 COPPER TUBING

A. Cut square ends, ream clean, and flare and make up tightly.

B. Prevent the tube from kinking or buckling on short radius bends. If tube should kink or buckle, cut out kinked or buckled sections and splice with brass fitting.

3.05 POLYETHYLENE PLASTIC PIPE

A. Install in conformance with manufacturer’s recommendations.

3.06 METER BOXES AND METERS

A. Installation:

1. Construct enclosures plumb, and flush with existing ground surface unless shown otherwise.
2. Use standard extension sections to adjust to grade.
3. Place lightly compacted earth backfill inside meter box to depth shown.
4. Backfill around meter vaults as specified in Section 31 23 23.15, Trench Backfill.
5. Install meter in horizontal position with dial at required depth below cover.
6. Corporation Stops: OPEN position.
7. Angle Stops: CLOSED position.

3.07 TESTING

A. Test service connection and piping at the normal main pressure after main has been connected and pressure tested as specified in Section 40 80 01, Process Piping Leakage Testing.

B. Test Duration: At least 15 minutes.

C. Inspect for leaks and repair before backfilling.

3.08 DISINFECTION OF SERVICE CONNECTIONS

A. Make connection to the main, which has been pressure tested as specified in Section 40 80 01, Process Piping Leakage Testing, and disinfected as specified in Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

B. Following connection to the main:

1. Close corporation stop and meter stop.
2. Connect new tubing to existing tubing or to meter stop.
3. Open corporation stop and allow to stand at main pressure for a minimum of 30 minutes.
4. Open meter stop.

C. Extra chlorine will be put into the system by Contracting Officer during service connection transfers to provide adequate disinfection capacity when above procedures are executed.

END OF SECTION

SECTION 33 12 16
WATER UTILITY DISTRIBUTION VALVES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C509, Resilient-Seated Gate Valves for Water Supply Service.
   b. C550, Protective Interior Coatings for Valves and Hydrants.
2. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components—Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components—Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate valve type number applicable tag number service where used.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Product data sheets for coating and lining products.
   d. Certification for compliance to NSF/ANSI 61 for valves used for drinking water service.

B. Informational Submittals:

1. Manufacturer’s Certificate of Compliance, in accordance with Section 01 67 00, Product Requirements.
   a. Resilient-seated gate valves, full compliance with AWWA C509.
2. Method for hydrostatic testing.
3. Tests and inspection results.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
5. Manufacturer’s Certificate of Proper Installation.

PART 2 PRODUCTS

2.01 GENERAL

A. Valve same size as adjoining pipe, unless otherwise indicated.

B. Valve ends to suit adjacent piping.

C. Valves shall have no leakage (drip tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in referenced valve standard.

D. Valve to open by turning counterclockwise, unless otherwise specified.

E. Valve materials in contact with or intended for drinking water service shall comply with requirements of NSF/ANSI 61 and other applicable federal, state, and local requirements.

F. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 GATE VALVES

A. Manufacturers:

1. Resilient-Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
   a. Mueller.
   b. Or equal.

B. Physical Characteristics:

1. General:
   a. Provide 2-inch operating nut for buried and exposed valves.
   b. Provide valve keys and extensions for buried and below grade valves.
   c. Provide handwheel for exposed valves where shown.
   d. Provide debris cap for top of valve boxes.
2. Resilient-Seated Ductile Iron Gate Valve 3 Inches to 36 Inches: Ductile-iron body, resilient seat, bronze stem and stem nut, flagged ends or

mechanical joint ends as shown on the Drawings, nonrising stem, full port.

3. Factory Finishing of Gate Valve:
   a. Lining and Coating:
      1) Dry Film Thickness: Minimum 10 mils.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. General:
   a. AWWA gate valves to be in compliance with referenced AWWA standard.
   b. Provide totally enclosed spur or bevel gear operator with indicator for AWWA gate valves 14 inches and larger.
   c. Mark AWWA gate valves with manufacturer's name or mark, year of valve casting, valve size, and working water pressure.
   d. Repaired AWWA gate valves will not be allowed.
2. Resilient-Seated Ductile Iron Gate Valve 3 Inches to 36 Inches:
   a. In accordance with AWWA C509.
   b. Minimum Design Working Water Pressure: 250 psig.
3. Factory Finishing of Gate Valve:
   a. In accordance with Section 09 90 00, Painting and Coating.
   b. Lining and Coating:
      1) Interior Lining:
         a) Manufacturer's standard.
         b) In accordance with AWWA C550.
         c) Formulated from materials deemed acceptable to NSF/ANSI 61.
      2) Exterior Coating:
         a) If valve and operator will not be subsequently field-coated, factory-applied coating shall be either two-part liquid material or heat-activated (fusion) material.
         b) In accordance with AWWA C550.

PART 3 EXECUTION

3.01 INSTALLATION

A. Mount buried valves such that operating nut is accessible and operable from above.

B. Install in accordance with manufacturer's written instructions.

3.02 DISINFECTION

A. Valves used for potable water service shall be disinfected in accordance with Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

3.03 FUNCTIONAL AND HYDROSTATIC TESTING

A. Functional Test:

1. Test that valves open and close smoothly under operating pressure conditions.
2. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.
3. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.

B. Hydrostatic Testing:

1. Valve may be tested while testing pipeline or as a separate step after pipeline has been tested.
2. Apply test pressure to one side of valve and measure the pressure on the opposite side to determine if there is an increase in pressure caused by leakage. Then apply test pressure to the other side, and measure the pressure on the opposite side.

END OF SECTION

SECTION 33 12 16.29
AIR AND VACUUM RELEASE VALVE ASSEMBLIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings (Classes 25, 125, and 250).
   b. B36.10M, Welded and Seamless Wrought Steel Pipe.
   c. B36.19M, Stainless Steel Pipe.
   d. Boiler and Pressure Vessel Code.
2. American Water Works Association (AWWA):
   a. C209, Cold-Applied Tape Coatings for the Exterior of Special Sections, Connections, and Fittings for Steel Water Pipelines.
   b. C214, Tape Coating Systems for the Exterior of Steel Water Pipelines.
   c. C220, Stainless Steel Pipe, 4 In. (100 mm) and Larger.
   d. C504, Rubber-Seated Butterfly Valves.
   e. C507, Ball Valves, 6 In. Through 48 In. (150 mm Through 1200 mm).
   f. C509, Resilient-Seated Gate Valves for Water Supply Service.
   g. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   h. C550, Protective Interior Coatings for Valves and Hydrants.
   i. C800, Underground Service Line Valves and Fittings.
3. ASTM International (ASTM):
   a. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   b. B43, Standard Specification for Seamless Red Brass Pipe, Standard Sizes.
   c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
   d. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
4. Environmental Protection Agency (EPA): Safe Drinking Water Act.
5. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.02 SUBMITTALS

A. Action Submittals:

1. Product data sheets for make and model.
2. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
3. Maximum recommended test pressure; maximum and minimum recommended working pressures of air valves, isolation valves, flanges, connecting piping, and fittings.
4. Recommended seating materials for specified operating pressures.

B. Informational Submittals:

1. Manufacturers' Instructions:
   a. Installation and testing of products specified.
   b. Pipeline tapping and service saddle installation.
   c. Instructions for maintaining and recharging carbon filter units, including recommendations to reduce restrictions of airflow caused by the filter unit.
2. Operation and maintenance data.
3. Affidavit of Compliance in accordance with AWWA C512 stating valve and all materials used conform to applicable requirements of AWWA C512 and these Specifications, and tests specified have been performed and all requirements have been met.
4. Affidavit of Compliance that materials comply with the requirements of the EPA Safe Drinking Water Act and other federal, state, and local requirements.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 COMBINATION AIR RELEASE VACUUM VALVES

A. Manufacturers and Products:

1. APCO (DeZurik).
2. Or equal.

B. Combination Air Valve, Water Service, 1 Inch to 16 Inches:

1. Physical Characteristics:
   a. Valve single body or dual body, air release valve mounted on air and vacuum valve, isolation valve mounted between the dual valves. 1-inch through 3-inch valves with NPT threaded inlet and outlet, 4-inch and larger valves with ASME B16.1 Class 125 flanged inlet and cover outlet.
   b. Rated 300 psi working pressure, cast-iron or ductile iron body and cover, stainless steel float and trim, built and tested to AWWA C512.
   c. Equip 4 inch and larger with anti-slam device to throttle flow of water into air valve and prevent damage caused by rapid closure.
2. Functional Characteristics:
   a. Suitable for water service, combines operating features of air and vacuum valve and air release valve.
   b. Air and vacuum portion to automatically exhaust air during filling of system and allow air to re-enter during draining or when vacuum occurs.
   c. Air release portion to automatically exhaust entrained air that accumulates in system.
3. Performance Characteristics:
   a. Air release, air/vacuum, and combination air valves shall conform to AWWA C512.
   b. Exterior of air valves shall be coated in accordance with Section 09 90 00, Painting and Coating.
   c. Interior of air valves shall be coated in accordance with AWWA C550.
   d. Air valves shall be factory tested in accordance with AWWA C512.
   e. Suitable for operating pressures between 50 psi and 125 psi.

2.03 CONNECTION TO MAINLINE

A. Flanged Outlet or Fitting: Flange shall be as required to match drilling pattern of adjoining valve and suitable for test pressure and working pressure.

B. Service Saddle: See Section 33 12 13, Water Service Connections.

2.04 ISOLATION VALVES

A. Gate Valve 3 Inches and Larger: See Section 33 12 16, Water Utility Distribution Valves.

B. Physical Characteristics:

1. Globe Valve 2 Inches and Smaller:
   a. All-bronze, screwed ends, union bonnet, inside screw, rising stem.
   b. Rated for minimum pressure of 200 psi.
2. Corporation Stop:
   a. AWWA C800 type, with ends suitable for adjoining pipe.
   b. Rated for minimum pressure of 200 psi.
3. Curb Stop:
   a. AWWA C800 type, with ends suitable for adjoining pipe.
   b. Rated for minimum pressure of 200 psi.
4. Ball Valve:
   a. AWWA C507, flanged ends.
   b. Rated for minimum pressure of 250 psi.
   c. Provide 2-inch operating nut.

C. Functional Characteristics: To allow complete shutoff of water.

D. Performance Characteristics: None.

2.05 PIPING BETWEEN MAINLINE AND AIR VALVE AND PIPING FOR AIR VENT

A. Piping between Mainline and Air Valve: HDPE, SDR-11.

B. Piping for Air Vent: Galvanized steel, Schedule 40.

2.06 VALVE VAULT

A. Precast concrete manhole, conforming to ASTM C478 with cast or ductile iron frame and cover. Frame and cover shall be designed for H-20 loading.

2.07 ACCESSORIES

A. Insulation: Cellular polystyrene, 1 inch thick.

B. Carbon Filter: Granulated activated impregnated carbon, PVC housing.

PART 3 EXECUTION

3.01 INSTALLATION

A. Valves:

1. In accordance with manufacturer's printed instructions.
2. Orient valve in vault with easy access to operator.
3. Replace valves that drip or do not function properly.

B. Service Saddle:

1. Tap and install in accordance with manufacturer's printed instructions.
2. Use adapters for size of line being tapped.

C. Valve Vault:

1. As shown on the Drawings for access to operators.
2. Install so finished grade of top of vault conforms to slope and elevation of adjacent ground.

D. Insulation:

1. Install within vault, above and around designated valve assemblies as required to protect valve from freezing.
2. Provide space for air passage to allow proper functioning of air valves.
3. Support insulation with clips anchored to manhole or vault wall.

E. Carbon Filter: Install in accordance with manufacturer's recommendations.

F. Pipe Support: Install in accordance with details as shown on the Drawings.

3.02 TESTING AND INSPECTION

A. Air Valve:

1. May be either tested while testing pipelines, or as a separate step.
2. Isolation valves shall be in open position during pipeline test.

B. Isolation Valves: Test that valves open and close smoothly with operating pressure on one side and atmospheric pressure on the other.

C. Air and Vacuum Valves: Inspect valves as pipe is being filled to verify venting and seating is fully functional.

D. Verify leak-free performance during testing.

E. Using the test kit provided by the manufacturer of the inflow prevention device, perform inflow prevention test as recommended by the manufacturer.

END OF SECTION

SECTION 33 12 19
WATER UTILITY DISTRIBUTION FIRE HYDRANTS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. C502, Dry-Barrel Fire Hydrants.
   b. C503, Wet Barrel Fire Hydrants.
   c. C600, Installation of Ductile-Iron Mains and Their Appurtenances.
2. ASTM International (ASTM): C94, Standard Specification for Ready-Mixed Concrete.
3. FM Global Approved.
4. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
5. UL: 246, Standard for Hydrants for Fire-Protection Service.

1.02 SUBMITTALS

A. Action Submittals: Shop Drawings.

1. Product data.
2. Include calculations for thrust blocks for high-pressure installations (if required).

B. Informational Submittal:

1. Certificate of Compliance: Upon completion of the system installation, verify all fire department hose connections, and check all fire safety devices to ensure their readiness for emergency connection and operation.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by

manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 HIGH PRESSURE HYDRANT

A. Manufacturers and Products:

1. Hydrant:
   a. Mueller Co.; Super Centurion 250 Catalog Number A-423.
   b. Or equal.

B. Physical Characteristics:

1. Hydrant:
   a. Break flange or safety top type.
   b. Nominal 5-1/4-inch minimum main valve opening with 6-inch bottom connections.
   c. Two 2-1/2-inch hose nozzles.
   d. One 4-1/2-inch pumper nozzle.
   e. Operating Nut: 1-1/2-inch National Standard pentagon nut.
   f. Mechanical joint inlet connection, 6-inch size.
   g. Painted above ground line.
      1) Hydrant shall have shop applied coat of paint. After installation, apply two additional coats of a compatible paint on the exposed portion of the hydrant. Color will be red and to be selected by the Contracting Officer. Paint shall be a high gloss exterior alkyd enamel.
   h. Five-foot extension marker to identify when covered by winter snow.
2. Main Valve:
   a. Depth of Bury: 4 feet minimum.
   b. Equip with O-ring seals.
   c. Valve opens to the left (counterclockwise rotation).

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Hydrant:
   a. Conform to AWWA C502.
   b. Working pressure of 250 psi.
   c. UL 246 listed.

2.03 FLUSH TYPE HYDRANTS

A. Manufacturers and Products:

1. Mueller Co.
2. Or equal.

B. Physical Characteristics:

1. Hydrant:
   a. Below-grade.
   b. Nominal 2-1/8-inch main valve opening one way.
   c. Compression type main valve closes with pressure.
   d. Conform to AWWA C502, dry barrel design.
   e. One 2-1/2-inch hose nozzle.
   f. Operating Nut: 1-1/2-inch National Standard pentagon nut.
   g. Mechanical joint inlet connection.
   h. Cast iron flush box and pipe barrel.
   i. NSF 61 and NSF 372 compliant.
   j. Install flush box lid even with ground.

C. Functional Characteristics: To flush water main to improve water quality.

D. Performance Characteristics: None.

E. Main Valve: Depth of bury 4 feet.

2.04 YARD HYDRANT

A. Manufacturers and Products:

1. Woodford sanitary yard hydrant S4H.
2. Or equal.

B. Physical Characteristics:

1. Cast iron yard hydrant with galvanized steel 3/8-inch rod.
2. 3/4-FNPT inlet with 1/8 drain hole and lockable handle.
3. Freeze proof, backflow protected, self closing.
4. NSF 61 and NSF 372 compliant.

C. Functional Characteristics: To flush water main to improve water quality.

D. Performance Characteristics: None.

2.05 PRECAST CONCRETE PIER BLOCK

A. Nominal dimensions of 8-inch thickness by 16-inch square base.

B. Compressive Strength: 3,000 psi at 28 days.

2.06 GRAVEL FOR DRAINAGE

A. Washed 3/4-inch drainage gravel. Free of organic matter, sand, loam, clay, and other small particles that will restrict water flow through gravel.

2.07 CONCRETE FOR THRUST BLOCKING

A. Ready-mix meeting ASTM C94, Alternative 2.

B. Compressive Strength: 2,500 psi at 28 days.

C. Aggregate Size: 1-1/2 inches.

D. Slump: 2 inches to 4 inches.

PART 3 EXECUTION

3.01 GENERAL

A. Install hydrants in accordance with Section 3.7 and Section 3.8 of AWWA C600, unless specified otherwise.

3.02 EXCAVATION

A. Excavate to subgrade. Fill over excavated areas with foundation stabilization material. Tamp to provide firm foundation.

3.03 BASE BLOCK

A. Place on firm, level subgrade to ensure uniform support.

3.04 INSTALLATION OF HYDRANTS

A. Locate hydrants to provide accessibility and to minimize potential damage from vehicles.

1. Relocate improperly set hydrants.
2. Hydrant Located behind Curbs: Set barrel so pumper nozzle or hose nozzle caps are a minimum of 18 inches from gutter face of curb.
3. Hydrant Located in Space between Curb and Sidewalk: Not less than 8 inches, clear from sidewalks.

4. Hydrant Located between Sidewalk and Property Line: Minimum clearance 8 inches from sidewalk.
5. Set hydrants so safety flange is a minimum of 2 inches above finished ground or sidewalk level.

B. Place hydrant on base block carefully to prevent the base block from breaking.

C. Joints shall conform to Section 3.4 of AWWA C600 when cast or ductile iron pipe is used.

D. Maintain hydrant in a plumb position during subsequent Work.

3.05 GRAVEL FOR DRAINAGE

A. Place gravel around base block and hydrant bottom in accordance with Section 3.7 of AWWA C600.

3.06 CONCRETE THRUST BLOCKING

A. Place blocking after hydrant is set in final position and join to pipe.

B. Concrete thrust block shall have a minimum of 4 square feet of bearing area against undisturbed earth for a standard pressure installation.

1. Calculate required bearing area for high pressure installation.

3.07 TESTING AND INSPECTION

A. Hydrostatic testing: Test in accordance to main waterline testing requirements.

B. Inspection and service pressure testing: Coordinate with Los Alamos Fire Department for final inspection and pressure testing.

END OF SECTION

SECTION 33 13 00
DISINFECTION OF WATER UTILITY DISTRIBUTION FACILITIES

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Water Works Association (AWWA):
   a. B300, Hypochlorites.
   b. B301, Liquid Chlorine.
   c. B303, Sodium Chlorite.
   d. C651, Disinfecting Water Mains.
   e. C652, Disinfection of Water Storage Facilities.
   f. C653, Disinfection of Water Treatment Plants.
2. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
3. Standard Methods for the Examination of Water and Wastewater, as published by American Public Health Association, American Water Works Association, and the Water Environment Federation.

1.02 SUBMITTALS

A. Informational Submittals:

1. Plan describing and illustrating conformance to appropriate AWWA standards and this specification.
2. Procedure and plan for cleaning system.
3. Procedures and plans for disinfection and testing.
4. Proposed locations within system where Samples will be taken.
5. Type of disinfecting solution and method of preparation.
6. Certification that employees working with concentrated chlorine solutions or gas have received appropriate safety training.
7. Method of disposal for highly chlorinated disinfecting water.
8. Independent Testing Agency: Certification that testing agency is qualified to perform chlorine concentration testing bacteriological testing in accordance with AWWA standards, agency requirements, and this specification.
9. Certified Bacteriological Test Results:
   a. Facility tested is free from coliform bacteria contamination.
   b. Forward results directly to Contracting Officer.

1.03 QUALITY ASSURANCE

A. Independent Testing Agency: Certified in the State of New Mexico with 10 years' experience in field of water sampling and testing. Agency shall use calibrated testing instruments and equipment, and documented standard procedures for performing specified testing.

1.04 SEQUENCING

A. Commence initial disinfection after completion of following:

1. Completion and acceptance of internal painting of system(s).
2. Hydrostatic and pneumatic testing, pressure testing, functional and performance testing and acceptance of pipelines, pumping systems, structures, and equipment.
3. Disinfection of:
   a. Pumps and associated system piping.
   b. Treatment plant basins and processes used to supply water to system.

PART 2 PRODUCTS

2.01 GENERAL

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 DISINFECTANTS

A. Acceptable Disinfectants:

1. Liquid Chlorine.
2. Sodium Hypochlorite.

B. Unacceptable Disinfectants: Calcium Hypochlorite

2.03 WATER FOR DISINFECTION AND TESTING

A. Clean, uncontaminated, and potable.

B. Make arrangements for water supply and convey water in disinfected pipelines or containers.

PART 3 EXECUTION

3.01 GENERAL

A. Conform to AWWA C651 for pipes and pipelines AWWA C652 for tanks and reservoirs, except as modified in these Specifications.

B. Contractor's Equipment:

1. Furnish chemicals and equipment, such as pumps and hoses, to accomplish disinfection.
2. Water used to fill pipeline may be supplied using a temporary connection to existing distribution system. Provide protection against cross-connections as required by AWWA C651.

C. Disinfect the following items installed or modified under this Project, intended to hold, transport, or otherwise contact potable water:

1. Pumps.
2. Tanks.
3. Filters.
4. Pipelines: Disinfect new pipelines that connect to existing pipelines up to point of connection.
5. Disinfect surfaces of materials that will contact finished water, both during and following construction, using one of the methods described in AWWA C652 and AWWA C653. Disinfect prior to contact with finished water. Take care to avoid recontamination following disinfection.

D. Prior to application of disinfectants, clean pump tank, filters, and pipelines of loose and suspended material.

E. Allow freshwater and disinfectant solution to flow into pipe or vessel at a measured rate so chlorine-water solution is at specified strength. Do not place concentrated liquid commercial disinfectant in pipeline or other facilities to be disinfected before it is filled with water.

3.02 TURBIDITY

A. Cleaning of equipment and facilities shall include removal of materials that result in a turbidity exceeding limits stated in Article Testing.

3.03 PIPING

A. Cleaning:

1. Before disinfecting, clean foreign matter from pipe in accordance with AWWA C651.
2. If continuous feed method or slug method of disinfection, as described in AWWA C651, are used flush pipelines with potable water until clear of suspended solids and color. Provide hoses, temporary pipes, ditches, and other conduits as needed to dispose of flushing water without damage to adjacent properties.
3. Flush service connections and hydrants. Flush distribution lines prior to flushing hydrants and service connections. Operate valves during flushing process at least twice during each flush.
4. Flush pipe through flushing branches and remove branches after flushing is completed.
5. Pipeline shall be cleaned by use of a pipe pig specifically designed for cleaning. Observe material removed by pig on each pass. Repeat process until pipe has been cleaned to the satisfaction of Contracting Officer.

B. Disinfecting Procedure: In accordance with AWWA C651, unless herein modified.

3.04 PUMPS

A. Disinfecting Solutions: Minimum free chlorine concentration of 100 ppm.

B. Application:

1. Inject disinfecting solution into pump and associated piping and circulate for a minimum 3-hour period of time. At end of 3-hour period, solution shall have a strength of at least 50 ppm free chlorine.
2. Operate valves and pump appurtenances during disinfection to ensure disinfecting solution is dispersed into all parts of pump and lines.
3. If disinfecting solution contained in pump has a residual free chlorine concentration less than 50 ppm after the 3-hour retention period, reclean pump, reapply disinfecting solution, and retest until a satisfactory test result is obtained.
4. After chlorination, flush water from pump until water through unit is chemically and bacteriologically equal to permanent source of supply.

3.05 TANKS AND RESERVOIRS

A. Cleaning:

1. Clean interior surfaces using water under pressure before sterilizing.
2. Isolate tank and reservoir from system to prevent contaminating materials from entering distribution system.
3. Cleaning shall:
   a. Remove deposits of foreign nature.
   b. Remove biological growths.
   c. Clean slopes, walls, top, and bottom.
   d. Avoid damage to structure.
   e. Avoid pollution or oil deposits by workers and equipment.
4. Dispose of water used in cleaning in accordance with applicable regulations before adding disinfecting solution to tank and reservoir.

B. Disinfecting Procedure: In accordance with AWWA C652, unless herein modified. Parts of structures, such as ceilings or overflows that cannot be immersed, shall be spray or brush disinfected.

3.06 FILTERS

A. Prior to disinfection, remove foreign material from filtration structures. Clean using fire hoses and tools suitable for adequate scrubbing and cleaning. Pump or drain scrub water from structures.

B. Disinfection Procedure: In accordance with AWWA C653, unless herein modified.

3.07 DISPOSAL OF CHLORINATED WATER

A. Do not allow flow into a waterway without neutralizing disinfectant residual.

B. See appendix of AWWA C651for acceptable neutralization methods.

3.08 TESTING

A. Collection of Samples:

1. Coordinate activities to allow Samples to be taken in accordance with this specification.
2. Provide valves at sampling points.
3. Provide access to sampling points.

B. Test Equipment:

1. Clean containers and equipment used in sampling and make sure they are free of contamination.
2. Obtain sampling bottles with instructions for handling from an independent testing laboratory.

C. Chlorine Concentration Sampling and Analysis:

1. Collect and analyze Samples in accordance with AWWA C651.
2. Sampling Frequency for Disinfection Solution: Two Samples per 24 hours.
3. Residual Free Chlorine Samples: Two samples per 24 hours.
4. Analysis to be performed by the Contractor's laboratory. Laboratory is required to be State of New Mexico Environment Department certified and acceptable to the Contracting Officer and other applicable local regulatory agencies. Samples will analyzed using amperometric titration method for free chlorine as described in latest edition of Standard Methods for the Examination of Water and Wastewater.

D. Turbidity Sampling and Analysis:

1. After tanks, reservoirs, filters, pumps, and pipelines have been cleaned, disinfected, and refilled with potable water, Contractor will take water Samples and have them analyzed for conformance to turbidity limitations for public drinking water supplies. Turbidity shall not exceed 0.3 NTU.
2. If turbidity is in excess of the limit, dispose of the water in accordance with this specification and applicable regulations, take action to remove source of turbidity, refill system, and retest.

E. If minimum Samples required above are bacterially positive, disinfecting procedures and bacteriological testing shall be repeated until bacterial limits are met.

END OF SECTION

SECTION 40 05 15
PIPING SUPPORT SYSTEMS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Civil Engineers (ASCE): 7, Minimum Design Loads for Buildings and Other Structures.
2. American Society of Mechanical Engineers (ASME): B31.1, Power Piping.
3. ASTM International (ASTM):
   a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   b. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvanealed) by the Hot-Dip Process.
   c. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
4. International Code Council (ICC):
5. International Building Code (IBC).
6. International Mechanical Code (IMC).
7. Manufacturers' Standardization Society (MSS):
   a. SP 58, Pipe Hangers and Supports—Materials, Design and Manufacture.
   b. SP 127, Bracing for Piping Systems Seismic-Wind-Dynamic Design, Selection, and Application.

1.02 DEFINITIONS

A. Wetted or Submerged: Submerged, less than 1 foot above liquid surface, below top of channel wall, under cover or slab of channel or tank, or in other damp locations.

1.03 SUBMITTALS

A. Action Submittals:

1. Catalog information and drawings of piping support system, locating each support, sway brace, seismic brace, hanger, guide, component, and anchor for piping 6 inches and larger. Identify support, hanger, guide, and anchor type by catalog number and Shop Drawing detail number.

2. Calculations for each type of pipe support, attachment, and anchor.
3. Revisions to support systems resulting from changes in related piping system layout or addition of flexible joints.
4. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Maintenance information on piping support system.

1.04 QUALIFICATIONS

A. Piping support systems shall be designed, and Shop Drawings prepared and sealed, by a registered professional engineer in the state of New Mexico.

1.05 DESIGN REQUIREMENTS

A. General:

1. Piping supports are shown around and throughout facilities. Drawings and Standard Details indicate the general type and location of supports. Additional pipe supports may be required in addition to those shown on the Drawings. It is the responsibility of the Contractor and/or subcontractor designing the systems to design, size and locate piping supports throughout the facilities whether shown or not. If, by opinion of the Contractor, additional or different piping support types or quantities are required, Contractor shall submit the recommended pipe support systems for Contracting Officer’s review.
2. Meet requirements of MSS SP 58 and ASME B31.1 or as modified by this section.

B. Pipe Support Systems:

1. Pipe support systems shall be designed for gravity and thrust loads imposed by weight of pipes or internal pressures, including insulation and weight of fluid in pipes.
2. Seismic loads in accordance with governing codes and as shown on Structural Notes on the Drawings.
3. Wind loads in accordance with governing codes and as shown on Structural Notes on the Drawings.

4. Maximum Support Spacing and Minimum Rod Size: In accordance MSS SP 58 Table 3 and Table 4.
   a. Ductile-iron Pipe 8 Inches and Under: Maximum span limited to that for standard weight steel pipe for water service.

C. Anchoring Devices: Design, size, and space support anchoring devices, including anchor bolts, inserts, and other devices used to anchor support, to withstand shear and pullout loads imposed by loading and spacing on each particular support.

D. Vertical Sway Bracing: 10-foot maximum centers or as shown.

E. Pedestrian Bridge Pipe Hangers:

1. Provide a submittal of the beam clamp and pipe hanger system for review and approval prior to placement. The submittal shall also identify locations of the hangers along the bridge.
2. Grout used for pipe penetration through the abutment shall be nonmetallic and shrink resistant and shall conform to ASTM C1107.
3. Provide a submittal of the pipe insulation and jacket for review and approval prior to placement.
4. Provide a submittal of the pipe expansion assembly for review and approval prior to placement.

PART 2 PRODUCTS

2.01 GENERAL

A. Special support and hanger products may be required for cases where standard catalog supports described in this section are not applicable.

B. Materials: In accordance with Table 1, attached as supplements at end of section.

C. Physical Characteristics: As described in subsections below.

D. Functional Characteristics: As described in subsections below.

E. Performance Characteristics: As described in subsections below.

2.02 PIPE SADDLES

A. Manufacturers and Products:

1. Nonadjustable Saddle: MSS SP 58, Type 37 with U-bolt.
   a. Anvil; Figure 259, sizes 4 inches through 36 inches with Figure 63C base.
   b. Or equal.

2. Adjustable Saddle: MSS SP 58, Type 38 without clamp.
   a. Anvil; Figure 264, sizes 2-1/2 inches through 36 inches with Figure 62C base.
   b. Or equal.

B. Physical Characteristics:

1. Provide 90-degree to120-degree pipe saddle for pipe 6 inches and larger with baseplates drilled for anchors bolts.
2. Minimum standard weight pipe stanchion, saddle, and anchoring flange as applicable.

C. Functional Characteristics: None.

D. Performance Characteristics: None.

2.03 CHANNEL TYPE SUPPORT SYSTEMS

A. Manufacturers:

1. Unistrut.
2. Or equal.

B. Physical Characteristics:

1. Channel Size: 12-gauge, 1-5/8-inch wide minimum steel, or 1-1/2-inch wide, minimum FRP.
2. Fasteners: Vinyl ester fiber, polyurethane base composite nuts and bolts, or encapsulated steel fasteners.

C. Functional Characteristics: None.

D. Performance Characteristics:

1. Members and Connections: Design for loads using one-half of manufacturer’s allowable loads.

2.04 ELBOW AND FLANGE SUPPORTS

A. Elbow with Adjustable Stanchion: Sizes 2 inches through 18 inches:

1. Manufacturers and Products:
   a. Anvil; Figure 62C base.
   b. Or equal.
2. Physical Characteristics:
   a. Materials: In accordance with Table 1, attached as supplements at end of section.

3. Functional Characteristics:
    a. Designed for support for stationary pipe elbows where vertical adjustment is required.
    b. Refer to requirements listed in Paragraph Pipe Support Systems within this specification.
4. Performance Characteristics: Refer to general requirements listed in Article Design Requirements within this specification.

B. Elbow with Nonadjustable Stanchion: Sizes 2-1/2 inches through 42 inches;

1. Manufacturers and Products:
    a. Anvil; Figure 63A or Figure 63B base.
    b. Or equal.
2. Physical Characteristics:
    a. Materials: In accordance with Table 1, attached as supplements at end of section.
3. Functional Characteristics:
    a. Designed for support for stationary pipe elbows where vertical adjustment is not required.
    b. Refer to requirements listed in Paragraph Pipe Support Systems within this specification.
4. Performance Characteristics: Refer to general requirements listed in Article Design Requirements within this specification.

C. Flange Support with Adjustable Base: Sizes 2 inches through 24 inches.

1. Manufacturers and Products:
    a. Standon; Model S89.
    b. Or equal.
2. Physical Characteristics:
    a. Materials: In accordance with Table 1, attached as supplements at end of section.
3. Functional Characteristics:
    a. Designed for support for stationary pipe where vertical adjustment is required, in which support attaches/conforms to pipe flange geometry in lieu of pipe saddle or elbow connection.
    b. Refer to requirements listed in Paragraph Pipe Support Systems within this specification.
4. Performance Characteristics: Refer to general requirements listed in Article Design Requirements within this specification.

2.05 PIPE ANCHORS

A. Manufacturers and Products:

1. B-Line; Figure B3147A or Figure B3147B.
2. Or equal.

B. Physical Characteristics:

1. Type: Anchor chair with U-bolt strap.
2. Materials: In accordance with Table 1, attached as supplements at end of section.

C. Functional Characteristics:

1. Designed for anchoring pipe to adjacent structure via baseplate/anchor chair with holes for passing U-bolt strap.
2. Refer to requirements listed in Paragraph Pipe Support Systems within this specification.

D. Performance Characteristics: Refer to general requirements listed in Article Design Requirements within this specification.

2.06 SEISMIC RESTRAINTS

A. Manufacturers:

1. Mason Industries.
2. Or equal.

B. Physical Characteristics:

1. Solid pipe bracing attachment to pipe clevis with clevis cross brace and angle rod reinforcement.
2. Materials: In accordance with Table 1, attached as supplements at end of section.

C. Functional Characteristics: None.

D. Performance Characteristics: Refer to general requirements listed in Article Design Requirements within this specification.

2.07 ACCESSORIES

A. Anchor Bolts:

1. Physical Characteristics:
   a. Bolt Length (Extension Above Top of Nut):
      1) Minimum Length: Flush with top of nut preferred. If not flush, shall be no more than one thread recessed below top of nut.
      2) Maximum Length: No more than a full nut depth above top of nut.
2. Functional Characteristics: None.

3. Performance Characteristics:
   a. Size and Material: Sized by Contractor for required loads, 1/2-inch minimum diameter, and as specified in Section 05 05 19, Post-Installed Anchors, or Section 05 50 00, Metal Fabrications.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:

1. Install support systems in accordance with MSS SP 58, unless shown otherwise.
2. Install pipe hanger rods plumb, within 4 degrees of vertical during shut down, start up or operations.
3. Support piping connections to equipment by pipe support and not by equipment.
4. Support large or heavy valves, fittings, and appurtenances independently of connected piping.
5. Do not support pipes from piping above it.
6. Support pipe at changes in direction or in elevation, adjacent to flexible joints and couplings, and where shown.
7. Do not install pipe supports and hangers in equipment access areas or monorail hoist runs.
8. Brace hanging pipes against horizontal movement by both longitudinal and lateral sway bracing and to reduce movement after startup.
9. Install lateral supports for seismic loads at changes in direction.
10. Install pipe anchors where required to withstand expansion thrust loads and to direct and control thermal expansion.
11. Repair mounting surfaces to original condition after attachments are completed.

B. Standard Pipe Supports:

1. Horizontal Suspended Piping:
   a. Single Pipes: Clevis hangers or adjustable swivel split-ring.
   b. Grouped Pipes: Trapeze hanger system.
2. Horizontal Piping Supported from Walls:
   a. Single Pipes: Wall brackets, or attached to wall, or to wall mounted framing with anchors.
   b. Stacked Piping: Wall mounted framing system and “J” hangers acceptable for pipe smaller than 3-inch.
   c. Pipe clamp that resists axial movement of pipe through support is not acceptable. Use pipe rollers supported from wall bracket.

3. Horizontal Piping Supported from Floors:
    a. Saddle Supports:
        1) Pedestal Type, elbow and flange.
        2) Provide minimum 1-1/2-inch grout beneath baseplate.
    b. Floor Mounted Channel Supports:
        1) Use for pipe smaller than 3-inch running along floors and in trenches at pipe elevations lower than can be accommodated using pedestal pipe supports.
        2) Attach channel framing to floors with baseplate on minimum 1-1/2-inch nonshrink grout and with anchor bolts.
        3) Attach pipe to channel with clips or pipe clamps.
    c. Concrete Cradles: Use for pipe larger than 3 inches along floor and in trenches at pipe elevations lower than can be accommodated using stanchion type.
4. Insulated Pipe:
    a. Pipe hanger and support shall be on outside of insulation. Do not enclose within insulation.
    b. Provide precut 120-degree sections of rigid insulation (minimum length same as shield), shields and oversized hangers or insulated saddle system (ISS).
    c. Wall-mounted pipe clips not acceptable for insulated piping.
5. Vertical Pipe: Support with wall bracket and elbow support, or riser clamp on floor penetration.

C. Standard Attachments:

1. New Concrete Ceilings:
    a. Concrete inserts, concrete attachment plates, or concrete anchors as limited below:
        1) Single point attachment to ceiling allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
        2) Where there is vibration or bending considerations, do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
2. Existing Concrete Ceilings:
    a. Channel type support with minimum of two anchor points, concrete attachment plates or concrete anchors as limited below:
        1) Single point attachment to ceiling is allowed only for 3/4-inch rod and smaller (8 inches and smaller pipe).
        2) Where there is vibration or bending considerations do not connect a single pipe support hanger rod directly to a drilled concrete anchor (single point attachment) regardless of size.
3. Steel Beams: I-beam clamp or welded attachments.

4. Concrete Walls: Concrete inserts or brackets or clip angles with concrete anchors.
5. Concrete Beams: Concrete inserts, or if inserts are not used attach to vertical surface similar to concrete wall. Do not drill into beam bottom.

D. Saddles for Steel or Concrete Pipe: Provide 90-degree to120-degree pipe saddle for pipe sizes 6 inches and larger when installed on top of steel or concrete beam or structure, pipe rack, trapeze, or where similar concentrated point supports would be encountered.

E. Intermediate and Pipe Alignment Guides:

1. Provide pipe alignment guides, or pipe supports that provide same function, at expansion joints and loops.
2. Guide pipe on each side of expansion joint or loop at 4 pipe and 14 pipe diameters from each joint or loop.
3. Install intermediate guides on metal framing support systems not carrying pipe anchor or alignment guide.

F. Accessories:

1. Insulation Shield: Install on insulated piping with oversize rollers and supports.
2. Dielectric Barrier:
   a. Provide between painted or galvanized carbon steel members and copper or stainless steel pipe or between stainless steel supports and nonstainless steel ferrous metal piping.
   b. Install rubber wrap between submerged metal pipe and oversized clamps.

3.02 FIELD FINISHING

A. Paint atmospheric exposed surfaces hot-dip galvanized steel components as specified in Section 09 90 00, Painting and Coating.

3.03 SUPPLEMENT

A. The supplement listed below, following “End of Section,” is a part of this specification:

1. Table 1: Nonchemical Areas.

END OF SECTION

TABLE 1 NONCHEMICAL AREAS	
Exposure Conditions	**Support Material**
Outdoor Areas	Type 316 stainless steel
Process Areas: All	Type 316 stainless steel

SECTION 40 27 00
PROCESS PIPING—GENERAL

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section and any supplemental Data Sheets:

1. American Society of Mechanical Engineers (ASME):
   a. Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
   b. B1.20.1, Pipe Threads, General Purpose (Inch).
   c. B16.1, Gray Iron Pipe Flanges and Flanged Fittings Classes 25, 125, and 250.
   d. B16.3, Malleable Iron Threaded Fittings Classes 150 and 300.
   e. B16.5, Pipe Flanges and Flanged Fittings NPS 1/2 through NPS 24 Metric/Inch Standard.
   f. B16.9, Factory-Made Wrought Buttwelding Fittings.
   g. B16.11, Forged Fittings, Socket-Welding and Threaded.
   h. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   i. B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   j. B16.25, Buttwelding Ends.
   k. B16.42, Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300.
   l. B31.1, Power Piping.
   m. B31.3, Process Piping.
   n. B31.9, Building Services Piping.
   o. B36.10M, Welded and Seamless Wrought Steel Pipe.
2. American Society for Nondestructive Testing (ASNT): SNT-TC-1A, Recommended Practice for Personal Qualification and Certification in Nondestructive Testing.
3. American Water Works Association (AWWA):
   a. C104/A21.4, Cement-Mortar Lining for Ductile-Iron Pipe and Fittings.
   b. C105/A21.5, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   c. C110/A21.10, Ductile-Iron and Gray-Iron Fittings.
   d. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   e. C115/A21.15, Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.

f. C151/A21.51, Ductile-Iron Pipe, Centrifugally Cast.
g. C153/A21.53, Ductile-Iron Compact Fittings.
h. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. Through 144 In. (100 mm Through 3,600 mm).
i. C606, Grooved and Shouldered Joints.

4. American Welding Society (AWS):
   a. D1.1/D1.1M, Structural Welding Code - Steel.
   b. QC1, Standard for AWS Certification of Welding Inspectors.
5. ASTM International (ASTM):
   a. A47/A47M, Standard Specification for Ferritic Malleable Iron Castings.
   b. A53/A53M, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   c. A105/A105M, Standard Specification for Carbon Steel Forgings for Piping Applications.
   d. A106/A106M, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
   e. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   f. A135/A135M, Standard Specification for Electric-Resistance-Welder Steel Pipe.
   g. A139/A139M, Standard Specification for Electro-Fusion (Arc)–Welded Steel Pipe (NPS 4 Inches and Over).
   h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
   i. A181/A181M, Standard Specification for Carbon Steel Forgings, for General-Purpose Piping.
   j. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   k. A183, Standard Specification for Carbon Steel Track Bolts and Nuts.
   l. A193/A193M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
   m. A240/A240M, Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   n. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   o. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   p. A320/A320M, Standard Specification for Alloy-Steel and Stainless Steel Bolting for Low-Temperature Service.
   q. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.

r. A403/A403M, Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
s. A563, Standard Specification for Carbon and Alloy Steel Nuts.
t. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
u. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
v. B32, Standard Specification for Solder Metal.
w. D1330, Standard Specification for Rubber Sheet Gaskets.
x. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
y. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
z. D2000, Standard Classification System for Rubber Products in Automotive Applications.
aa. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
bb. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
cc. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
dd. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
ee. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.

6. FM Global (FM).
7. Manufacturers Standardization Society of the Valve and Fittings Industry, Inc. (MSS): SP-43, Wrought and Fabricated Butt-Welding Fittings for Low-Pressure, Corrosion Resistant Applications.
8. NSF International (NSF):
   a. ANSI 61: Drinking Water System Components - Health Effects.
   b. ANSI 372: Drinking Water System Components - Lead Content.

1.02 DEFINITIONS

A. Submerged or Wetted:

1. Zone below elevation of:
   a. Top face of channel walls and cover slabs.
   b. Top of basin or tank wall or under tank cover.

1.03 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Shop Fabricated Piping:
      1) Detailed pipe fabrication or spool drawings showing special fittings and bends, dimensions, coatings, and other pertinent information.
      2) Layout drawings showing locations of each pipe section and each special length; number or otherwise designate laying sequence on each piece.
      3) Shop drawings are required for all piping systems, regardless of exposure type indicated on the Drawings, including encased piping systems underneath and adjacent to each facility.
   b. Pipe Wall Thickness: Identify wall thickness and rational method or standard applied to determine wall thickness for each size of each different service including exposed, submerged, buried, and concrete-encased installations for Contractor-designed piping.
   c. Hydraulic Thrust Restraint for Restrained Joints: Details including materials, sizes, assembly ratings, and pipe attachment methods.
   d. Dissimilar Buried Pipe Joints: Joint types and assembly drawings.
   e. Pipe Corrosion Protection: Product data.
   f. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Manufacturer’s Certification of Compliance, in accordance with Section 01 67 00, Product Requirements.
2. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
3. Flanged Pipe and Fittings: Manufacturer’s product data sheets for gaskets including torqueing requirements and bolt tightening procedures.
4. Qualifications:
   a. Nondestructive Testing Personnel: SNT-TC-1A Level II certification and qualifications.
   b. AWS QC1 Certified Welding Inspector: Submit evidence of current certification prior to commencement of welding activities.
   c. Welders:
      1) Continuity log for welders and welding operators.
      2) Welder qualification test records conducted by Contractor or manufacturer.

5. Welding Procedures: Qualified in accordance with ASME Boiler and Pressure Vessel Code, Section IX for weld type(s) and base metal(s).
6. Nondestructive inspection and testing procedures.
7. Test logs.
8. Pipe coating applicator certification.
9. Laboratory Testing Equipment: Certified calibrations, manufacturer's product data, and test procedures.
10. CWI inspection records and NDE test records.

1.04 QUALITY ASSURANCE

A. Qualifications:

1. Independent Inspection and Testing Agency:
   a. Ten years' experience in field of welding and welded pipe and fittings' testing required for this Project.
   b. Calibrated instruments and equipment and documented standard procedures for performing specified testing.
   c. Certified in accordance with ASNT SNT-TC-1A for testing procedures required for this Project.
   d. Testing Agency: Personnel performing tests shall be NDT Level II certified in accordance with ASNT SNT-TC-1A.
   e. Verification Welding Inspector: AWS QC1 Certified.
2. Welding Procedures: In accordance with ASME BPVC SEC IX (Forms QW-482 and QW-483) or AWS D1.1/D1.1M (Annex N Forms).
3. Welder Qualifications: In accordance ASME BPVC SEC IX (Form QW-484) or AWS D1.1/D1.1M (Annex N Forms).
4. Contractor's CWI: Certified in accordance with AWS QC1 and having prior experience with specified welding codes. Alternate welding inspector qualifications require approval by Contracting Officer.

B. Quality Assurance: Provide services of independent inspection and testing agency for welding operations.

1. Note, the presence of Contracting Officer's Special Inspector or Verification CWI does not relieve Contractor from performing own quality control, including 100 percent visual inspection of welds.

1.05 DELIVERY, STORAGE, AND HANDLING

A. In accordance with Section 01 67 00, Product Requirements:

1. Flanges: Securely attach metal, hardboard, or wood protectors over entire gasket surface.
2. Threaded or Socket Welding Ends: Fit with metal, wood, or plastic plugs or caps.
3. Linings and Coatings: Prevent excessive drying.

4. Cold Weather Storage: Locate products to prevent coating from freezing to ground.
5. Handling: Use heavy canvas or nylon slings to lift pipe and fittings.

PART 2 PRODUCTS

2.01 GENERAL PERFORMANCE REQUIREMENTS

A. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

B. Where pipe diameter, thickness, pressure class, pressure rating, or thrust restraint is not shown or specified, design piping system in accordance with the following:

1. Process Piping: ASME B31.3, normal fluid service unless otherwise specified.
2. Building Service Piping: ASME B31.9, as applicable.
   a. Sanitary Building Drainage and Vent Systems: ICC International Plumbing Code and local plumbing code.
3. Thrust Restraints: Design for test pressure as shown on the Drawings.

2.02 PIPING

A. Physical Characteristics:

1. Diameters Shown on the Drawings:
   a. Standardized Products: Nominal size.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. As specified on Piping Data Sheets in Article Supplements in this section and on the Drawings.
2. Fabricated Steel Piping (Except Cement-Lined): Outside diameter, ASME B36.10M.

2.03 JOINTS

A. Manufacturers:

1. Pipeline Products Corp.
2. Or equal.

B. Physical Characteristics:

1. Grooved End System:
   a. Rigid type.
   b. Use of flexible grooved joints allowed where shown on the Drawings or with prior approval by Contracting Officer.
   c. Flanges: When required, furnish with grooved type flange adapters of same manufacturer as grooved end couplings.
2. Flanged Joints:
   a. Flat-faced, carbon steel, or alloy flanges when mating with flat-faced cast or ductile iron flanges.
   b. Higher pressure rated flanges as required to mate with equipment when equipment flange is of higher pressure rating than required for piping.
   c. One piece PVC flanges when mating with flat-faced PVC, Class 125.
3. Mechanical Joint Anchor Gland Follower:
   a. Thrust rated to 250 psi minimum.
   b. UL and FM approved.
   c. Ductile iron anchor type, wedge action, with break-off tightening bolts.
   d. Rated operating deflection not less than:
      1) 3 degrees for sizes through 12 inches.
      2) 2 degrees for sizes 14 inches through 16 inches.
      3) 1.5 degrees for sizes 18 inches through 24 inches.
      4) 1 degree for sizes 30 inches through 48 inches.

C. Functional Characteristics:

1. Mechanical connections of high-density polyethylene pipe to auxiliary equipment such as valves, pumps, tanks, and other piping systems shall be through-flanged connections consisting of the following:
   a. Polyethylene stub end thermally butt-fused to end of pipe.
   b. ASTM A240/A240M, Type 304 stainless steel backing flange, 125-pound, ASME B16.1 standard. Use insulating flanges where shown.

c. Bolts and nuts of sufficient length to show a minimum of three complete threads when joint is made and tightened to manufacturer's standard. Retorque nuts after 4 hours.
d. Gaskets as specified on Piping Data Sheets in Article Supplements in this section.

D. Performance Characteristics:

1. Threaded Joints: NPT taper pipe threads in accordance with ASME B1.20.1.
2. Flexible Mechanical Compression Joint Coupling: Stainless steel, ASTM A276, Type 305 bands.

2.04 GASKET LUBRICANT

A. Physical Characteristics: Lubricant shall be supplied by pipe manufacturer.

B. Functional Characteristics: Lubricant shall reduce friction and prevent premature wear of sealing components.

C. Performance Characteristics: Lubricant shall be chemically compatible with gasket material and adjacent joining pipe.

2.05 PIPE CORROSION PROTECTION

A. Flange Insulating Kits:

1. Physical Characteristics:
a. In accordance with applicable piping material specified in Piping Data Sheets in Article Supplements in this section. Complete assembly shall have ASME B31.3 working pressure rating equal to or higher than that of joint and pipeline.
b. Galvanically compatible with piping.
c. Resistant for intended exposure, operating temperatures, and products in pipeline.
d. Gaskets: Full-face, Type E with elastomeric sealing element. Sealing element shall be retained in a groove within retainer portion of gasket.
e. Insulating Sleeves: Full-length fiberglass reinforced epoxy (NEMA LI-1, G-10 grade).
f. Insulating Washers: Fiberglass-reinforced epoxy (NEMA LI-1, G-10 grade).
g. Steel Washers: Hardened steel, ASTM F436, 1/8 inch thick.
1) Flange Diameters 36 Inches or Less: Provide two washers per bolt.
2) Flange Diameters Larger Than 36 Inches: Provide four washers per bolt.

2. Functional Characteristics: None.
3. Performance Characteristics:
   a. Coatings: See Section 09 90 00, Painting and Coating, for details of coating requirements.

2.06 VENT AND DRAIN VALVES

A. Physical Characteristics:

1. Pipeline 2-Inch Diameter and Smaller: 1/2-inch vent, 1-inch drain, unless shown otherwise.
2. Pipelines 2-1/2-Inch Diameter and Larger: 3/4-inch vent, 1-inch drain, unless shown otherwise.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

2.07 FABRICATION

A. Mark each pipe length on outside with the following:

1. Size or diameter and class.
2. Manufacturer’s identification and pipe serial number.
3. Location number on laying drawing.
4. Date of manufacture.

B. Code markings according to approved Shop Drawings.

C. Shop fabricate flanged pipe in shop, not in field, and delivered to Site with flanges in place and properly faced. Threaded flanges shall be individually fitted and machine tightened on matching threaded pipe by manufacturer.

2.08 FINISHES

A. Physical Characteristics: Factory prepare, prime, and finish coat in accordance with Piping Data Sheets in Article Supplements in this section and as shown on the Drawings.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify size, material, joint types, elevation, horizontal location, and pipe service of existing pipelines to be connected to new pipelines or new equipment.

B. Inspect size and location of structure penetrations to verify adequacy of wall pipes, sleeves, and other openings.

3.02 PREPARATION

A. See piping as shown on the Drawings and Section 09 90 00, Painting and Coating, for additional requirements.

B. Notify Contracting Officer at least 2 weeks prior to field fabrication of pipe or fittings.

C. Inspect pipe and fittings before installation, clean ends thoroughly, and remove foreign matter and dirt from inside.

D. Damaged Coatings and Linings: Repair using original coating and lining materials in accordance with manufacturer’s instructions.

3.03 WELDING

A. Perform in accordance with Section IX, ASME Boiler and Pressure Vessel Code and ASME B31.3 for Pressure Piping, as may be specified on Piping Data Sheets in Article Supplements in this section, and if recommended by piping or fitting manufacturer.

B. Weld Identification: Keep paper record of which welder welded each joint.

C. Pipe End Preparation:

1. Machine Shaping: Preferred.
2. Oxygen or Arc Cutting: Smooth to touch, true, and slag removal by chipping or grinding.
3. Beveled Ends for Butt Welding: ASME B16.25.

D. Surfaces:

1. Clean and free of paint, oil, rust, scale, slag, or other material detrimental to welding.
2. Clean stainless steel joints with stainless steel wire brushes or stainless steel wool prior to welding.
3. Thoroughly clean each layer of deposited weld metal, including final pass, prior to deposition of each additional layer of weld metal with a power-driven wire brush.

E. Alignment and Spacing:

1. Align ends to be joined within existing commercial tolerances on diameters, wall thicknesses, and out-of-roundness.
2. Root Opening of Joint: As stated in qualified welding procedure.
3. Minimum Spacing of Circumferential Butt Welds: Minimum four times pipe wall thickness or 1 inch, whichever is greater.

F. Climatic Conditions:

1. Do not perform welding if there is impingement of any rain, snow, sleet, or wind exceeding 5 mph on the weld area, or if ambient temperature is below 32 degrees F.
2. Stainless Steel and Alloy Piping: If ambient is less than 32 degrees F, local preheating to a temperature warm to the hand is required.

G. Tack Welds: Performed by qualified welder using same procedure as for completed weld, made with electrode similar or equivalent to electrode to be used for first weld pass, and not defective. Remove those not meeting requirements prior to commencing welding procedures.

H. Surface Defects: Chip or grind out those affecting soundness of weld.

I. Weld Quality: Meet requirements of governing welding codes.

3.04 INSTALLATION—GENERAL

A. Join pipe and fittings in accordance with manufacturer’s instructions, unless otherwise shown or specified.

B. Remove foreign objects prior to assembly and installation.

C. Flanged Joints:

1. Install perpendicular to pipe centerline.
2. Bolt Holes: Straddle vertical centerlines, aligned with connecting equipment flanges or as shown.

3. Use torque-limiting wrenches to ensure uniform bearing and proper bolt tightness.
4. Plastic Flanges: Install annular ring filler gasket at joints of raised-face flange.
5. Grooved Joint Flange Adapters: Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.
6. Raised-Face Flanges: Use flat-face flange when joining with flat-faced ductile or cast iron flange.
7. Verify compatibility of mating flange to adapter flange gasket prior to selecting grooved adapter flanging.
8. Flange fillers are to be avoided, but if necessary, may be used to make up for small angles up to 6 degrees and for filling gaps up to 2 inches between flanges. Stacked flange fillers shall not be used.
9. Threaded flanged joints shall be shop fabricated and delivered to Site with flanges in-place and properly faced.
10. Manufacturer: Same as pipe manufacturer or grooved joint flange adapter manufacturer.

D. Threaded and Coupled Joints:

1. Conform to ASME B1.20.1.
2. Produce sufficient thread length to ensure full engagement when screwed home in fittings.
3. Countersink pipe ends, ream and clean chips and burrs after threading.
4. Make connections with not more than three threads exposed.
5. Lubricate male threads only with thread lubricant or tape as specified on Piping Data Sheets in Article Supplements in this section.

E. Grooved-End Joints:

1. Piping shall be grooved in accordance with manufacturer’s latest published instructions and shall be accurately cut with tools conforming to coupling manufacturer’s standards and to AWWA C606.
2. Install grooved joint couplings and gaskets in accordance with manufacturer’s latest published installation instructions.

F. Soldered Joints:

1. Use only solder specified for particular service.
2. Cut pipe ends square and remove fins and burrs.
3. After thoroughly cleaning pipe and fitting of oil and grease using solvent and emery cloth, apply noncorrosive flux to the male end only.
4. Wipe excess solder from exterior of joint before hardened.
5. Before soldering, remove stems and washers from solder joint valves.

G. Brazed Joints for Refrigerant Piping:

1. Braze copper piping with silver solder complying with AWS A5.8/A5.8M.
2. Construct joints according to AWS Brazing Handbook, Chapter Pipe and Tube.
3. Inside of tubing and fittings shall be free of flux.
4. Clean parts to be joined with emery cloth and keep hot until solder has penetrated the full depth of the fitting and extra flux has been expelled.
5. Cool joints in air and remove flame marks and traces of flux.
6. During brazing operation, prevent an oxide film from forming on inside of tubing by slowly flowing dry nitrogen to expel the air.
7. When brazing, 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.

H. PVC Piping:

1. Provide Schedule 80 threaded nipple where necessary to connect to threaded valve or fitting.
2. Use strap wrench for tightening threaded plastic joints. Do not overtighten fittings.
3. Do not thread Schedule 40 pipe.

I. Ductile Iron Piping:

1. Cutting Pipe: Cut pipe with milling type cutter, rolling pipe cutter, or abrasive blade cutter. Do not flame cut.
2. Dressing Cut Ends:
   a. General: As required for the type of joint to be made.
   b. Rubber Gasketed Joints: Remove sharp edges or projections.
   c. Push-On Joints: Bevel, as recommended by pipe manufacturer.
   d. Flexible Couplings, Flanged Coupling Adapters, and Grooved End Pipe Couplings: As recommended by the coupling or adapter manufacturer.

3.05 INSTALLATION—EXPOSED PIPING

A. Piping Runs:

1. Parallel to building or column lines and perpendicular to floor, unless shown otherwise.
2. Piping upstream and downstream of flow measuring devices shall provide straight lengths as required for accurate flow measurement.

B. Supports: As specified in Section 40 05 15, Piping Support Systems.

C. Group piping wherever practical at common elevations; install to conserve building space and not interfere with use of space and other work.

D. Unions or Flanges: Provide at each piping connection to equipment or instrumentation on equipment side of each block valve to facilitate installation and removal.

E. Install piping so that no load or movement in excess of that stipulated by equipment manufacturer will be imposed upon equipment connection; install to allow for contraction and expansion without stressing pipe, joints, or connected equipment.

F. Piping clearance, unless otherwise shown:

1. Over Walkway and Stairs: Minimum of 7 feet 6 inches, measured from walking surface or stair tread to lowest extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
2. Between Equipment or Equipment Piping and Adjacent Piping: Minimum 3 feet, measured from equipment extremity and extremity of piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
3. From Adjacent Work: Minimum 1 inch from nearest extremity of completed piping system including flanges, valve bodies or mechanisms, insulation, or hanger/support systems.
4. Do not route piping in front of or to interfere with access ways, ladders, stairs, platforms, walkways, openings, doors, or windows.
5. Headroom in front of openings, doors, and windows shall not be less than the top of the opening.
6. Do not install piping containing liquids or liquid vapors in transformer vaults or electrical equipment rooms.
7. Do not route piping over, around, in front of, in back of, or below electrical equipment including controls, panels, switches, terminals, boxes, or other similar electrical work.

3.06 INSTALLATION—BURIED PIPE

A. Joints:

1. Dissimilar Buried Pipes: Provide flexible mechanical compression joints for pressure pipe.
2. Concrete Encased or Embedded Pipe: Do not encase joints in concrete, unless specifically shown.

B. Placement:

1. Keep trench dry until pipe laying and joining are completed.
2. Pipe Base and Pipe Zone: As specified in Section 31 23 23.15, Trench Backfill.
3. Exercise care when lowering pipe into trench to prevent twisting or damage to pipe.
4. Measure for grade at pipe invert, not at top of pipe.
5. Excavate trench bottom and sides of ample dimensions to permit visual inspection and testing of entire flange, valve, or connection.
6. Prevent foreign material from entering pipe during placement.
7. Close and block open end of last laid pipe section when placement operations are not in progress and at close of day's work.
8. Lay pipe upgrade with bell ends pointing in direction of laying.
9. Deflect pipe at joints for pipelines laid on a curve using unsymmetrical closure of spigot into bell. If joint deflection of standard pipe lengths will not accommodate horizontal or vertical curves in alignment, provide:
   a. Shorter pipe lengths.
   b. Special mitered joints.
   c. Standard or special fabricated bends.
10. After joint has been made, check pipe alignment and grade.
11. Place sufficient pipe zone material to secure pipe from movement before next joint is installed.
12. Prevent uplift and floating of pipe prior to backfilling.

C. PVC and HDPE Pipe Placement:

1. Lay pipe snaking from one side of trench to other.
2. Offset: As recommended by manufacturer for maximum temperature variation between time of solvent welding and during operation.
3. Do not lay pipe when temperature is below 40 degrees F, or above 90 degrees F when exposed to direct sunlight.
4. Shield ends to be joined from direct sunlight prior to and during the laying operation.

D. Tolerances:

1. Deflection from Horizontal Line, Except PVC or HDPE: Maximum 2 inches.
2. Deflection from Vertical Grade: Maximum 1/4 inch.
3. Joint Deflection: Maximum of 75 percent of manufacturer's recommendation.
4. Horizontal position of pipe centerline on alignment around curves maximum variation of 1.75 feet from position shown.
5. Pipe Cover: Minimum 3 feet, unless otherwise shown.

3.07 INSTALLATION—CONCRETE ENCASED

A. Provide reinforced concrete pipe encasement where shown on the Drawings and where otherwise required. Some piping may be required to be concrete encased for pipe strength requirements that are included in the Specifications. Piping under and within the influence of buildings, utility trenches, vaults, slabs, and other structures shall be concrete encased. See details on the Drawings for encasement requirements.

B. Where concrete encased piping crosses structure construction and expansion joints, provide flexible piping joints to coincide with structure joints to prevent excessive pipe stress and breakage.

3.08 PIPE CORROSION PROTECTION

A. Ductile Iron Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating, and as shown on the Drawings.
2. Buried:. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.
3. Submerged or Embedded: Coat with NSF/ANSI 61 approved epoxy as specified in Section 09 90 00, Painting and Coating.

B. Carbon Steel Pipe:

1. Exposed: As specified on the Drawings and in Section 09 90 00, Painting and Coating.
2. Lining and Coating: Fusion Bonded Epoxy as shown on the Drawings and in Section 40 27 00.03, Carbon Steel Pipe and Fittings—Water Service Data Sheet.

C. Copper Pipe:

1. Exposed: As specified in Section 09 90 00, Painting and Coating.
2. Buried: As specified in Section 09 90 00, Painting and Coating.

D. PVC Pipe, Exposed: As specified in Section 09 90 00, Painting and Coating.

E. Piping Accessories:

1. Exposed:
   a. Field paint black and galvanized steel, brass, copper, and bronze piping components as specified in Section 09 90 00, Painting and Coating, as applicable to base metal material.

b. Accessories include, but are not limited to, pipe hangers, supports, expansion joints, pipe guides, flexible couplings, vent and drain valves, and fasteners.

2. Buried:
   a. Ferrous Metal and Stainless Steel Components: Coat with coal-tar epoxy as specified in Section 09 90 00, Painting and Coating.
   b. Bolts, Nuts, and Similar Items: Coat with bituminous paint.
   c. Flexible Couplings, Grooved Couplings, and Similar Items: Wrap with heat shrink wrap.
   d. Buried Valves and Similar Elements on Wrapped Pipelines: Coat with bituminous paint and wrap entire valve in polyethylene encasement.

F. Polyethylene Encasement: Install in accordance with AWWA C105/A21.5 and manufacturer's instructions.

G. Tape Coating System: As specified in Section 09 90 00, Painting and Coating.

H. Heat Shrink Wrap: Apply in accordance with manufacturer's instructions to surfaces that are cleaned, prepared, and primed.

I. Insulating Flanges, Couplings, and Unions:

1. Applications:
   a. Dissimilar metal piping connections.
   b. Submerged to unsubmerged metallic piping connections.
   c. Connections to existing metallic pipe.
   d. Where required for electrically insulated connection.
2. Pipe Installation:
   a. Insulating joints connecting immersed piping to nonimmersed piping shall be installed above maximum water surface elevation.
   b. Submerged carbon steel, ductile iron, or galvanized piping in reinforced concrete shall be isolated from the concrete reinforcement steel.
   c. Align and install insulating joints as shown on the Drawings and according to manufacturer's recommendations. Bolt lubricants that contain graphite or other metallic or electrically conductive components that can interfere with the insulating capabilities of the completed flange shall not be used.

3.09 THRUST RESTRAINT

A. Location:

1. Buried Piping: Where shown or specified and where required to restrain force developed at pipeline tees, plugs, caps, bends, and other locations

where unbalanced forces exist because of hydrostatic testing and normal operating pressure.

2. Interior and Exterior Exposed Piping: At all joints in piping.

B. Mechanical Joint Valve Restraint in Proprietary Restrained Joint Piping: Install pipe joint manufacturer's adapter gland follower and pipe end retainer, or mechanical joint anchor gland follower.

3.10 BRANCH CONNECTIONS

A. Do not install branch connections smaller than 1/2-inch nominal pipe size, including instrument connections, unless shown otherwise.

B. When line of lower pressure connects to a line of higher pressure, requirements of Piping Data Sheet (in Article Supplements in this section) for higher pressure rating prevails up to and including first block valve in the line carrying the lower pressure, unless otherwise shown.

C. Threaded Pipe Tap Connections:

1. Ductile Iron Piping: Connect only with service saddle or at tapping boss of a fitting, valve body, or equipment casting.
2. Welded Steel or Alloy Piping: Connect only with welded threadolet or half-coupling as specified on Piping Data Sheets in Article Supplements in this section.
3. Limitations: Threaded taps in pipe barrel are unacceptable.

3.11 VENTS AND DRAINS

A. Vents and drains at high and low points in piping required for completed system may or may not be shown. Install vents on high points and drains on low points of pipelines as shown at all low and high point locations.

3.12 DISINFECTION

A. See Section 33 13 00, Disinfection of Water Utility Distribution Facilities.

3.13 FIELD FINISHING

A. Notify Contracting Officer at least 3 days prior to start of surface preparation or coating application work.

B. As specified in Section 09 90 00, Painting and Coating.

3.14 FIELD QUALITY CONTROL

A. Pressure Leakage Testing: As specified in Section 40 80 01, Process Piping Leakage Testing.

B. Minimum Duties of Welding Inspector:

1. Job material verification and storage.
2. Qualification of welders.
3. Certify conformance with approved welding procedures.
4. Maintenance of records and preparation of reports in a timely manner.
5. Notification to Contracting Officer of unsatisfactory weld performance within 24 hours of weld test failure.

C. Required Weld Examinations:

1. Perform examinations in accordance with Piping Code ASME B31.3 for Normal Fluid Service.
2. Perform examinations for every pipe thickness and for each welding procedure, progressively, for piping covered by this section.
3. Examine at least one of each type and position of weld made by each welder or welding operator.
4. For each weld found to be defective under the acceptance standards or limitations on imperfections contained in the applicable Piping Code, examine two additional welds made by the same welder that produced the defective weld. Such additional examinations are in addition to the minimum required above. Examine, progressively, two additional welds for each tracer examination found to be unsatisfactory.

3.15 CLEANING

A. Following assembly and testing, and prior to disinfection and final acceptance, flush pipelines, except as stated below, with water at 2.5 fps minimum flushing velocity until foreign matter is removed.

B. Blow clean of loose debris gas lines with compressed air at 4,000 fpm; do not flush with water.

C. Immediately after cleaning gas service piping, dry to minus 40 degrees F dew point with dry compressed instrument air or compressed commercial grade nitrogen.

D. If impractical to flush large diameter pipe at 2.5 fps or blow at 4,000 fpm velocity, clean in-place from inside by brushing and sweeping, then flush or blow line at lower velocity.

E. Insert cone strainers in flushing connections to attached equipment and leave in-place until cleaning is complete.

F. Remove accumulated debris through drains 2 inches and larger or by removing spools and valves from piping.

3.16 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Data Sheets.

Number	Title
40 27 00.01	Fusion Bonded-Epoxy-Lined Ductile Iron Pipe and Fittings
40 27 00.03	Carbon Steel Pipe and Fittings—Water Service
40 27 00.10	Polyvinyl Chloride (PVC) Pipe and Fittings
40 27 00.13	Copper and Copper Alloy Pipe, Tubing, and Fittings

END OF SECTION

SECTION 40 27 00.01 FUSION BONDED-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
General	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Materials in contact with potable water shall conform to NSF 61 acceptance. Pipe manufacturer shall submit certification that source manufacturing facility has been producing ductile iron pipe of specified diameters, dimensions, and standards for a period of not less than 10 years. Testing of pipe required by AWWA C151/A21.51 shall be conducted in testing and laboratory facilities located in the USA and operating under USA laws and regulations. Pipe shall be handled during manufacture and shipped without nesting (without insertion of one pipe inside another).
Pipe	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Exposed Pipe Using Grooved End and Flange Joints: AWWA C115/A21.15, thickness Class 53 minimum, 250 psi minimum working pressure.
Lining and Coating	Physical Characteristics: Fusion Bonded Epoxy: Pipe and fittings to be factory applied fusion bonded epoxy lined/coated shall not have been previously lined/coated. Surface preparation shall be made to surfaces free of grease, oil, or other substance with abrasive blasting using clean sand or grit abrasive. Lining/coating shall be done within 8 hours of surface preparation and surfaces shall be reblasted if rusting appears before lining. Line/coat with a total dry film thickness of 40 mils of ceramic epoxy. Fusion Bonded epoxy shall be amine-cured epoxy with 20 percent minimum volume ceramic quartz pigment. Lining/coating shall be applied above 40 degrees F ambient temperature and shall not be applied to flange faces. Lining/coating thickness shall be tested using a magnetic film thickness gauge. Lining/coating integrity shall be tested on surfaces with a nondestructive, 2,500-volt dielectric resistance test. Functional Characteristics: None. Performance Characteristics: FBE per AWWA C213.

SECTION 40 27 00.01 FUSION BONDED-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Fittings	Physical Characteristics: Lined and coated same as pipe. Proprietary Restrained: Restraint shall be achieved with removable metal elements fitted between a welded bar on the pipe barrel and the inside of the joint bell or fitting sizes smaller than 16 inches may be mechanical joint, restrained by anchor gland followers, ductile iron anchor type, wedge action, with break-off tightening bolts. Assembled joints shall be rated for deflection in operation at rated pressure. Rated deflection shall be not less than 1-1/2 degrees for 36-inch and smaller pipe. Rated deflection shall be not less than 1/2 degree for 42-inch and larger pipe. Clow Corp., American Cast Iron Pipe Co., U.S. Pipe, or equal. Restrained joints relying on metal teeth molded into the gasket to prevent joint separation under pressure will not be accepted. Functional Characteristics: None. Performance Characteristics: FBE per AWWA C213. Mechanical: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53 ductile iron, 250 psi minimum working pressure. Follower glands shall be ductile iron. Proprietary Restrained: AWWA C110/A21.10, AWWA C111/A21.11, and AWWA C153/A21.53, ductile iron, 250 psi minimum working pressure. Grooved End: AWWA C606 and AWWA C110/A21.10, ductile iron, 250 psi minimum working pressure. Flange: AWWA C110/A21.10 ductile iron, faced and drilled, Class 125 flat face. Gray cast iron will not be allowed.

SECTION 40 27 00.01 FUSION BONDED-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Joints	Manufacturers and Products: Proprietary Restrained: American Cast Iron Pipe Co., Flex-Ring. Or equal. Grooved End: Victaulic. Or equal. Physical Characteristics: Proprietary Restrained: Joints designed to be used in pressurized applications to prevent joins of the pipeline from separating due to thrust forces. Grooved End: Restrained joint in which a small groove is made at the end of each pipe with a grooving machine. Pipes are then joined with a grooved coupling device. Functional Characteristics: None. Performance Characteristics: FBE per AWWA C213. Minimum working pressure.: 250 psi Grooved End: Rigid type radius cut conforming to AWWA C606, 250 psi minimum working pressure; Victaulic, or equal. Flange: Dimensions per AWWA C110/A21.10 flat face, ductile iron, threaded conforming to AWWA C115/A21.15. Gray cast iron will not be allowed.

SECTION 40 27 00.01 FUSION BONDED-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Couplings	Certification: Components in contact with potable water shall be certified to comply with NSF/ANSI 61. Bolted Sleeve Type Couplings: Manufacturers: Dresser 38, or equal. Physical Characteristics: For 3-inch through 20-inch diameters Functional Characteristics: designed to connect piping for differential settlement. Performance Characteristics: AWWA C219. 250 psi minimum working pressure. Coatings to be FBE per AWWA C13. Grooved End: Manufacturers: Victaulic, or equal. Physical Characteristics: Steel Pipe, 2-inch through 8-inch diameters. Ductile Iron Pipe, 3-inch through 36-inch diameters. Functional Characteristics: Restrained connection of FBE coated steel or ductile iron pipe. Performance Characteristics: 250 psi minimum working pressure, malleable iron per ASTM A47/A47M or ductile iron per ASTM A536.
Bolting	Physical Characteristics: Mechanical, Proprietary Restrained, and Grooved End Joints: Manufacturer's standard. Functional Characteristics: None. Performance Characteristics: Flanged: ASTM A307, Grade B carbon steel heavy hex head or stud bolts, ASTM A563, Grade A carbon steel heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations. Flanged Joints in Sumps, Wet Wells, and Submerged and Wetted Installations: Type 316 stainless steel, ASTM A320/A320M, Grade B8M heavy hex head or stud bolts; ASTM A194/A194M, Grade 8M heavy hex nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Stud bolts are not allowed when bolting to tapped flanges. Torque bolts per gasket manufacturer recommendations.

SECTION 40 27 00.01 FUSION BONDED-EPOXY-LINED DUCTILE IRON PIPE AND FITTINGS	
Item	**Description**
Gaskets	Physical Characteristics: Full face for flat-faced flanges, flat-ring type for raised-face flanges. Blind flanges shall be epoxy-lined in accordance with the system specified above. Gasket pressure rating to equal or exceed the system hydrostatic test pressure. Functional Characteristics: None. Performance Characteristics: General: Gaskets in contact with potable water shall be NSF ANSI 61 certified. Mechanical and Proprietary Restrained Joints; Water and Sewage Service: Halogenated butyl or EPDM, Shore A hardness durometer 60, conforming to AWWA C111/A21.11. Grooved End Joints: Halogenated butyl conforming to ASTM D2000 and AWWA C606. Flanged Water Services: 1/8-inch-thick, homogeneous black rubber (EPDM), hardness 60-80 (Shore A), rated to 275 degrees F, conforming to ASME B16.21 and ASTM D2000.
Joint Lubricant	Physical Characteristics: Manufacturer’s standard. Functional Characteristics: None. Performance Characteristics: None.
Note	This specification generally applies to the process mechanical drawings shown on Facilities 03, 10, and 15 for the Canyon Mechanical Building and Entrance Road Tank. See Section 33 05 01, Conveyance Piping—General, for civil related ductile iron piping.

END OF SECTION

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—WATER SERVICE		
Note: For carbon steel pipe for gas service, see Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.		
Item	**Size**	**Description**
Lining/Coating	All	Physical Characteristics: Factory applied interior exterior fusion bonded epoxy. Functional Characteristics: To function as corrosion resistance for water service piping. Performance Characteristics: Fusion Bonded Epoxy per AWWA C213. Note: All internal and external surfaces of the pipe are required to be 100 percent holiday tested and repaired as needed with two-part liquid applied epoxy per AWWA C210.
Pipe	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Black carbon steel, ASTM A106/A106M, Grade B seamless or ASTM A53/A53M, Grade B seamless or ERW. Threaded, butt-welded, grooved end, and flanged joints:
	Threaded: 1-1/2" & smaller	Physical Characteristics: Standard weight. Functional Characteristics: None. Performance Characteristics: None.
	Welded: 2" thru 10"	Physical Characteristics: Standard weight. Functional Characteristics: None. Performance Characteristics: None.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—WATER SERVICE		
Note: For carbon steel pipe for gas service, see Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.		
Item	**Size**	**Description**
Joints	1-1/2" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Threaded or flanged at valves and equipment or grooved end meeting the requirements of AWWA C606.
	2" & larger	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Butt-welded or flanged at valves and equipment, or grooved end meeting the requirements of AWWA C606.
Fittings	1-1/2" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Threaded: 150-pound or 300-pound malleable iron, ASTM A197/A197M or ASTM A47/A47M, dimensions in accordance with ASME B16.3. Fire sprinkler fittings to be UL listed. Grooved End: Malleable iron ASTM A47/A47M or ductile iron ASTM A536, grooved ends to accept couplings without field preparation.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—WATER SERVICE		
Note: For carbon steel pipe for gas service, see Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.		
Item	**Size**	**Description**
	2" & larger	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Butt Welded: Wrought carbon steel butt-welding, ASTM A234/A234M, Grade WPB meeting the requirements of ASME B16.9; fitting wall thickness to match adjoining pipe; long radius elbows unless shown otherwise. Grooved End: Malleable iron ASTM A47/A47M, ductile iron ASTM A536, forged steel ASTM A234/A234M, or factory fabricated from ASTM A53/A53M pipe. Grooved ends to accept couplings without field preparation.
Branch Connections	1-1/2" & smaller	Physical Characteristics: For Threaded Pipe: Threaded, straight, or reducing tees in conformance with Fittings specified above. For welded or grooved pipe, use threadolet. Functional Characteristics: None. Performance Characteristics: None.
	2" & larger	Physical Characteristics: Butt-welding or grooved end tee in conformance with Fittings specified above. Functional Characteristics: None. Performance Characteristics: None.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—WATER SERVICE		
Note: For carbon steel pipe for gas service, see Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.		
Item	**Size**	**Description**
Flanges	1-1/2" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Forged carbon steel, ASTM A105/A105M, Grade II, ASME B16.5 Class 150 or Class 300 socket-weld or threaded, 1/16-inch raised face.
	2" & larger	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Butt-Welded Systems Standard Flange (RFWN): Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 slip-on or welding neck, 1/8-inch raised face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside. Butt-Welded Systems Standard Flange (FFWN): Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150 slip-on or welding neck, 1/8-inch flat face; weld neck bore to match pipe internal diameter. Use weld neck flanges when abutting butt-weld fittings. Weld slip-on flanges inside and outside. Butt-Welded Systems Blind Flange: Forged carbon steel, ASTM A105/A105M, ASME B16.5 Class 150, 1/8-inch flat face. Grooved End Adapter Flange: Malleable iron ASTM A47/A47M or ductile iron ASTM A536. Include stainless steel washer plates as required for mating to serrated faces and lined valves and equipment.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—WATER SERVICE		
Note: For carbon steel pipe for gas service, see Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.		
Item	**Size**	**Description**
Unions	1-1/2" & smaller	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Threaded malleable iron, ASTM A197/A197 or ASTM A47/A47M, 150-pound or 300-pound WOG, meeting the requirements of ASME B16.3.
Couplings	2" & larger	Screwed End: Malleable iron, ASTM A197/A197M or ASTM A47/A47M Grooved End: Physical Characteristics: None. Functional Characteristics: Grooved End: Rigid joint malleable iron, ASTM A47/A47M or ductile iron, ASTM A536. Performance Characteristics: For 2 inch through 8 inch. Working pressures of 150 psi or otherwise noted on the drawings.
Bolting	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Flanges: Carbon steel ASTM A307, Grade A hex head bolts; ASTM A563, Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. When mating flange on equipment is cast iron and gasket is flat ring, provide ASTM A307, Grade B hex head bolts; ASTM A563, Grade A heavy hex nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—WATER SERVICE		
Note: For carbon steel pipe for gas service, see Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.		
Item	**Size**	**Description**
		Grooved End Couplings: Carbon steel, ASTM A183 bolts and nuts, 110,000 psi minimum tensile strength.
Gaskets	All flanges	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Water and Air Services: Gasket, inorganic aramid fiber with nitrile binder, CL150, 1/8-inch thick, Shore A 80 Durometer, ASME B16.21 and ASME B16.5, ASTM D2000, NSF 61, full-face gasket for raised-face flange, extended to inner edge of bolt. Fuel Gas Service: 1/8-inch thick, homogeneous black rubber (EPDM), hardness 60 (Shore A), rated 250 degrees F continuous and conforming to ASME B16.21, ASTM D1330, Steam Grade. Blind Flanges: Gasketed covering the entire inside face with the gasket cemented to the blind flange. Gasket, inorganic aramid fiber with nitrile binder, CL150, 1/8-inch thick, Shore A 80 Durometer, ASME B16.21 and ASME B16.5, ASTM D2000, NSF 61, flat-ring gasket for flat-face flange. Insulating Gasket: ASME B16.21 and ASME 16.5, fabric reinforced phenolic neoprene faced gasket, sleeves, washers, CL150, 1/8-inch thick, 175 degrees F.

SECTION 40 27 00.03 CARBON STEEL PIPE AND FITTINGS—WATER SERVICE		
Note: For carbon steel pipe for gas service, see Section 22 10 01.15, Carbon Steel Pipe and Fittings—Gas Service Data Sheet.		
Item	**Size**	**Description**
		Grooved Couplings: Gasket, inorganic aramid fiber with nitrile binder, CL150, 1/8-inch thick, Shore A 80 Durometer, ASME B16.21 and ASME B16.5, ASTM D2000, NSF 61, full-face gasket for raised-face flange, extended to inner edge of bolt. NSF 61 approved for potable water service.
Thread Lubricant	1-1/2" & smaller	Physical Characteristics: General Service: 100 percent virgin polytetrafluoroethylene (PTFE) tape. Fuel Gas Service: Yellow polytetrafluoroethylene (PTFE) tape designed for fuel gas service, Air Force A-A-58092, AA Thread Seal Tape, Inc. Functional Characteristics: None. Performance Characteristics: None.

END OF SECTION

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
General	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Materials in contact with potable water shall conform to NSF 61 acceptance.
Pipe	All	Physical Characteristics: Pipe shall be manufactured with titanium dioxide for ultraviolet protection. Threaded Nipples: Schedule 80 PVC. Functional Characteristics: None. Performance Characteristics: Schedule 80 PVC: Type I, Grade I or Class 12454-B conforming to ASTM D1784 and ASTM D1785.
Tubing	1.5" and smaller	Physical Characteristics: Reinforced PVC Tubing with Polyester Braid. Kink resistant heavy wall. Rated for 100 psi working pressure. Functional Characteristics: None. Performance Characteristics: Temperature Range: 25 degrees F to 150 degrees F.
Fittings	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Schedule to Match Pipe Above: ASTM D2466 and ASTM D2467 for socket weld type and Schedule 80 ASTM D2464 for threaded type. Fittings shall be manufactured with titanium dioxide for ultraviolet protection.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Tubing Fittings	1.5" and smaller	Physical Characteristics: PVC construction with barbed connections for connecting tubing to tubing. 100 psi working pressure. Threaded compression tube type fittings for connecting tubing to hard wall piping. Fitting material shall be compatible with fluid services as indicated on Piping Schedule located on the Drawings. Stainless steel worm gear pipe clamps shall be provided for all barbed connections. Functional Characteristics: None. Performance Characteristics: None.
Joints	All	Physical Characteristics: Solvent socket weld except where connection to threaded valves and equipment may require future disassembly. Functional Characteristics: None. Performance Characteristics: None.
Flanges	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: One-piece, molded hub type PVC flat face flange in accordance with Fittings above, ASME B16.1, Class 125 drilling.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Bolting	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Flat Face Mating Flange and In Corrosive Areas: ASTM A193/A193M, Type 316 stainless steel Grade B8M hex head bolts, ASTM A194/A194M Grade 8M hex head nuts and ASTM F436 Type 3 alloy washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress. With Raised Face Mating Flange: Carbon steel ASTM A307 Grade B square head bolts, ASTM A563 Grade A heavy hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.
Gaskets	All	Physical Characteristics: Flat Face Mating Flange: Full faced 1/8-inch thick ethylene propylene (EPR) rubber. Raised Face Mating Flange: Flat ring 1/8-inch ethylene propylene (EPR) rubber, with filler gasket between OD of raised face and flange OD to protect the flange from bolting moment. Functional Characteristics: None. Performance Characteristics: None.

SECTION 40 27 00.10 POLYVINYL CHLORIDE (PVC) PIPE AND FITTINGS		
Item	**Size**	**Description**
Solvent Cement	All	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Socket type joints shall be made employing solvent cement that meets or exceeds the requirements of ASTM D2564 and primer that meets or exceeds requirements of ASTM F656, chemically resistant to the fluid service, and as recommended by pipe and fitting manufacturer, except solvent weld cement for PVC pipe joints in sodium hypochlorite service shall be free of silica filler and shall be certified by the manufacturer to be suitable for that service, IPS Weld-On 724, or equal. Certification shall be submitted. Solvent cement and primer shall be listed by NSF 61 for contact with potable water.
Thread Lubricant	All	Physical Characteristics: Polytetrafluoroethylene (PTFE) tape. Functional Characteristics: None. Performance Characteristics: None.
Note		See Division 33, Utilities, for PVC pipe relating to the civil design and buried water mains.

END OF SECTION

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
General	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Materials in contact with potable water shall conform to NSF 61 acceptance.
Tubing	Physical Characteristics: Seamless, conforming to ASTM B88 as follows: Water (buried) .....Type K, soft or hard temper Water (exposed).....Type L, hard drawn Domestic hot water .....Type L, hard drawn Laboratory air service .....Type L, hard drawn Laboratory vacuum service.....Type L, hard drawn Refrigerant service.....Type L, hard drawn P-Trap priming service .....Type L, soft temper Laboratory gas service.....Type L, hard drawn Functional Characteristics: None. Performance Characteristics: None.
Fittings	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: ASTM B75/B75M commercially pure wrought copper, socket joint, dimensions conforming to ASME B16.22.
Flanges	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Class 150, ASTM B75/B75M commercially pure wrought copper, socket joint, ASME B16.24 standard.
Bolting	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: ASTM A307, carbon steel, Grade A hex head bolts, ASTM A563 Grade A hex head nuts and ASTM F436 hardened steel washers at nuts and bolt heads. Achieve 40 percent to 60 percent of bolt minimum yield stress.

SECTION 40 27 00.13 COPPER AND COPPER ALLOY PIPE, TUBING, AND FITTINGS	
Item	**Description**
Gaskets	Physical Characteristics: 1/16-inch thick non-asbestos compression type, full face Functional Characteristics: None. Performance Characteristics: None.
Solder	Physical Characteristics: None. Functional Characteristics: None. Performance Characteristics: Joints 2-1/2 Inch and Smaller: Wire solder (95 percent tin), conforming to ASTM B32 Alloy Grade Sn95. Do not use cored solder. Joints Larger Than 2-1/2 Inch: Wire solder, melt range approximately 440 degrees F to 660 degrees F, conforming to ASTM B32 Alloy Grade HB or HN. Do not use cored solder.

END OF SECTION

SECTION 40 27 02
PROCESS VALVES AND OPERATORS

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. American Society of Mechanical Engineers (ASME):
   a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
2. American Society of Sanitary Engineers (ASSE): 1011, Performance Requirements for Hose Connection Vacuum Breakers.
3. American Water Works Association (AWWA):
   a. C111/A21.11, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   b. C500, Metal-Seated Gate Valves for Water Supply Service.
   c. C504, Rubber-Seated Butterfly Valves, 3 In. (75 mm) Through 72 In. (1,800 mm).
   d. C508, Swing-Check Valves for Waterworks Service, 2-In. Through 24-In. (50-mm Through 600-mm) NPS.
   e. C509, Resilient-Seated Gate Valves for Water Supply Service.
   f. C510, Double Check Valve Backflow Prevention Assembly.
   g. C511, Reduced-Pressure Principle Backflow Prevention Assembly.
   h. C512, Air-Release, Air/Vacuum, and Combination Air Valves for Waterworks Service.
   i. C515, Reduced-Wall, Resilient-Seated Gate Valves for Water Supply Service.
   j. C550, Protective Interior Coatings for Valves and Hydrants.
   k. C606, Grooved and Shouldered Joints.
   l. C800, Underground Service Line Valves and Fittings.
4. ASTM International (ASTM):
   a. A276, Standard Specification for Stainless Steel Bars and Shapes.
   b. A351/A351M, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
   c. A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
   d. A564/A564M, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
   e. B61, Standard Specification for Steam or Valve Bronze Castings.
   f. B62, Standard Specification for Composition Bronze or Ounce Metal Castings.

g. B98/B98M, Standard Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
h. B127, Standard Specification for Nickel-Copper Alloy (UNS N04400) Plate, Sheet, and Strip.
i. B139/B139, Standard Specification for Phosphor Bronze Rod, Bar and Shapes.
j. B164, Standard Specification for Nickel-Copper Alloy Rod, Bar, and Wire.
k. B194, Standard Specification for Copper-Beryllium Alloy Plate, Sheet, Strip, and Rolled Bar.
l. B584, Standard Specification for Copper Alloy Sand Castings for General Applications.
m. D429, Standard Test Methods for Rubber Property-Adhesion to Rigid Substrates.
n. D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.

5. Chlorine Institute (CI): Pamphlet 6, Piping Systems for Dry Chlorine.
6. FM Global (FM).
7. Food and Drug Administration (FDA).
8. International Association of Plumbing and Mechanical Officials (IAPMO).
9. Manufacturers Standardization Society (MSS):
   a. SP-80, Bronze Gate, Globe, Angle, and Check Valves.
   b. SP-81, Stainless Steel, Bonnetless, Flanged Knife Gate Valves.
   c. SP-85, Gray Iron Globe and Angle Valves, Flanged and Threaded Ends.
   d. SP-88, Diaphragm Valves.
   e. SP-110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
10. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
11. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
12. UL.
13. USC Foundation for Cross-Connection Control and Hydraulic Research.

1.02 SUBMITTALS

A. Action Submittals:

1. Shop Drawings:
   a. Product data sheets for each make and model. Indicate valve Type Number, applicable Tag Number, and facility name/number or service where used.
   b. Complete catalog information, descriptive literature, specifications, and identification of materials of construction.
   c. Power and control wiring diagrams, including terminals and numbers. Where shown on the Drawings, the network and ethernet communication details to the Plant Control System.
   d. Provide certification by an accredited certification organization in accordance with NSF/ANSI 61 for each valve type and coating used for drinking water service.
   e. Anchorage and bracing drawings and cut sheets, as required by Section 01 88 15, Anchorage and Bracing.

B. Informational Submittals:

1. Anchorage and bracing calculations as required by Section 01 88 15, Anchorage and Bracing.
2. Component and attachment testing seismic certificate of compliance as required by Section 01 45 33, Special Inspection and Testing.
3. Tests and inspection data.
4. Operation and Maintenance Data as specified in Section 01 78 23, Operation and Maintenance Data.
5. Manufacturer’s Certificate of Proper Installation, in accordance with Section 01 67 00, Product Requirements.

PART 2 PRODUCTS

2.01 GENERAL CHARACTERISTICS

A. Physical Characteristics:

1. Valves to include operator, actuator, handwheel, chain wheel, extension stem, floor stand, operating nut, chain, wrench, and accessories to allow a complete operation from the intended operating level.
2. Valve same size as adjoining pipe, unless otherwise called out on the Drawings or in Supplements.
3. Valve ends to suit adjacent piping.
4. Factory mount operator, actuator, and accessories.
5. Use or reuse of components and materials without a traceable certification is prohibited.

B. Functional Characteristics:

1. Size operators and actuators to operate valve for full range of pressures and velocities.
2. Valve to open by turning counterclockwise, unless otherwise specified.

C. Performance Characteristics:

1. Valve to be suitable for intended service. Renewable parts not to be of a lower quality than specified.
2. Resilient seated valves shall have no leakage (drip-tight) in either direction at valve rated design pressure. All other valves shall have no leakage (drip-tight) in either direction at valve rated design pressure, unless otherwise allowed for in this section or in stated valve standard.
3. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.
4. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MATERIALS

A. Physical Characteristics:

1. Bronze and brass valve components and accessories that have surfaces in contact with water to be alloys containing less than 16 percent zinc and 2 percent aluminum.
   a. Approved alloys are of the following ASTM designations: B61, B62, B98/B98M (Alloy UNS No. C65100, C65500, or C66100), B139/B139M (Alloy UNS No. C51000), B584 (Alloy UNS No. C90300 or C94700), B164, B194, and B127.
   b. Stainless steel Alloy 18 8 may be substituted for bronze.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. Valve materials in contact with or intended for drinking water service to meet the following requirements:
   a. Materials to comply with requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements.
   b. Coatings materials to be formulated from materials deemed acceptable to NSF/ANSI 61.

c. Supply certification product is certified as suitable for contact with drinking water by an accredited certification organization in accordance with NSF/ANSI 61. Provide certification for each valve type used for drinking water service.

2.03 FACTORY FINISHING

A. Physical Characteristics: None.

B. Functional Characteristics: None.

C. Performance Requirements:

1. Interior coatings for valves and hydrants shall be in accordance with AWWA C550, unless otherwise specified.
2. Exterior coating for valves and hydrants shall be in accordance with Section 09 90 00, Painting and Coating.
3. Material in contact with potable water shall conform to NSF/ANSI 61.
4. Exposed safety isolation valves and lockout valves with handles, handwheels, or chain wheels shall be “safety yellow.”
5. Where epoxy lining and coating are specified, factory finishing shall be as follows:
   a. In accordance with AWWA C550.
   b. Either two-part liquid material or heat-activated (fusion) material except only heat-activated material if specified as “fusion” or “fusion bonded” epoxy.
   c. Minimum 7-mil dry film thickness except where limited by valve operating tolerances.

2.04 VALVES

A. Gate Valves:

1. Type V108 Gate Valve 2 Inches to 24 Inches:
   a. Manufacturers and Products:
      1) Crane; Figure 461.
      2) Or equal.
   b. Physical Characteristics: Iron body, bronze mounted, flanged ends, solid wedge gate, nonrising bronze stem, stainless steel bolting, 2-inch operating nut and handwheel for AWWA gate valves 12 inches and smaller. Mark AWWA gate valves with manufacturer’s name or mark, year of valve casting, valve size, and working water pressure.
   c. Functional Characteristics: Isolation of water services
   d. Performance Characteristics: Class 125 rated 125 psi SWP, 200 psi CWP for 2 inches through 12 inches and 100 psi SWP.

AWWA gate valves to be in full compliance with stated AWWA standard.

B. Ball Valves:

1. Type V300 Ball Valve 3 Inches and Smaller for General Water and Air Service:
   a. Manufacturers:
      1) Conbraco Apollo.
      2) Or equal.
   b. Physical Characteristics: Two-piece, standard port, NPT threaded ends, bronze body and end piece, hard chrome-plated solid bronze or brass ball, RTFE seats and packing, blowout-proof stem, adjustable packing gland, zinc-coated steel hand lever operator with vinyl grip.
   c. Functional Characteristics: None.
   d. Performance Characteristics:
      1) Rated 600-pound WOG.
      2) Rated 150-pound SWP.
      3) Complies with MSS SP-110.

C. Butterfly Valves:

1. Physical Characteristics:
   a. Provide linings and coatings per AWWA, unless otherwise indicated on the Drawings or specified herein.
   b. Non-AWWA butterfly valves to meet the following actuator requirements:
      1) For above ground installations, provide handle and notch plate for valves 6 inches and smaller and heavy-duty, totally enclosed gearbox type operators with handwheel, position indicator and travel stops for valves 8 inches and larger, unless otherwise indicated on the Drawings or specified herein.
2. Functional Characteristics:
   a. Suitable for throttling operations and infrequent operation after periods of inactivity.
   b. Self-adjusting V-type or O-ring shaft seals.
   c. No travel stops for disc on interior of body.
3. Performance Characteristics:
   a. In full compliance with AWWA C504 and following requirements:
      1) Elastomer seats which are bonded or vulcanized to the body shall have adhesive integrity of bond between seat and body assured by testing, with minimum 75-pound pull in accordance with ASTM D429, Method B.

2) Bubble-tight with rated pressure applied from either side. Test valves with pressure applied in both directions.
3) Isolate metal-to-metal thrust bearing surfaces from flowstream.
4) Provide traveling nut or worm gear actuator with handwheel. Valve actuators to meet the requirements of AWWA C504.
5) Buried service operators shall withstand 450 foot-pounds of input torque at fully open and fully closed positions.
6) Valves to be in full compliance with NSF/ANSI 61. Provide NSF/ANSI 61 certificate for each valve.

4. Type V500 Butterfly Valve Water Works Service 3 Inches to 72 Inches:
   a. Manufacturers and Products:
      1) DeZurik; AWWA Valve.
      2) Or equal.
   b. Physical Characteristics:
      1) Lugged body style.
      2) Cast-iron body, cast or ductile iron disc, Type 304 stainless steel shafts, rubber seat bonded or molded in body only, and stainless steel seating surface.
      3) Provide epoxy lining and coating in compliance with AWWA C550.
   c. Functional Characteristics: None.
   d. Performance Characteristics:
      1) Rated to a minimum of 150 psi or as indicated on the Drawings.
      2) AWWA C504, Class 150B.

D. Check and Flap Valves:

1. Type V694 Check Valve 1 Inch to 48 Inches:
   a. Manufacturers:
      1) Red Valve Co.
      2) Or equal.
   b. Physical Characteristics:
      1) Elastomer type flanged or slip-on as shown on the Drawings, round entry area to match pipe, contoured duckbilled shaped exit, flat bottom and off-set bill design, curved bill for 18 inches and larger
      2) Flanges steel backing flange type, drilled to ASME B16.1, Class 125, plain-end valve attached with two Type 316 stainless steel adjustable bands, elastomer nylon-reinforced Rubber.
   c. Functional Characteristics: Valve open with approximately 2 inches of line pressure and return to CLOSED position under zero flow condition.

d. Performance Characteristics:
    1) Rated for 50 psi minimum operating pressure.
    2) NSF 61 compliant.

E. Self-Regulated Automatic Valves:

1. Where applicable all self regulated valves includes a Specialized Stem:
    a. Manufacturers and Productions:
        1) Cla-Val Dura-Kleen.
        2) Or equal.
    b. Physical Characteristics: Acetal resin or equal material, rifled surface with grooves.
    c. Functional Characteristics:
        1) Self cleaning channel which prevents build up or deposits, compatible with pressure reducing valves, lowers maintenance requirements.
    d. Performance Characteristics:
        1) Minimal friction for smooth and reliable valve operation.
        2) Maximum operating pressure of 250 psi.
        3) Channels away deposits under flow rates ranging from 0.33 feet per second to 33 feet per second.
2. Type V714 Pressure-Reducing Valve 3 Inches and Larger:
    a. Valve Tag PCV 413:
        1) Manufacturers and Products:
            a) Cla-Val; 90-01KO.
            b) Or equal.
        2) Physical Characteristics:
            a) Hydraulically operated, diaphragm actuated, pilot controlled globe valve, ductile iron body, ASME B16.1 Class 300 flanged ends.
            b) Bronze or stainless steel trim, stainless steel stem, externally mounted strainers with cocks.
            c) Includes main valve, ejector, isolation valve, pressure reducing valve, and pressure reducing control.
            d) Includes flow control closing and speed control opening features.
            e) FDA approved fusion bonded epoxy lining and coating installed in accordance with AWWA C550.
        3) Functional Characteristics:
            a) Maintains a constant downstream pressure regardless of fluctuations in flow or upstream pressure.
            b) An increase in outlet pressure forces the pilot control to close and a decrease in outlet pressure opens the control.

4) Performance Characteristics:
   a) Size/Rating: 6 inch, maximum of 750 gpm, with inlet pressure of approximatley150 psig. Outlet pressure set at approximately 50 psi psig. Includes anticavitation trim.
   b) NSF 61 approved.

b. Valve Tag PCV 420A:
   1) Manufacturers and Products:
      a) Cla-Val; 90-48.
      b) Or equal.
   2) Physical Characteristics:
      a) Hydraulically operated, diaphragm actuated, pilot controlled angle valve, ductile iron body, ASME B16.1 Class 300 flanged ends.
      b) Bronze or stainless steel trim, stainless steel stem, externally mounted strainers with cocks.
      c) Includes main valve, ejector, isolation valve, pressure reducing valve, and pressure reducing control.
      d) Includes flow control closing and speed control opening features.
      e) FDA approved fusion bonded epoxy lining and coating installed in accordance with AWWA C550.
   3) Functional Characteristics:
      a) Maintains a constant downstream pressure regardless of fluctuations in flow or upstream pressure.
      b) An increase in outlet pressure forces the pilot control to close and a decrease in outlet pressure opens the control.
   4) Performance Characteristics:
      a) Size/Rating: 4 inch, maximum of 750 gpm, with inlet pressure of 170 psig. Outlet pressure set at approx. 50 psi psig With 3/4-inch pilot line for low flows of 1 gpm to 20 gpm. Includes a low flow pressure reducing by-pass.
      b) NSF 61 approved.

c. Valve Tag PCV 420B:
   1) Manufacturers and Products:
      a) Cla-Val; 90-48.
      b) Or equal.
   2) Physical Characteristics:
      a) Hydraulically operated, diaphragm actuated, pilot controlled angle valve, ductile iron body, ASME B16.1 Class 300 flanged ends.
      b) Bronze or stainless steel trim, stainless steel stem, externally mounted strainers with cocks.

c) Includes main valve, ejector, isolation valve, pressure reducing valve, and pressure reducing control.
d) Includes flow control closing and speed control opening features.
e) FDA approved fusion bonded epoxy lining and coating installed in accordance with AWWA C550.

3) Functional Characteristics:
a) Maintains a constant downstream pressure regardless of fluctuations in flow or upstream pressure.
b) An increase in outlet pressure forces the pilot control to close and a decrease in outlet pressure opens the control.

4) Performance Characteristics:
a) Size/Rating: 2 inch, maximum of 210 gpm, with inlet pressure of 170 psig. Outlet pressure set at approx. 50 psi psig With 3/4-inch pilot line for low flows of 1 gpm to 20 gpm. Includes a low flow pressure reducing by-pass.
b) NSF 61 approved.

3. Type V730 Pressure Relief Valve 2 Inches and Smaller:
a. Valve Tag PRV 421:
1) Manufacturer and Product:
a) Cla-Val; 50 01.
b) Or equal.

2) Physical Characteristics: Direct diaphragm, spring controlled, bronze body, stainless steel trim, synthetic rubber, NPT threaded ends, 300 psi rated. Opening Speed control feature.

3) Functional Characteristics: Opens when upstream pressure reached a maximum set point.

4) Performance Characteristics:
a) Size Rating: 2 inches, Adjustment Ranges between 20 psi to 200 psi with a factory set point of 90 psi. Minimum flow rate of 5 gpm and maximum flow rate of 210 gpm.
b) NSF 61 approved.

4. Type V740 Air and Vacuum Valve 1/2 Inch to 16 Inches:
a. See Section 33 12 16.29, Air and Vacuum Release Valve Assemblies, for water distribution service. Note: This section relates to mechanical drawings for Facilities 10 and 15.
b. Tag ARV 414 and ARV 415:
1) Manufacturers and Products: Cla-Val; 36 Series.
2) Physical Characteristics:
a) 1/2-inch through 3-inch NPT inlets and outlets, 4-inch and larger ASME B16.1 Class 125 flanged inlet with plain outlet and protective hood.

b) Cast-iron or ductile iron body and cover, stainless steel float and trim.

3) Functional Characteristics:

a) Releases small amounts of trapped air and allows air to enter a pipe to avoid vacuum conditions.

4) Performance Characteristics:

a) Rated 150 psi working pressure.

b) Operating pressure is approximately 50 psi.

c) Built and tested to AWWA C512.

d) NSF 61 approved.

5. Type V780 Combination Rate of Flow Control Valve and Pressure Reducing Valve:

a. Valve Tag PCV 303:

1) Manufacturers and Products:

a) Cla-Val; 49-01 or 649.

b) Or equal.

2) Physical Characteristics: Ductile iron body, globe pattern style body, ANSI Class 150 flanged ends, stainless steel trim, stainless steel stem, Rubber disc, internally and external epoxy coated, inlet and outlet pressure gauges, position indicator, and externally mounted strainer.

3) Functional Characteristics: Hydraulically operated, diaphragm actuated to limit the supply feed rate and pressure to the receiving altitude valve and tank.

4) Performance Characteristics:

a) Rated minimum pressure of 150 psi.

b) Design flow rate of 200 gpm.

c) Inlet pressure of 50 psi.

d) Outlet pressure set to a maximum of 25 psi

e) NSF 61 approved.

6. Type V781 Electronic Combination Rate of Flow Control Valve and Pressure Reducing Valve with Solenoid shutoff:

a. Valve Tag LCV: 412.

1) Manufacturers and Products:

a) Cla-Val; 43-01.

b) Or equal.

2) Physical Characteristics:

a) Size: 3 inch.

b) Ductile iron body, ANSI B16.42 Class 150 flanged ends, stainless steel trim, stainless steel stem, Rubber disc and diaphragm, and externally mounted strainer.

c) Includes solenoid valve, restriction fitting, differential control, orifice plate assembly, drain to atmosphere, pressure gauge, valve position indicator.

3) Functional Characteristics: Hydraulically operated, diaphragm actuated, solenoid controlled globe valve.

4) Performance Characteristics:
a) Rated Maximum Pressure of 250 psi.
b) Design fill rate of 250 gpm.
c) Solenoid valve shall have 24V dc power.
d) Inlet pressure of approximately 50 psi and outlet pressure of 10 psi.
e) NSF 61 approved.

7. Type V790 Altitude and Level Control Valve:
a. Tag LCV: 302.
1) Manufacturers and Products:
a) Cla-Val; 210-01KO.
b) Or equal.
2) Physical Characteristics:
a) Valve Size: 3 inch
b) Ductile Iron Valve Body and Cover, ANSI B16.42 Class 150 flanged ends, Stainless Steel Trim, Rubber Disc and Diaphragm, stainless steel stem/nut/spring.
c) Pilot includes stainless steel trim.
d) Includes Anticavitation trim.
e) Includes Pressure gauges.
f) No Floats.
3) Functional Characteristics: Hydraulically operated control for high water level in reservoirs without the need for floats. Non-throttling. One way flow.
4) Performance Characteristics:
a) Rated Maximum Pressure of 150 psi
b) Design Fill Rate of 200 gpm
c) Inlet flow line pressure approximately 20 psi
d) NSF 61 approved.

2.05 OPERATORS AND ACTUATORS

A. Manual Operators:

1. Physical Characteristics:
a. Operator self-locking type or equipped with self-locking device.
b. Position indicator on quarter-turn valves.
c. Worm and gear operators one-piece design, worm-gears of gear bronze material. Worm of hardened alloy steel with thread ground and polished. Traveling nut type operator’s threaded steel reach rod with internally threaded bronze or ductile iron nut.
d. Exposed Operator:
1) Galvanized and painted handwheel.
2) Cranks on gear type operator.

e. Buried Operator:
   1) Buried service operators on valves larger than 2-1/2 inches shall have a 2-inch AWWA operating nut. Buried operators on valves 2 inches and smaller shall have cross handle for operation by forked key. Enclose moving parts of valve and operator in housing to prevent contact with the soil.
   2) Buried service operators to be grease packed and gasketed to withstand submersion in water to 20 feet minimum.
   3) Buried valves shall have extension stems, bonnets, and valve boxes.
   4) See buried valve box standard details for more information.

2. Functional Characteristics:
   a. Exposed Operator:
      1) Chain wheel operator with tieback, extension stem, floor stand, and other accessories to permit operation from normal operation level.
      2) Valve handles to take a padlock, and wheels a chain and padlock.

3. Performance Characteristics:
   a. For AWWA valves, operator force not to exceed requirements of applicable valve standard. Provide gear reduction operator when force exceeds requirements.
   b. For non-AWWA valves, operator force not to exceed applicable industry standard or 80 pounds, whichever is less, under operating condition, including initial breakaway. Provide gear reduction operator when force exceeds requirements.

B. Tagging:

1. Physical Characteristics: 1-1/2-inch diameter heavy brass or stainless steel tag attached with No. 16 solid brass or stainless steel jack chain for each valve bearing valve tag number herein.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

C. T-Handled Operating Wrench:

1. Manufacturers and Products:
   a. Mueller; No. A-24610.
   b. Or equal.
2. Physical Characteristics:
   a. Galvanized operating wrenches, 4 feet long.
   b. One each galvanized operating keys for cross handled valves.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

D. Extension Bonnet for Valve Operator:

1. Manufacturers:
   a. Pratt.
   b. Or equal.
2. Physical Characteristics: Complete with enclosed stem, extension, support brackets, and accessories for valve and operator.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

E. Floor Stand:

1. Manufacturers and Products:
   a. Clow; Figure F-5515.
   b. Or equal.
2. Physical Characteristics:
   a. Stainless steel stem and U-joints.
   b. Nonrising, heavy pattern, indicating type.
   c. Complete with solid extension stem, coupling, handwheel, stem guide brackets, and yoke attachment.
   d. Anchor Bolts: Type 304 stainless steel.
3. Functional Characteristics: Stem length as required to connect valve operating nut and floor stand.
4. Performance Characteristics:
   a. Stem Guide: Space such that stem L/R ratio does not exceed 200.

F. Floor Box:

1. Manufacturers and Products:
   a. Neenah Foundry; R 7506.
   b. Or equal.
2. Physical Characteristics:
   a. Plain type, for support of non-rising type stem.
   b. Complete with solid extension stem, operating nut, and stem guide brackets.
   c. Anchor Bolts: Type 304 stainless steel.
3. Functional Characteristics: Stem length as required to extend valve operating nut to within 3 inches of finish floor.
4. Performance Characteristics:
   a. Stem Guide: Space such that stem L/R ratio does not exceed 200.

PART 3 EXECUTION

3.01 INSTALLATION

A. Flange Ends:

1. Flanged valve bolt holes shall straddle vertical centerline of pipe.
2. Clean flanged faces, insert gasket and bolts, and tighten nuts progressively and uniformly.

B. Screwed Ends:

1. Clean threads by wire brushing or swabbing.
2. Apply joint compound.

C. Valve Installation and Orientation:

1. General:
   a. Install valves so handles operate from fully open to fully closed without encountering obstructions.
   b. Install valves in location for easy access for routine operation and maintenance.
   c. Install valves per manufacturer's recommendations.
2. Gate, Globe, and Ball Valves:
   a. Install operating stem vertical when valve is installed in horizontal runs of pipe having centerline elevations 4 feet 6 inches or less above finished floor, unless otherwise shown.
   b. Install operating stem horizontal in horizontal runs of pipe having centerline elevations greater than 4 feet 6 inches above finish floor, unless otherwise shown.
3. Butterfly Valves:
   a. Unless otherwise restricted or shown on the Drawings, install valve a minimum of 8 diameters downstream of a horizontal elbow or branch tee with shaft in horizontal position.
   b. For vertical elbow or branch tee immediately upstream of valve, install valve with shaft in vertical position.
   c. For horizontal elbow or branch tee immediately upstream of valve, install valve with shaft in horizontal position.
   d. When installed immediately downstream of swing check, install valve with shaft perpendicular to swing check shaft.
   e. For free inlet or discharge into basins and tanks, install valve with shaft in vertical position.

4. Check Valves: Install valve in accordance with manufacturer's instructions and provide required distance from immediate upstream fitting.

D. Install line size ball valve and union upstream of each solenoid valve, in-line flow switch, or other in-line electrical device, excluding magnetic flowmeters, for isolation during maintenance.

E. Locate valve to provide accessibility for control and maintenance. Install access doors in finished walls and plaster ceilings for valve access.

F. Extension Stem for Operator: Where depth of valve operating nut is 3 feet or greater below finish grade, furnish operating extension stem with 2-inch operating nut to bring operating nut to a point within 6 inches of finish grade.

G. Torque Tube: Where operator for quarter-turn valve is located on floor stand, furnish extension stem torque tube of a type properly sized for maximum torque capacity of valve.

H. Floor Box and Stem: Steel extension stem length shall locate operating nut in floor box.

3.02 TESTS AND INSPECTION

A. Valve may be either tested while testing pipelines, or as a separate step.

B. Test that valves open and close smoothly under operating pressure conditions. Test that two-way valves open and close smoothly under operating pressure conditions from both directions.

C. Inspect air and vacuum valves as pipe is being filled to verify venting and seating is fully functional.

D. Count and record number of turns to open and close valve; account for discrepancies with manufacturer's data.

E. Set, verify, and record set pressures for relief and regulating valves.

F. Automatic valves to be tested in conjunction with control system testing. Set opening and closing speeds, limit switches, as required or recommended by Engineer.

G. Test hydrostatic relief valve seating; record leakage. Adjust and retest to maximum leakage of 0.1 gpm per foot of seat periphery.

3.03 MANUFACTURER'S SERVICES

A. Valve(s) as listed below require manufacturer's field services: All self-regulated valves.

B. Manufacturer's Representative:

1. Present at Site for minimum person-days listed below, travel time excluded:
   a. 2 person-days for installation assistance and inspection.
   b. 1 person-day for functional and performance testing and completion of Manufacturer's Certificate of Proper Installation, as specified in Section 01 67 00, Product Requirements.

C. See Section 01 67 00, Product Requirements, and Section 01 91 14, Total System Commissioning.

END OF SECTION

SECTION 40 80 01
PROCESS PIPING LEAKAGE TESTING

PART 1 GENERAL

1.01 SUBMITTALS

A. Informational Submittals:

1. Testing Plan:
   a. Submit prior to testing and include at least the information that follows.
      1) Testing dates.
      2) Piping systems and section(s) to be tested.
      3) Test type.
      4) Method of isolation.
      5) Calculation of maximum allowable leakage for piping section(s) to be tested.
2. Certifications of Calibration: Testing equipment.
3. Certified Test Report.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION

3.01 PREPARATION

A. Notify Contracting Officer in writing 5 days in advance of testing. Perform testing in presence of Contracting Officer.

B. Pressure Piping:

1. Install temporary thrust blocking or other restraint as necessary to protect adjacent piping or equipment and make taps in piping prior to testing.
2. Wait 5 days minimum after concrete thrust blocking is installed to perform pressure tests. If high-early strength cement is used for thrust blocking, wait may be reduced to 2 days.
3. Prior to test, remove or suitably isolate appurtenant instruments or devices that could be damaged by pressure testing.
4. New Piping Connected to Existing Piping:
   a. Isolate new piping with grooved-end pipe caps, spectacle blinds, blind flanges, or as acceptable to Contracting Officer.
   b. Test joint between new piping and existing piping by methods that do not place entire existing system under test load, as approved by Contracting Officer.

5. Items that do not require testing include: Equipment seal drains, tank overflows to atmospheric vented drains, tank atmospheric vents.
6. Test Pressure: As indicated on Piping Schedule as shown on the Drawings.

C. Test section may be filled with water and allowed to stand under low pressure prior to testing.

D. Gravity Piping:

1. Perform testing after service connections, manholes, and backfilling have been completed between stations to be tested.
2. Determine groundwater level at time of testing by exploratory holes or other method acceptable to Contracting Officer.
3. Pipe 42 Inches Diameter and Larger: Joint testing device may be used to isolate and test individual joints.

3.02 HYDROSTATIC TEST FOR PRESSURE PIPING

A. Fluid: Clean water of such quality to prevent corrosion of materials in piping system.

B. Exposed Piping:

1. Perform testing on installed piping prior to application of insulation.
2. Maximum Filling Velocity: 0.25 foot per second, applied over full area of pipe.
3. Vent piping during filling. Open vents at high points of piping system or loosen flanges, using at least four bolts, or use equipment vents to purge air pockets.
4. Maintain hydrostatic test pressure continuously for 30 minutes, minimum, and for such additional time as necessary to conduct examinations for leakage.
5. Examine joints and connections for leakage.
6. Correct visible leakage and retest as specified.
7. Empty pipe of water prior to final cleaning or disinfection.

C. Buried Piping:

1. Test after backfilling has been completed.
2. Expel air from piping system during filling.
3. Apply and maintain specified test pressure with hydraulic force pump. Valve off piping system when test pressure is reached.
4. Maintain hydrostatic test pressure continuously for 2 hours minimum, reopening isolation valve only as necessary to restore test pressure.
5. Determine actual leakage by measuring quantity of water necessary to maintain specified test pressure for duration of test.

6. Maximum Allowable Leakage:

$$L = \frac{SD(P)^{1/2}}{148{,}000}$$

where:

L = Allowable leakage, in gallons per hour.
S = Length of pipe tested, in feet.
D = Nominal diameter of pipe, in inches.
P = Test pressure during leakage test, in pounds per square inch.

7. Correct leakage greater than allowable, and retest as specified.

3.03 PNEUMATIC TEST FOR PRESSURE PIPING

A. Do not perform on:

1. PVC or CPVC pipe.
2. Piping larger than 4 inches.
3. Buried and other non-exposed piping.

B. Fluid: Oil-free, dry air.

C. Procedure:

1. Apply preliminary pneumatic test pressure of 25 psig maximum to piping system prior to final leak testing, to locate visible leaks. Apply soap bubble mixture to joints and connections; examine for leakage.
2. Correct visible leaks and repeat preliminary test until visible leaks are corrected.
3. Gradually increase pressure in system to half of specified test pressure. Thereafter, increase pressure in steps of approximately one-tenth of specified test pressure until required test pressure is reached.
4. Maintain pneumatic test pressure continuously for minimum of 10 minutes and for such additional time as necessary to conduct soap bubble examination for leakage.
5. Correct visible leakage and retest as specified.

D. Allowable Leakage: Piping system, exclusive of possible localized instances at pump or valve packing, shall show no visual evidence of leakage.

E. After testing and final cleaning, purge with nitrogen those lines that will carry flammable gases to assure no explosive mixtures will be present in system during filling process.

3.04 HYDROSTATIC TEST FOR GRAVITY PIPING

A. Testing Equipment Accuracy: Plus or minus 1/2-gallon water leakage under specified conditions.

B. Maximum Allowable Leakage: 0.16 gallon(s) per hour per inch diameter per 100 feet. Include service connection footage in test section, subjected to minimum head specified.

C. Duration: Test leakage for a minimum duration of 2 hours.

D. Gravity Sanitary and Roof Drain Piping: Test with 15 feet of water to include highest horizontal vent in filled piping. Where vertical drain and vent systems exceed 15 feet in height, test systems in 15-foot vertical sections as piping is installed.

E. Exfiltration Test:

1. Hydrostatic Head:
   a. At least 6 feet above maximum estimated groundwater level in section being tested.
   b. No less than 6 feet above inside top of highest section of pipe in test section, including service connections.
2. Length of Pipe Tested: Limit length such that pressure on invert of lower end of section does not exceed 30 feet of water column.

F. Infiltration Test:

1. Groundwater Level: At least 6 feet above inside top of highest section of pipe in test section, including service connections.

G. Piping with groundwater infiltration rate greater than allowable leakage rate for exfiltration will be considered defective even if pipe previously passed a pressure test.

H. Defective Piping Sections: Replace or test and seal individual joints, and retest as specified.

3.05 FIELD QUALITY CONTROL

A. Test Report Documentation:

1. Test date.
2. Description and identification of piping tested.
3. Test fluid.
4. Test pressure.

5. Remarks, including:
   a. Leaks (type, location).
   b. Repair/replacement performed to remedy excessive leakage.
6. Signed by Contractor and Contracting Officer to represent that test has been satisfactorily completed.

END OF SECTION

SECTION 40 90 00
INSTRUMENTATION AND CONTROL
FOR PROCESS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for Process Instrumentation and Control (PIC). The following PIC subsections expand on requirements of this section:

1. Division 26, Electrical.
2. Section 40 91 00, Instrumentation and Control Components.
3. Section 40 95 60, Telemetry System.
4. Section 40 95 80, Fiber-Optic Communication System.

B. Major Work Items: Includes but is not limited to engineering, furnishing, installing, calibrating, adjusting, testing, documenting, starting up, and training for complete PIC.

1. Process instrumentation including primary elements, transmitters, control devices, and control panels.
2. Programmable controllers.
3. Remote Monitoring Systems.
4. Computers and networks for Human Machine Interface (HMI).
5. Applications Software:
   a. Provided by Contractor for PLCs and network components. Work related to supporting this activity includes:
      1) Configuration and programming PLC, and network equipment at a staging site.
      2) Demonstration testing at staging site.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section and other PIC subsections:

1. ACIO-2020-002: Cybersecurity of Building Automation and Control Systems within NPS Facilities.
2. American National Standards Institute (ANSI).
3. ASTM International (ASTM):
   a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.

c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
d. B32, Standard Specification for Solder Metal.
e. B88, Standard Specification for Seamless Copper Water Tube.

4. Deutsche Industrie-Norm (DIN): VDE 0611, Specification for modular terminal blocks for connection of copper conductors up to 1,000V ac and up to 1,200V dc.
5. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
6. International Society of Automation (ISA):
   a. RP12.06.01, Recommended Practice for Wiring Methods for Hazardous (Classified) Locations Instrumentation Part 1: Intrinsic Safety.
   b. S5.1, Instrumentation Symbols and Identification.
   c. S5.4, Instrument Loop Diagrams.
   d. S50.1, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
   e. TR20.00.01, Specification Forms for Process Measurement and Control Instruments, Part 1: General.
7. International Conference on Energy Conversion and Application (ICECA).
8. National Electrical Code (NEC).
9. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
   b. ICS 1, Industrial Control and Systems General Requirements.
10. National Fire Protection Association (NFPA): 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
11. NSF International (NSF):
    a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
    b. NSF/ANSI 372, Drinking Water System Components - Lead Content.
12. UL: 508A, Standard for Safety, Industrial Control Panels.

1.03 DEFINITIONS

A. Abbreviations:

1. AFD: Adjustable Frequency Drive.
2. DCU: Distributed Control Unit.
3. FDT: Factory Demonstration Test.
4. HMI: Human-Machine Interface.
5. HVAC: Heating, Ventilating, and Air Conditioning.
6. I&C: Instrumentation and Control.

7. I/O: Input and Output.
8. O&M: Operation and Maintenance.
9. P&ID: Process and Instrument Diagram.
10. PC: Personal Computer.
11. PIC: Process Instrumentation and Control.
12. PLC: Programmable Logic Controller.
13. RTU: Remote Terminal Unit.
14. SCADA: Supervisory Control and Data Acquisition.
15. SLDC: Single Loop Digital Controller.
16. SSDT: Staging Site Demonstration Test.

B. Enclosure: Control panel, console, cabinet, or instrument housing.

C. Instructor Day: Eight hours of actual instruction time.

D. Standard Software: Software packages that are independent of Project on which they are used. Standard software includes system software, supervisory control, and data acquisition (SCADA) software.

1. System Software: Application independent (non-project specific) software developed by digital equipment manufacturers and software companies. Includes, but is not limited to, operating systems; network support, programming languages (C, C++, Visual C++, BASIC, Visual Basic, etc.); Office Suites (word processor, spreadsheet, database, etc.); e-mail; security (firewall, antivirus; spam, spyware, etc.) debugging aids; and diagnostics.
2. Controller Programming Software: Software packages for the configuring of PLCs, RTUs, DCUs, SLDC, and fieldbus devices.

E. Rising/Falling: Define action of discrete devices about their setpoint.

1. Rising: Contacts close when an increasing process variable rises through setpoint.
2. Falling: Contacts close when a decreasing process variable falls through setpoint.

F. Signal Types:

1. Analog Signal, Current Type:
   a. 4 mA dc to 20 mA dc signals conforming to ISA S50.1.
   b. Unless otherwise indicated for specific PIC subsection components, use the following ISA S50.1 options.
      1) Transmitter Type: Number 2, two-wire.
      2) Transmitter Load Resistance Capacity: Class L.
      3) Fully isolated transmitters and receivers.

2. Analog Signal, Voltage Type: 1V dc to 5V dc within panel where common high precision dropping resistor is used.
3. Discrete signals, two-state logic signals using dc or 120V ac sources as indicated.
4. Pulse Frequency Signals:
    a. Direct-current pulses whose repetition rate is linearly proportional to process variable.
    b. Pulses generated by contact closures or solid state switches.
    c. Power source less than 30V dc.
5. Special Signals: Other types of signals used to transmit analog and digital information between field elements, transmitters, receivers, controllers, and digital devices.

1.04 SYSTEM DESCRIPTION

A. Detailed Wiring Design: Panel wiring diagrams, interconnecting wiring diagrams, and loop wiring diagrams are included in Contract Drawings and designed to completely show control panel wiring, terminations, wire numbers, interfaces with other systems, hardwired functions, interlocks, and wiring of components to be provided.

B. Design Requirements:

1. Complete detailed design of PIC components and PIC drawings.
2. Provide consistent hardware and software functions for PIC. For example, provide functions in control logic, sequence controls, and display layouts in same or similar manner.
3. PIC design as shown and specified includes:
    a. Functional requirements, performance requirements, and component specifications.
    b. P&IDs, block diagrams, and network diagrams.
4. Typical drawings for installation details, control panel layouts, control panel schedules, PLC I/O module wiring, panel power, and control diagrams.

C. Use a qualified PIC System Integrator for at least the following work:

1. For PIC Equipment and Ancillaries:
    a. Completing detail design.
    b. Submittals.
    c. Equipment, enclosures, and ancillaries.
    d. Instructions, details, and recommendations to, and coordination with Contractor for Certificate of Proper Installation.
    e. Verify readiness for operation.

f. Verify correctness of final power and signal connections (lugging and connecting).
g. Adjusting and calibrating.
h. Starting up.
i. Testing and coordination of testing.
j. Training.
k. Assist Engineer with Functional Test Part 2 as defined in Article Field Quality Control.

2. Verify following Work not by PIC System Integrator is provided:
   a. Correct type, size, and number of signal wires with their raceways.
   b. Correct electrical power circuits and raceways.
   c. Correct size, type, and number of PIC-related pipes, valves, fittings, and tubes.
   d. Correct size, type, materials, and connections of process mechanical piping for in-line primary elements.
3. NonPIC Equipment Directly Connected to PIC Equipment:
   a. Obtain from Contractor, manufacturers' information on installation, interface, function, and adjustment.
   b. Coordinate with Contractor to allow required interface and operation with PIC.
   c. For operation and control, verify installations, interfacing signal terminations, and adjustments have been completed in accordance with manufacturer's recommendations.
   d. Test to demonstrate required interface and operation with PIC.
   e. Examples of items in this category, but not limited to the following:
      1) Valve operators, position switches, and controls.
      2) Chemical feed pump and feeder speed/stroke controls.
      3) Automatic samplers.
      4) Motor control centers.
      5) Adjustable speed and adjustable frequency drive systems.
   f. Examples of items not in this category:
      1) Internal portions of equipment provided under Division 26, Electrical, that are not directly connected to PIC equipment.
      2) Internal portions of package system instrumentation and controls that are not directly connected to PIC equipment.

1.05 SUBMITTALS

A. General:

1. Submittal Format:
   a. Electronic Copies: Required, unless otherwise noted for specific items.
      1) Manufacturers' Standard Documents: Adobe Acrobat PDF.
      2) Documents created specifically for Project:
         a) Text and Graphics: Microsoft Word.
         b) Lists: Microsoft Excel, unless otherwise noted for specific items.
         c) Drawings: AutoCAD.

B. Action Submittals:

1. Bill of Materials: List of required equipment.
   a. Group equipment items by enclosure and field, and within an enclosure, as follows:
      1) PIC Components: By component identification code.
      2) Other Equipment: By equipment type.
   b. Data Included:
      1) Equipment tag number.
      2) Description.
      3) Manufacturer, complete model number and all options not defined by model number.
      4) Quantity supplied.
      5) Component identification code where applicable.
      6) For panels, include panel reference number and name plate inscription.
   c. Formats: Hard copy and Microsoft Excel.
2. Catalog Cuts: I&C components, electrical devices, and mechanical devices:
   a. Catalog information, marked to identify proposed items and options.
   b. Descriptive literature.
   c. External power and signal connections.
   d. Scaled drawings showing exterior dimensions and locations of electrical and mechanical interfaces.
3. Instrument List:
   a. Initial Instrument List is provided as a supplement to this section. Data from this may be used as starting point for creating final Instrument List and Component Data Sheets.

b. Applicable fields to be completed include, but are not limited to:

Instrument List Characteristics	
Item	**Initially Completed By**
Tag Number	
Loop Number	
Description	
Manufacturer and complete model number	
Size and scale range	
Setpoints	
Reference P&IDs, Electrical, Mechanical, Interconnection Drawings and Installation Details Drawings	
Instrument detail number	

c. Submit updated version of Instrument List in Microsoft Excel.

4. Component Data Sheets: Data sheets for I&C components.
   a. Format:
      1) Similar to ISA TR20.00.01.
      2) Microsoft Excel, one component per data sheet.
      3) Submit proposed format for Component Data Sheets before completing data sheets for individual components.
   b. Content:
      1) Specific features and configuration data for each component, including but not limited to:
         a) Tag Number.
         b) Component type identification code and description.
         c) Location or service.
         d) Service conditions.
         e) Manufacturer and complete model number.
         f) Size and scale range.
         g) Setpoints.
         h) Materials of construction.
         i) Options included.
         j) Power requirements.
         k) Signal interfaces.
         l) Name, address, and telephone number of manufacturer’s local office, representative, distributor, or service facility.
   c. Electronic Copies: Microsoft Excel.

5. Sizing and Selection Calculations:
    a. Primary Elements:
        1) Complete calculations plus process data used. Example for Flow Elements:
            a) Minimum and maximum values, permanent head loss, and assumptions made.
    b. Controller, Computing, and Function Generating Modules: Actual scaling factors with units and how they were computed.
    c. Electronic Copies: Microsoft Excel, one file for each group of components with identical sizing calculations.
6. Preliminary Panel Elevation Drawings: Provide prior to submitting Panel Construction Drawings:
    a. Scale Drawings: Show dimensions and location of front of panel devices.
    b. Panel Legend (Bill of Material): List front of panel devices by tag number. Include nameplate inscriptions, service legends, and annunciator inscriptions.
    c. Submit electronic copies of Drawings.
7. Panel Construction Drawings:
    a. Scale Drawings: Show dimensions and locations of panel-mounted devices, doors, louvers, subpanels, internal and external.
    b. Panel Legend (Bill of Material): List front of panel devices by tag numbers, nameplate inscriptions, service legends, and annunciator inscriptions.
    c. Bill of Materials: List devices mounted within panel that are not listed in panel legend. Include tag number, description, manufacturer, and model number.
    d. Construction Details: NEMA rating, materials, material thickness, structural stiffeners and brackets, lifting lugs, mounting brackets and tabs, door hinges and latches, and welding and other connection callouts and details.
    e. Construction Notes: Finishes, wire color schemes, wire ratings, wire, terminal block numbering, and labeling scheme.
    f. Submit electronic copies of Drawings.
8. Diagrams:
    a. Detailed Wiring Diagrams:
        1) Diagrams including:
            a) Panel Wiring Diagrams for discrete control and power circuits.
            b) Loop Wiring Diagrams showing individual wiring diagram for each analog or pulse frequency loop.
            c) Interconnecting Wiring Diagrams showing electrical connections between equipment, consoles, panels, terminal junction boxes, and field-mounted components.

2) Prepare as-built redline markup of detailed wiring diagrams. Show terminal numbers on switch blocks, relays, and internal components.

b. Panel Wiring Diagrams:
   1) Cover wiring within a panel including, but not limited to, instrumentation, control, power, and communications, and digital networks.
   2) Objectives: For use in wiring panels, making panel connections, and future panel trouble shooting.

c. Diagram Type:
   1) Ladder diagrams where applicable. Include devices that are mounted in or on the panel that require electrical connections. Show unique rung numbers on left side of each rung.
   2) Schematic drawings for wiring of circuits that cannot be well represented by ladder diagrams.

d. Item Identification: Identify each item with attributes listed.
   1) Wires: Wire number and color. Cable number if part of multiconductor cable.
   2) Terminals: Location (enclosure number, terminal junction box number, or MCC number), terminal strip number, and terminal block number.
   3) Components:
      a) Tag number, terminal numbers, and location (“FIELD”, enclosure number, or MCC number).
      b) Switching action (open or close on rising or falling process variable), setpoint value and units, and process variable description (for example, Sump Level High).
   4) I/O Points: PLC unit number, I/O tag number, I/O address, terminal numbers, and terminal strip numbers.
   5) Relay Coils:
      a) Tag number and its function.
      b) On right side of run where coil is located, list contact location by ladder number and sheet number. Underline normally closed contacts.
   6) Relay Contacts: Coil tag number, function, and coil location (ladder rung number and sheet number).
   7) Communications and Networks: Network type, address or node identification, port or channel number, and type of connector.
   8) Show each circuit individually. No “typical” diagrams or “typical” wire lists will be allowed.
   9) Ground wires, surge protectors, and connections.
   10) Wire and Cable Names: Show names and wire color corresponding to Circuit and Raceway Schedule for circuits

entering and leaving a panel. Refer to Division 26, Electrical.

e. Loop Wiring Diagrams: Individual, end-to-end wiring diagram for each analog and discrete or equipment loop.
   1) Conform to the minimum requirements of ISA S5.4.
   2) Under Paragraph 5.3 of ISA S5.4, include the information listed under Subparagraphs 2 and 6.
   3) Show loop components within a panel and identify each component, component terminals, and panel terminals.
   4) If a loop connects to panels or devices not provided under this section and its subsections, such as control valves, motor control centers, package system panels, variable speed drives, include the following information:
      a) Show the first component connected to within the panel or device that is not provided under this section and its subsections.
      b) Identify the component by tag and description.
      c) Identify panel and component terminal numbers.
   5) Drawing Size: Individual 11-inch by 17-inch sheet for each loop.
   6) Divide each loop diagram into areas for panel face, back-of-panel, field, and PLC.
   7) One Drawing Per Loop: Show each loop individually. No “typical” loop diagrams will be allowed.
   8) Show:
      a) Terminal numbers, location of dc power supply, and location of common dropping resistors.
      b) Switching contacts in analog loops and output contacts of analog devices. Reference specific control diagrams where functions of these contacts are shown.
      c) Tabular summary on each analog loop diagram:
         (1) Transmitting Instruments: Output capability.
         (2) Receiving Instruments: Input impedance.
         (3) Loop Wiring Impedance: Estimate based on wire sizes and lengths shown.
         (4) Total loop impedance.
         (5) Reserve output capacity.
      d) Circuit and raceway schedule names.

f. Communications and Digital Networks Diagrams:
   1) Scope: Includes connections to Ethernet network.
   2) Format: Network schematic diagrams for each different type of network.
   3) Show:
      a) Interconnected devices, both passive and active.
      b) Device names and numbers.
      c) Terminal numbers.

d) Communication Media: Type of cable.
e) Connection Type: Type of connector.
f) Node and device address numbers.
g) Wire and cable numbers and colors.

g. Panel Plumbing Diagrams: For each panel containing piping and tubing. Show type and size for:
1) Pipes and Tubes: Thickness, pressure rating, and materials.
2) Components: Valves, regulators, and filters.
3) Connections to panel-mounted devices.
4) Panel interface connections.
5) Submit electronic copies of Drawings.

9. Panel Power Requirements and Heat Dissipation:
a. For control panels tabulate and summarize:
1) Required voltages, currents, and phases(s).
2) Maximum heat dissipations Btu per hour.
3) Calculations.
4) Steady State Temperature Calculations: For nonventilated panels, provide heat load calculations showing the panel estimated internal steady state temperature for ambient air temperatures of 90 degrees F.

10. Installation Details: Include modifications or further details required and define installation of I&C components.
11. Spares, expendables, and test equipment.
12. PLC I/O List: Submit I/O assignment and Rack/Slot/Point.
13. Identify proposed items, options, installed spares, and other provisions for future work (for example, reserved panel space; unused components, wiring, and terminals).
14. Color schedule for control panels.
15. Applications Software Documentation: For equipment for which Engineer does not provide applications software provide:
a. Complete configuration documentation for microprocessor based programmable devices.
b. For each device, include program listings and function block diagrams, as appropriate, showing:
1) Functional blocks or modules used.
2) Configuration, calibration, and tuning parameters.
3) Descriptive annotations.
c. Refer to PIC subsections for additional requirements.

16. Factory and Field Test Documentation:
a. Submit test plans prior to Factory and Field Tests.
b. Submit test reports and punch lists from the Factory and Field tests.
c. Submit final sign off documentation from the Factory and Field tests.

17. Legends and Abbreviation Lists:
    a. Definition of symbols and abbreviations used; for example, engineering units, flowstreams, instruments, structures, and other process items used in nameplates, legends, data sheets, point descriptions, HMI displays, alarm/status logs, and reports.
    b. Use identical abbreviations in PIC subsections.
    c. Submit updated versions as they occur.
18. Shop Drawings for Changes Impacting PLC Programming: Submit details of changes required to PLC control resulting from installation of alternative or upgraded process equipment and instrumentation, and other causes.

C. Informational Submittals:

1. Proposed Submittal breakdown consisting of sequencing and packaging of information in accordance with Project Schedule.
2. Statements of Qualification:
    a. PIC System Integrator.
    b. PIC System Integrator's site representative.
    c. Resume for each PIC System Integrator's onsite startup and testing team member (engineers, technicians, and software/configuring personnel).
3. Operation and Maintenance Data:
    a. General:
        1) Provide sufficient detail to allow operation, removal, installation, adjustment, calibration, maintenance and purchasing replacements for PIC components.
        2) Submittal Format: Both hard copy and electronic copies for all submittals. Refer to Article Submittals, heading Submittal Format.
    b. Manufacturer's O&M manuals for components, electrical devices, and mechanical devices:
        1) Content for Each O&M Manual:
            a) Table of Contents.
            b) Operations procedures.
            c) Installation requirements and procedures.
            d) Maintenance requirements and procedures.
            e) Troubleshooting procedures.
            f) Calibration procedures.
            g) Internal schematic and wiring diagrams.
            h) Component and I/O Module Calibration Sheets from field quality control calibrations.
        2) Provide PDF file will linked index to all manuals.
    c. List of spares, expendables, test equipment and tools provided.

d. List of additional recommended spares, expendables, test equipment, and tools. Include quantities, unit prices, and total costs.

4. Provide Manufacturer's Certificate of Proper Installation where specified.
5. Testing Related Submittals:
   a. Factory Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures:
         a) Proposed test procedures, forms, and checklists.
         b) Capacity, Timing, and Simulation: Describe simulation and monitoring methods used to demonstrate compliance with capacity and timing requirements.
      3) Test Documentation: Copy of signed off test results.
   b. Staging Site Demonstration Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed-off test results when tests are completed.
   c. Functional Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation:
         a) Copy of signed-off test results.
         b) Completed component calibration sheets.
   d. Performance Test:
      1) Preliminary Test Procedures: Outline of proposed tests, forms, and checklists.
      2) Final Test Procedures: Proposed test procedures, forms, and checklists.
      3) Test Documentation: Copy of signed-off test results.
6. Maintenance Service Agreement: Prior to Substantial Completion, submit service agreements signed by Owner and maintenance provider for work required under Article Maintenance Service.

1.06 QUALITY ASSURANCE

A. Qualifications:

1. PIC System Integrator: Minimum of 10 years' experience providing, integrating, installing, and starting up similar systems as required for this Project.
2. PIC System Integrator's Site Representative: Minimum of 5 years' experience installing systems similar to PIC required for this Project.

B. PIC Coordination Meetings:

1. PIC Schedule Coordination Meeting:
   a. Timing: Following Engineer review of PIC Schedule.
   b. Purpose: Discuss Engineer's comments and resolve scheduling issues.
2. Training Coordination Meeting:
   a. Timing: Following Engineer review of preliminary training plan.
   b. Purpose:
      1) Resolve required changes to proposed training plan.
      2) Identify specific Owner personnel to attend training.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Prior to shipment, include corrosive inhibitive vapor capsules in shipping containers, and related equipment as recommended by capsule manufacturer.

B. Prior to installation, store items in dry indoor locations. Provide heating in storage areas for items subject to corrosion under damp conditions.

C. Cover panels and other elements that are exposed to dusty construction environments.

1.08 SEQUENCING AND SCHEDULING

A. Prerequisite Activities and Lead Times:

1. Do not start following key Project activities until prerequisite activities and lead times listed below have been completed and satisfied:
   a. Shop Drawing Reviews by Contracting Officer:
      1) Prerequisite: Contracting Officer acceptance of Schedule of Values and Progress Schedule.

1.09 MAINTENANCE

A. Maintenance Service Agreement:

1. Duration of 2 years, unless otherwise noted in PIC subsections.
2. Start on date of Substantial Completion.
3. Performed by factory-trained service engineers with experience on PIC systems to be maintained.
4. PIC Systems Covered: PIC components, PLC, HMI, and network equipment.
5. Materials and labor for preventive maintenance and monthly Site visits.
6. Materials and labor for demand maintenance with coverage 8:00 a.m. to 5:00 p.m. Monday through Friday.
7. Spare Parts: If not stocked onsite, delivered to Site within 24 hours from time of request.
8. Repair or replace components or software found to be faulty.
9. Replace and restock within 1 month onsite spare parts and expendables used for maintenance. Provide list of items used and replaced.
10. Submit records of inspection, maintenance, calibration, repair, and replacement within 2 weeks after each Site visit.

B. Telephone Support: As specified in PIC subsections.

C. Software Subscription: As specified in PIC subsections.

1.10 EXTRA MATERIALS

A. As specified in PIC subsections.

B. In computing spare parts quantities based on specified percentages, round up to nearest whole number.

C. Spare Parts:

Description	**Percent of Each Type and Size Used**	**No Less Than**
dc power supplies	20	2
Fuses	20	5
Relays	20	3
Terminal Blocks	10	10
120V ac Isolation Transformers	10	2
Surge Suppressors	10	2

D. Expendables: For following items provide manufacturer's recommended 2-year supply, unless otherwise noted.

1. Chemical for analyzers.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide PIC functions shown on the Drawings and required in PIC subsections for each system and loop. Furnish equipment items required in PIC subsections. Furnish materials, equipment, and software whether indicated or not, necessary to effect required system and loop performance.

B. Like Equipment Items:

1. Use products of one manufacturer and of the same series or family of models to achieve standardization for appearance, operation, maintenance, spare parts, and manufacturer's services.
2. Implement same or similar functions in same or similar manner. For example control logic, sequence controls, and display layouts.

C. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 I&C COMPONENTS

A. Specifications: Refer to Section 40 91 00, Instrumentation and Control Components, for specifications for I&C components.

B. Components for Each Loop: Major components for each loop are listed in Instrument List referenced in Article Supplements. Furnish equipment that is necessary to achieve required loop performance.

C. Control Panels: Reference Control Panel Schedule in Article Supplements.

2.03 PROGRAMMABLE LOGIC CONTROLLERS

A. Reference PLC components in Section 40 91 00, Instrumentation and Control Components.

2.04 NETWORK, AND HMI COMPONENTS

A. Reference Network and HMI components in Section 40 91 00, Instrumentation and Control Components.

2.05 SERVICE CONDITIONS

A. Standard Service Conditions:

1. The following defines certain types of environments. PIC subsections refer to these definitions by name to specify the service conditions for individual equipment units. Design equipment for continuous operation in these environments:
   a. Server Room, Air Conditioned:
      1) Temperature: 60 degrees F to 80 degrees F.
      2) Relative Humidity: 40 percent to 60 percent.
      3) NEC Classification: Nonhazardous.
   b. Inside, Air Conditioned:
      1) Temperature:
         a) Normal: 60 degrees F to 80 degrees F.
         b) With Up to 4-Hour HVAC System Interruptions: 40 degrees F to 105 degrees F.
      2) Relative Humidity:
         a) Normal: 10 percent (winter) to 70 percent (summer).
         b) With Up to 4-Hour HVAC System Interruption: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.
   c. Inside:
      1) Temperature: 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent.
      3) NEC Classification: Nonhazardous.
   d. Outside:
      1) Temperature: Minus 20 degrees F to 104 degrees F.
      2) Relative Humidity: 10 percent to 100 percent, rain, snow, freezing rain.
      3) NEC Classification: Nonhazardous.

B. Standard Service Conditions for Panels and Consoles:

1. Unless otherwise noted, in Instrument List and Control Panel Schedule located in Article Supplements at “End of Section,” design equipment for continuous operation in these environments:
   a. Freestanding Panel and Consoles:
      1) Inside, Air Conditioned: NEMA 1.
      2) Inside: NEMA 12.

b. Smaller Panels and Assemblies (that are not freestanding):
   1) Inside, Air Conditioned: NEMA 12.
   2) All Other Locations: NEMA 4X.
c. Field Elements: Outside.

C. Special Environmental Requirements: Design following panels for continuous operation in environments listed.

2.06 NAMEPLATES AND TAGS

A. Panel Nameplates: Enclosure identification located on enclosure face.

1. Location and Inscription: Refer to Example Control Panel Layouts and Control Panel Schedule drawings.
2. Materials: Laminated plastic attached to panel with stainless steel screws.
3. Letters: 1/2-inch high, white on black background, unless otherwise noted.

B. Component Nameplates, Panel Face: Component identification located on panel face under or near component.

1. Location and Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, white on black background, unless otherwise noted.

C. Component Nameplates, Back of Panel: Component identification located on or near component inside of enclosure.

1. Inscription: Component tag number.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, white on black background, unless otherwise noted.

D. Legend Plates for Panel Mounted Pushbuttons, Lights, and Switches.

1. Inscription:
   a. Refer to table under Paragraph Standard Pushbutton Colors and Inscriptions.
   b. Refer to table under Paragraph Standard Light Colors and Inscriptions.
   c. Refer to P&IDs on the Drawings.
2. Materials: Stainless steel, keyed legend plates. Secured to panel by mounting nut for pushbutton, light, or switch.
3. Letters: Black on gray or white background.

E. Service Legends: Component identification nameplate located on face of component.

1. Inscription: As shown on panel drawing.
2. Materials: Adhesive-backed, laminated plastic.
3. Letters: 3/16-inch high, white on black background, unless otherwise noted.

F. Nametags: Component identification for field devices.

1. Inscription: Component tag number.
2. Materials: 16-gauge, Type 304 stainless steel.
3. Letters: 3/16-inch high, imposed.
4. Mounting: Affix to component with 16-gauge or 18-gauge stainless steel wire or stainless steel screws.

2.07 MECHANICAL SYSTEM COMPONENTS

A. Reference Section 40 91 00, Instrumentation and Control Components.

2.08 FUNCTIONAL REQUIREMENTS FOR CONTROL LOOPS

A. Shown on the Drawings, in panel control diagrams, and Process and Instrumentation Diagrams (P&ID). P&ID format and symbols are in accordance with ISA S5.1, except as specified or shown on the Drawings.

B. Supplemented by Loop Specifications that describe requirements not obvious on P&IDs or panel control diagrams.

C. Supplemented by standard functional requirements in PIC subsections.

2.09 ELECTRICAL REQUIREMENTS

A. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes for Electrical Systems.

B. Wiring External to PIC Equipment:

1. Special Control and Communications Cable: Provided by PIC System Integrator as noted in Component Specifications and PIC subsections.
2. Other Wiring and Cable: As specified in Section 26 05 05, Conductors.

C. I&C and electrical components, terminals, wires, and enclosures UL recognized or UL listed.

D. Wires within Enclosures:

1. ac Circuits:
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current to be carried, but not less than No. 18 AWG.
2. Analog Signal Circuits:
   a. Type: 600-volt stranded copper, twisted shielded pairs or triad with a 100 percent, aluminum-polyester shield, rated 60 degrees C.
   b. Panels with Circuits Less Than 600 volts: Rated at 600 volts. Belden No. 18 AWG Type 9341, Triad Beldon No. 1121A.
   c. Size: No. 18 AWG, minimum.
3. Other dc Circuits.
   a. Type: 600-volt, Type MTW stranded copper.
   b. Size: For current carried, but not less than No. 18 AWG.
4. Special Signal Circuits: Use manufacturer's standard cables.
5. Wire Identification: Numbered and tagged at each termination.
   a. Wire Tags: Machine printed, heat shrink.

E. Terminate and identify wires entering or leaving enclosures as follows:

1. Analog and discrete signal, terminate at numbered terminal blocks.
2. Special signals terminated using manufacturer's standard connectors.
3. Identify wiring in accordance with requirements in Section 26 05 05, Conductors.

F. Terminal Blocks for Enclosures:

1. Quantity:
   a. Accommodate present and spare indicated needs.
   b. Wire spare PLC I/O points to terminal blocks.
   c. One wire per terminal for field wires entering enclosures.
   d. Maximum of two wires per terminal for No. 18 AWG wire for internal enclosure wiring.
   e. Spare Terminals: 20 percent of connected terminals, but not less than 5 per terminal block, unless otherwise shown on the Drawings.
2. Terminal Block Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.

G. Grounding of Enclosures:

1. Furnish isolated copper grounding bus for signal and shield ground connections.
2. Ground this ground bus at a common signal ground point in accordance with National Electrical Code requirements.

3. Single Point Ground for Each Analog Loop:
    a. Locate signal ground at dc power supply for loop.
    b. Use to ground wire shields for loop.
4. Ground terminal block rails to ground bus.

H. Analog Signal Isolators:

1. Furnish signal isolation for analog signals that are sent from one enclosure to another.
2. Do not wire in series instruments on different panels, cabinets, or enclosures.

I. Intrinsic Safety System Installation:

1. Comply with NEC Article 504, Intrinsically Safe Systems.
2. Install intrinsically safe circuits in a separate wire way that:
    a. Is separated from nonintrinsically safe circuits as specified by NEC.
    b. Is colored light blue and has message “Intrinsically Safe Circuits Only” on raceway cover every 6 inches.

J. Electrical Transient Protection:

1. General:
    a. Function: Protect elements of PIC against damage due to electrical transients induced in interconnecting lines by lightning and nearby electrical systems.
    b. Surge suppressors are not shown for external analog transmitters. Determine quantity and location, and show in Shop Drawings. Refer to example wiring in installation details in Drawings.
    c. Provide, install, coordinate, and inspect grounding of surge suppressors at:
        1) Connection of ac power to PIC equipment including panels, consoles assembles, and field-mounted analog transmitters and receivers.
        2) At the field and panel, console, or assembly connection of signal circuits that have portions of the circuit extending outside of a protective building.
2. Surge Suppressor Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Surge Suppressors.
3. Installation and Grounding of Suppressors:
    a. As shown. See Surge Suppressor Installation Details.
    b. Grounding equipment, installation of grounding equipment, and terminations for field mounted devices are provided under Division 26, Electrical.

2.10 PANEL FABRICATION

A. General:

1. Nominal Panel Dimensions: As shown on the Drawings.
2. Instrument Arrangements: As shown on the Drawings.
3. Panel Construction and Interior Wiring: In accordance with the National Electrical Code (NEC), state and local codes, and applicable sections of NEMA, ANSI, UL, and ICECA.
4. Fabricate panels, install instruments and wire, and plumb at PIC System Integrator's facility. No fabrication other than correction of minor defects or minor transit damage permitted onsite.
5. UL Listing Mark for Enclosures: Mark stating "Listed Enclosed Industrial Control Panel" per UL 508A.
6. Electrical Work: In accordance with the applicable requirements of Division 26, Electrical.

B. Temperature Control:

1. Freestanding Panels:
   a. Nonventilated Panels: Size to adequately dissipate heat from equipment mounted inside panel and on panel.
   b. Ventilated Panels:
      1) Furnish with louvers and forced ventilation as required to prevent temperature buildup from equipment mounted inside panel and on panel.
      2) For panels with backs against wall, furnish louvers on top and bottom of panel sides.
      3) For panels without backs against wall, furnish louvers on top and bottom of panel back.
      4) Louver Construction: Stamped sheet metal.
      5) Ventilation Fans:
         a) Furnish where required to provide adequate cooling.
         b) Create positive internal pressure within panel.
         c) Fan Motor Power: 120V ac, 60-Hz, thermostatically controlled.
      6) Air Filters: Washable aluminum, Hoffman Series A-FLT.
   c. Refrigerated System: Furnish where heat dissipation cannot be adequately accomplished with natural convection or forced ventilation.
2. Smaller Panels (that are not freestanding): Size to adequately dissipate heat from equipment mounted inside panel and on panel face.
3. Space Heaters:
   a. Thermostatically controlled to maintain internal panel temperatures above dewpoint.
   b. Refer to Control Panel Schedule in Article Supplements.

C. Freestanding Panel Construction:

1. Materials:
   a. Sheet steel, unless otherwise shown on the Drawings.
   b. Minimum Thickness: 10-gauge, unless otherwise noted.
2. Panel Front:
   a. Fabricated from a single piece of sheet steel, unless otherwise shown on the Drawings.
   b. No seams or bolt heads visible when viewed from front.
   c. Panel Cutouts: Smoothly finished with rounded edges.
   d. Stiffeners: Steel angle or plate stiffeners or both on back of panel face to prevent panel deflection under instrument loading or operation.
3. Internal Framework:
   a. Structural steel for instrument support and panel bracing.
   b. Permit panel lifting without racking or distortion.
4. Lifting rings to allow simple, safe rigging and lifting of panel during installation.
5. Adjacent Panels: Securely bolted together so front faces are parallel.
6. Door:
   a. Full height, fully gasketed access door where shown on the Drawings.
   b. Latch: Three-point, Southco Type 44.
   c. Handle: “D” ring, foldable type.
   d. Hinges: Full-length, continuous, piano-type, steel hinges with stainless steel pins.
   e. Rear Access: Extend no further than 24 inches beyond panel when opened to 90-degree position.
   f. Front and Side Access Doors: As shown on the Drawings.

D. Nonfreestanding Panel Construction:

1. Based on environmental design requirements provide the following unless otherwise noted in Control Panel Schedule in Article Supplements:
   a. Panels Listed as Inside, Air Conditioned:
      1) Enclosure Type: NEMA 12.
      2) Materials: Steel.
   b. Other Panels:
      1) Enclosure Type: NEMA 4X.
      2) Materials: Type 316 stainless steel.
2. Metal Thickness: 14-gauge, minimum.
3. Doors:
   a. Rubber-gasketed with continuous hinge.
   b. Stainless steel lockable quick-release clamps.

E. Breather and Drains: Furnish with NEMA 250, Type 4 and Type 4X panels:

F. Control Panel Electrical:

1. Power Distribution within Panels:
   a. Feeder Circuits:
      1) One or more 120V ac, 60-Hz feeder circuits as shown on the Drawings.
      2) Make provisions for feeder circuit conduit entry.
      3) Furnish terminal block for termination of wires.
   b. Power Panel: Furnish main circuit breaker and circuit breaker on each individual branch circuit distributed from power panel.
      1) Locate to provide clear view of and access to breakers when door is open.
      2) Breaker Sizes: Coordinate such that fault in branch circuit will blow only branch breaker, but not trip main breaker.
         a) Branch Circuit Breakers: 15 amps at 250V ac.
   c. Circuit Wiring:
      1) P&IDs and Control Diagrams on the Drawings show function only. Use following rules for actual circuit wiring:
         a) Devices on Single Circuit: 20, maximum.
         b) Multiple Units Performing Parallel Operations: To prevent failure of any single branch circuit from shutting down entire operation, do not group all units on same branch circuit.
         c) Branch Circuit Loading: 12 amperes continuous, maximum.
         d) Panel Lighting and Service Outlets: Put on separate 15 amp, 120V ac branch circuit.
         e) Provide 120V ac plugmold for panel components with line cords.
2. Signal Distribution:
   a. Signal Wiring: Separate analog signal cables from power and control within a panel and cross at right angles where necessary.
   b. Within Panels: 4 mA dc to 20 mA dc signals may be distributed as 1V dc to 5V dc.
   c. Outside Panels: Isolated 4 mA dc to 20 mA dc only.
   d. Signal Wiring: Twisted shielded pairs.
   e. RTD and Thermocouple Extension Cable:
      1) Continuous field to panel with no intermediate junction boxes or terminations.
      2) RTDs in motor windings are considered a 600-volt circuit.
      3) Terminate thermocouple extension wire directly to loop instrument.

3. Signal Switching:
   a. Use dry circuit type relays or switches.
   b. No interruption of 4 mA to 20 mA loops during switching.
   c. Switching Transients in Associated Signal Circuit:
      1) 4 mA dc to 20 mA dc Signals: 0.2 mA, maximum.
      2) 1V dc to 5V dc Signals: 0.05V, maximum.
4. Relay Types: Reference Section 40 91 00, Instrumentation and Control Components, Part 2, Article Electrical Components.
5. Push-to-Test Circuitry: For each push-to-test indicating light, provide a fused push-to-test circuit.
6. Internal Panel Lights for Freestanding Panels:
   a. Type: Switched 100-watt incandescent back-of-panel lights.
   b. Quantity: One light for every 4 feet of panel width.
   c. Mounting: Inside and in the top of back-of-panel area.
   d. Protective metal shield for lights.
7. Service Outlets for Freestanding Panels:
   a. Type: Three-wire, 120-volt, 15-ampere, GFCI GFCI duplex receptacles.
   b. Quantity:
      1) Panels 4 Feet Wide and Smaller: One.
      2) Panels Larger than 4 Feet Wide: One for every 4 feet of panel width, two minimum per panel.
   c. Mounting: Evenly spaced along back-of-panel area.
8. Internal Panel Lights and Service Outlets for Smaller Panels:
   a. Internal Panel Light: Switched 100-watt incandescent light.
   b. Service Outlet: Breaker protected 120-volt, 15-amp, GFCI GFCI duplex receptacle:
   c. Required for panels. Refer to Control Panel Schedule in Article Supplements.
9. Standard Pushbutton Colors and Inscriptions:
   a. Use following unless otherwise noted:

Tag Function	Inscription(s)	Color
OO	ON OFF	Black Black
OC	OPEN CLOSE	Black Black
OCA	OPEN CLOSE AUTO	Black Black Black
OOA	ON OFF AUTO	Black Black Black

Tag Function	Inscription(s)	Color
LR	LOCAL REMOTE	Black Black
SS	START STOP	Black Black
RESET	RESET	Black
EMERGENCY STOP	EMERGENCY STOP	Red

b. Lettering Color:
   1) Black on white and yellow buttons.
   2) White on black, red, and green buttons.

10. Standard Light Colors and Inscriptions:
    a. Use following color code and inscriptions for service legends and lens colors for indicating lights, unless otherwise noted:

Tag Function	Inscription(s)	Color
ON	ON	Red
OFF	OFF	Green
OPEN	OPEN	Red
CLOSED	CLOSED	Green
LOW	LOW	Amber
FAIL	FAIL	Amber
HIGH	HIGH	Amber
AUTO	AUTO	White
MANUAL	MANUAL	Yellow
LOCAL	LOCAL	White
REMOTE	REMOTE	Yellow

    b. Lettering Color:
       1) Black on white and amber lenses.
       2) White on red and green lenses.

G. PIC Enclosure Internal Wiring:

1. Restrain by plastic ties or ducts or metal raceways.
2. Hinge Wiring: Secure at each end so bending or twisting will be around longitudinal axis of wire. Protect bend area with sleeve.
3. Arrange wiring neatly, cut to proper length, and remove surplus wire.

4. Provide abrasion protection for wire bundles that pass through holes or across edges of sheet metal.
5. Connections to Screw Type Terminals:
    a. Locking-fork-tongue or ring-tongue lugs.
    b. Use manufacturer's recommended tool with required sized anvil to make crimp lug terminations.
    c. Wires terminated in a crimp lug, maximum of one.
    d. Lugs installed on a screw terminal, maximum of two.
6. Connections to Compression Clamp Type Terminals:
    a. Strip, prepare, and install wires in accordance with terminal manufacturer's recommendations.
    b. Wires installed in a compression screw and clamp, maximum of one for field wires entering enclosure, otherwise maximum of two.
7. Splicing and tapping of wires, allowed only at device terminals or terminal blocks.
8. Terminate 24V dc and analog signal circuits on separate terminal block from ac circuit terminal blocks.
9. Separate analog and dc circuits by at least 6 inches from ac power and control wiring, except at unavoidable crossover points and at device terminations.
10. Arrange wiring to allow access for testing, removal, and maintenance of circuits and components.
11. Plastic Wire Duct Fill: Do not exceed manufacturer's recommendations.
12. Conductors Carrying Foreign Voltages within a Panel:
    a. Route foreign voltage conductors into panel and land on a circuit blade disconnect type terminal block.
    b. Use wire with pink insulation to identify foreign voltage circuits within panel from terminal block on. Do not use wires with pink insulation for any other purpose.
13. Harness Wiring:
    a. 120V ac: No. 14 AWG, MTW.
    b. 24V dc: No. 16 AWG, MTW where individual conductors are used and Type TC shielded tray cable where shielded wire is used.
14. Panelwork:
    a. No exposed connections.
    b. Allow adjustments to equipment to be made without exposing these terminals.
    c. For power and control wiring operating above 80V ac or dc use covered channels or EMT raceways separate from low voltage signal circuits.
15. Plastic Wire Ducts Color:
    a. 120V ac: White.
    b. 24V dc: Gray.
    c. Communications Cables and Fiber Optic Jumpers: Orange.

16. Provide a communications plastic wire duct for communications cables and fiber optic cables between the communications devices in control panel and communications raceways. Design plastic wire duct design to take into account the minimum bending radius of the communications cable.
17. Make plastic wire ducts the same depth.
18. Provide a minimum of 1-1/2 inches between plastic wire ducts and terminal blocks.

H. Control Relay Arrangement: Install control relays associated with specific loops in same panel section as corresponding terminal blocks or side panels. Provide 20 percent space for future relays. Locate spare space in same sections as spare terminal blocks.

I. Factory Finishing:

1. Furnish materials and equipment with manufacturer's standard finish system in accordance with Section 09 90 00, Painting and Coating.
2. Use specific color if indicated. Otherwise use manufacturer's standard finish color, or light gray if manufacturer has no standard color.
3. Stainless Steel and Aluminum: Not painted.
4. Nonmetallic Panels: Similar to steel panels.
5. Steel Panels:
   a. Sand panel and remove mill scale, rust, grease, and oil.
   b. Fill imperfections and sand smooth.
   c. Paint panel interior and exterior with one coat of epoxy coating metal primer, two finish coats of two-component type epoxy enamel.
   d. Sand surfaces lightly between coats.
   e. Dry Film Thickness: 3 mils, minimum.
   f. Color: Manufacturer's standard.

2.11 CORROSION PROTECTION

A. Corrosion-Inhibiting Vapor Capsules:

1. Areas Where Required: Refer to Article Protection.

2.12 TEST EQUIPMENT AND TOOLS

A. Digital Multimeter:

1. Type: Industrial True RMS Digital Multimeter, CAT IV 600V protection with test leads, removable test probes, long reach alligator clips, magnetic hanger, temperature probe, and carrying case.
2. Quantity: Two.

B. Clamp-on Ammeter:

1. Type: True RMS Digital Clamp-on meter with 3-1/2-digit display and protective case.
2. Quantity: One.

C. DC Digital Process Signal Calibrator:

1. Type: Portable, two-channel, with test leads, rechargeable batteries, charger, and carrying case.
2. Quantity: Two.

D. Pressure and Electrical Calibrator:

1. Type: Test leads, rechargeable batteries, ac charger, pressure transducer modules, and protective case.
2. Pressure Ranges: Appropriate for pressure devices provided.
3. Quantity: One.

E. Pressure Pump Kit:

1. Type: Hand pump (0 psig to 600 psig), calibration labels, tubing, fittings, and carrying case.
2. Quantity: One.

F. Small Tool Kit:

1. Type: Kit of instrument maintenance tools in soft, zipper case.
2. Quantity: One.

G. Large Tool Kit:

1. Type: Kit of instrument maintenance tools in high-density polyethylene case.
2. Quantity: One.

2.13 SOURCE QUALITY CONTROL

A. General:

1. Contracting Officer may actively participate in many of the tests.
2. Contracting Officer reserves right to test or retest specified functions.
3. Contracting Officer’s decision will be final regarding acceptability and completeness of testing.
4. Procedures, Forms, and Checklists:
   a. Except for Unwitnessed Factory Test, conduct tests in accordance with, and documented on, Contracting Officer accepted procedures, forms, and checklists.

b. Describe each test item to be performed.
c. Have space after each test item description for sign off by appropriate party after satisfactory completion.

5. Required Test Documentation: Test procedures, forms, and checklists signed by Contracting Officer.
6. Conducting Tests:
   a. Provide special testing materials and equipment.
   b. Wherever possible, perform tests using actual process variables, equipment, and data.
   c. If not practical to test with real process variables, equipment, and data provide suitable means of simulation.
   d. Define simulation techniques in test procedures.
   e. Test Format: Cause and effect.
      1) Person conducting test initiates an input (cause).
      2) Specific test requirement is satisfied if correct result (effect), occurs.

B. Unwitnessed Factory Test:

1. Scope: Inspect and test PIC to ensure it is operational, ready for FDT.
2. Location: PIC System Integrator's facility.
3. Integrated Test:
   a. Interconnect and test PIC, except for primary elements and smaller panels.
   b. Exercise and test functions.
   c. Provide stand-alone testing of smaller panels.
   d. Simulate inputs and outputs for primary elements, final control elements, and panels excluded from test.

C. Factory Demonstration Tests (FDT):

1. Notify Contracting Officer of test schedule 4 weeks prior to start of test.
2. Scope:
   a. Submit FDT test procedures as a submittal at least 2 weeks prior to scheduling the FDT.
   b. Test entire PIC, with exception of primary elements, final control elements, and certain smaller panels, to demonstrate it is operational.
   c. Refer to Control Panel Schedule in Article Supplements for list of panels for which FDT is required.
3. Location: PIC System Integrator's facility.
4. Correctness of wiring from panel field terminals to PLC system input/output points and to panel components.
   a. Simulate each discrete signal at terminal strip.
   b. Simulate correctness of each analog signal using current source.

5. Operation of communications between PLCs and remote I/O and between PLCs and HMI computers.
6. Operation of communications between the PLC system and AFDs.
7. Loop-Specific Functions:
    a. Demonstrate functions shown on P&IDs, control diagrams, and control descriptions:
        1) One of each type function; for example, if there are filter backwash sequence control for several identical filters, demonstrate controls for one filter.
        2) All required and shown functions for 100 percent of loops.
8. Nonloop-Specific Functions:
    a. Capacity: Demonstrate that PIC systems have required spare capacity for expansion. Include tests for both storage capacity and processing capacity.
    b. Timing: Include tests for timing requirements.
    c. Diagnostics: Demonstrate online and offline diagnostic tests and procedures.
9. Correct deficiencies found and complete prior to shipment to Site.
10. Failed Tests:
    a. Repeat and witnessed by Contracting Officer.
    b. With approval of Contracting Officer, certain tests may be conducted by PIC System Integrator and witnessed by Contracting Officer as part of Functional Test.
11. Make following documentation available to Contracting Officer at test site both before and during FDT:
    a. Drawings, Specifications, Addenda, and Change Orders.
    b. Master copy of FDT procedures.
    c. List of equipment to be tested including make, model, and serial number.
    d. Approved hardware Shop Drawings for equipment being tested.
    e. Approved preliminary software documentation Submittal.
12. Daily Schedule for FDT:
    a. Begin each day with meeting to review day’s test schedule.
    b. End each day with each meeting to review day’s test results and to review or revise next day’s test schedule.

PART 3 EXECUTION

3.01 EXAMINATION

A. For equipment not provided by PIC System Integrator, but that directly interfaces with PIC, verify the following conditions:

1. Proper installation.
2. Calibration and adjustment of positioners and I/P transducers.
3. Correct control action.

4. Switch settings and dead bands.
5. Opening and closing speeds and travel stops.
6. Input and output signals.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to PIC components and assemblies, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

C. Electrical Raceways: As specified in Section 26 05 33, Raceway and Boxes for Electrical Systems.

D. Mechanical Systems:

1. Copper and Stainless Steel Tubing Support: Continuously supported by aluminum tubing raceway system.
2. Plastic Tubing Support: Except as shown on the Drawings, provide continuous support in conduit or by aluminum tubing raceway system.
3. Install conduit for plastic tubing and tubing raceways parallel with, or at right angles to, structural members of buildings. Make vertical runs straight and plumb.
4. Tubing and Conduit Bends:
   a. Tool-formed without flattening, and of same radius.
   b. Bend Radius: Equal to or larger than conduit and tubing manufacturer's recommended minimum bend radius.
   c. Slope instrument connection tubing in accordance with installation details.
   d. Do not run liquid filled instrument tubing immediately over or within a 3-foot plan view clearance of electrical panels, motor starters, or mechanical mounting panel without additional protection. Where tubing must be located in these zones, shield electrical device to prevent water access to electrical equipment.
   e. Straighten coiled tubing by unrolling on flat surface. Do not pull to straighten.
   f. Cut tubing square with sharp tubing cutter. Deburr cuts and remove chips. Do not gouge or scratch surface of tubing.
   g. Blow debris from inside of tubing.
   h. Make up and install fittings in accordance with manufacturer's recommendations. Verify make up of tube fittings with manufacturer's inspection gauge.
   i. Use lubricating compound or TFE tape on stainless steel threads to prevent seizing or galling.

j. Run tubing to allow but not limited to, clear access to doors, controls and control panels; and to allow for easy removal of equipment.
k. Provide separate support for components in tubing runs.
l. Supply expansion loops and use adapters at pipe, valve, or component connections for proper orientation of fitting.
m. Keep tubing and conduit runs at least 12 inches from hot pipes.
n. Locate and install tubing raceways in accordance with manufacturer's recommendations. Locate tubing to prevent spillage, overflow, or dirt from above.
o. Securely attach tubing raceways to building structural members.

5. Enclosure Lifting Rings: Remove rings following installation and plug holes.

E. Field Finishing: Refer to Section 09 90 00, Painting and Coating.

3.03 FIELD QUALITY CONTROL

A. General:

1. Coordinate PIC testing with Contracting Officer and affected Subcontractors.
2. Notify Contracting Officer of Performance Test schedule 4 weeks prior to start of test.
3. Contracting Officer may actively participate in tests.
4. Contracting Officer reserves right to test or retest specified functions.
5. Contracting Officer's decision will be final regarding acceptability and completeness of testing.

B. Onsite Supervision:

1. Require PIC System Integrator to observe PIC equipment installation to extent required in order to provide Certificates of Proper Installation.
2. Require PIC site representative to supervise and coordinate onsite PIC activities.
3. Require PIC site representative to be onsite while onsite work covered by this section and PIC subsystems is in progress.

C. Leak Tests: During preparation for testing, conduct leak tests in accordance with Section 40 80 01, Process Piping Leakage Testing.

D. Testing:

1. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.

2. Preparation for Testing: Performed by PIC System Integrator to test and document PIC is ready for operation.
    a. Documentation that the relevant FDTs and resultant punch lists have been completed.
    b. Loop/Component Inspections and Tests:
        1) These inspections and tests will be spot checked by Contracting Officer.
        2) Check PIC for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.
        3) Provide space on forms for signoff by PIC System Integrator.
        4) Use loop status report to organize and track inspection, adjustment, and calibration of each loop and include the following:
            a) Project name.
            b) Loop number.
            c) Tag number for each component.
            d) Checkoffs/Signoffs for Each Component:
                (1) Tag/identification.
                (2) Installation.
                (3) Termination wiring.
                (4) Termination tubing.
                (5) Calibration/adjustment.
            e) Checkoffs/Signoffs for the Loop:
                (1) Panel interface terminations.
                (2) I/O interface terminations with PLC.
            f) I/O Signals for PLCs are Operational: Received/sent, processed, adjusted.
            g) Total loop operational.
            h) Space for comments.
        5) Component calibration sheet for each active I&C component (except simple hand switches, lights, gauges, and similar items) and each PLCs I/O module and include the following:
            a) Project name.
            b) Loop number.
            c) Component tag number or I/O module number.
            d) Component code number for I&C elements.
            e) Manufacturer for I&C elements.
            f) Model number/serial number for I&C elements.
            g) Summary of Functional Requirements; For Example:
                (1) Indicators and recorders, scale and chart ranges.
                (2) Transmitters/converters, input and output ranges.
                (3) Computing elements’ function.

(4) Controllers, action (direct/reverse) and control modes (P, I, D).
(5) Switching elements, unit range, differential (fixed/adjustable), reset (auto/manual).
(6) I/O Modules: Input or output.

h) Calibrations, for example, but not limited to:
(1) Analog Devices: Actual inputs and outputs at 0, 10, 50, and 100 percent of span, rising and falling.
(2) Discrete Devices: Actual trip points and reset points.
(3) Controllers: Mode settings (P&ID).
(4) I/O Modules: Actual inputs or outputs of 0, 10, 50, and 100 percent of span, rising and falling.
(5) Space for comments.

c. Maintain loop status reports, valve adjustment sheets, and component calibration sheets at Site, and make them available to Engineer at all times.

d. Engineer reviews loop status sheets and component calibration sheets and spot-check their entries periodically, and upon completion of Preparation for Testing. Correct deficiencies found.

e. FDT-Repeat:
1) Repeat FDT onsite with installed PIC equipment and software.
2) As listed in PIC subsections, certain portions of FDT may not require retesting.
3) Use FDT test procedures as basis for this test.
4) In general, this test shall not require witnessing. However, portions of this test, as identified by Engineer during original FDT shall be witnessed.

f. Forms: See Loop Status Report, Instrument Calibration Sheet, and I&C Valve Adjustment Sheet referenced in Article Supplements.

3. Functional Test:
a. Scope: Confirm PIC, including applications software, is ready for operation.
b. Refer to PIC subsections for additional requirements.
c. Completed when Functional Test has been conducted and Engineer has spot-checked associated test forms and checklists in field.

4. Required Test Documentation: Test procedures, forms, and checklists. Signed by Engineer and Contractor except for Functional Test items signed only by Contractor.

E. Performance Test During and After Facility Startup:

1. Once a facility's Functional Test has been completed and that facility has been started up, perform witnessed Performance Test on associated PIC equipment to demonstrate that it is operating as required by Contract Documents. Demonstrate each required function on a paragraph-by-paragraph, loop-by-loop, and site-by-site basis.
2. Loop-specific and nonloop-specific tests same as required for FDT except that entire installed PIC tested using actual process variables and functions demonstrated.
3. Perform local and manual tests for each loop before proceeding to remote and automatic modes.
4. Where possible, verify test results using visual confirmation of process equipment and actual process variable. Unless otherwise directed, exercise and observe devices supplied by others, as needed to verify correct signals to and from such devices and to confirm overall system functionality. Test verification by means of disconnecting wires or measuring signal levels is acceptable only where direct operation of plant equipment is not possible.
5. Make updated versions of documentation required for Performance Test available to Engineer at Site, both before and during tests.
6. Make O&M data available to Engineer at Site both before and during testing.
7. Follow daily schedule required for FDT.
8. Determination of Ready for Operation: When Functional Test has been completed.
9. Refer to examples of Performance Test procedures and forms in Article Supplements.

3.04 MANUFACTURER'S SERVICES

A. Manufacturer's Representative: As required by each PIC subsection.

3.05 TRAINING

A. General:

1. Provide an integrated training program for Contracting Officer's personnel.
2. Perform training to meet specific needs of Contracting Officer's personnel.
3. Include training sessions, classroom and field, for managers, engineers, operators, and maintenance personnel.

4. Provide instruction on two working shifts as needed to accommodate the Contracting Officer's personnel schedule.
5. Contracting Officer reserves the right to reuse digital recordings of training sessions.

B. Operations and Maintenance Training:

1. General:
   a. Refer to specific requirements specified in PIC Subsections.
   b. Include review of O&M data and survey of spares, expendables, and test equipment.
   c. Use equipment similar to that provided.
   d. Unless otherwise specified in PIC subsections, provide training suitable for instrument technicians with at least a 2-year associate engineering or technical degree, or equivalent education and experience in electronics, instrumentation, or digital systems.
2. Operations Training: For Contracting Officer's operations personnel on operation of I&C components.
   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: Two.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed to use I&C components and functions to monitor and control the plant on a day-to-day basis.
   e. Content: Conduct training on loop-by-loop basis.
      1) Loop Functions: Understanding of loop functions, including interlocks for each loop.
      2) Loop Operation: For example, adjusting process variable setpoints, LOCAL/REMOTE control transfer, REMOTE and LOCAL control, annunciator acknowledgement and resetting.
      3) Interfaces with PIC subsystems.
3. Maintenance Training:
   a. Training Session Duration: 1 instructor day.
   b. Number of Training Sessions: Two.
   c. Location: Project Site.
   d. Course Objective: Develop skills needed for routine maintenance of PIC.
   e. Content: Provide training for each type of component and function provided.
      1) Loop Functions: Understanding details of each loop and how they function.
      2) Component calibration.
      3) Adjustments: For example, controller tuning constants, current switch trip points, and similar items.
      4) Troubleshooting and diagnosis for equipment and software.

5) Replacing lamps, chart paper, and fuses.
6) I&C components removal and replacement.
7) Periodic preventive maintenance.

3.06 CLEANING

A. Upon completion of Work, remove materials, scraps, and debris from interior and exterior of equipment.

3.07 PROTECTION

A. Use corrosion-inhibiting vapor capsules in enclosures to protect electrical, instrumentation, and control devices, including spare parts, from corrosion.

B. Periodically replace capsules based on capsule manufacturer's recommendations.

3.08 SUPPLEMENTS

A. The supplements listed below, following "End of Section," are a part of this specification:

1. Process Control Narrative – Loop Specific.
2. Control Panel Schedule.
3. Instrument List.
4. PLC Input/Output List.
5. Preparation for Testing and Functional Test Forms:
   a. Loop Status Report: Each sheet shows status of instruments on a loop. Also, gives functional description for loop.
   b. Instrument Calibration Sheet: Shows details on each instrument (except simple hand switches, lights, and similar items).
   c. I&C Valve Adjustment Sheet: Shows details for installation, adjustment, and calibration of a given valve.
6. Performance Test Sheet: Describe Performance Test for a given loop.
   a. List requirements of the loop.
   b. Briefly describe test.
   c. Cite expected results.
   d. Provide space for checkoff by witness.

END OF SECTION

PROCESS CONTROL NARRATIVE – LOOP SPECIFIC

A. Standard Analog Instrument Functions:

1. Functions:
   a. Monitor analog instrument value.
   b. Alarm on HIGH, HIGH, LOW and LOW LOW values.
   c. Alarm on Transducer failure, less than 3.8 mA greater than 20.2 mA.
2. PLC Functions:
   a. Receive and scale analog instrument value.
   b. Provide operator entered adjustable HIGH HIGH, HIGH, LOW and LOW LOW alarm and clear (reset) dead band setpoints.
   c. Provide operator entered adjustable Transducer alarm setpoints.
   d. Provide operator entered adjustable time delay to prevent nuisance alarm notification. 5 seconds minimum.
   e. Provide flow totalization with daily, weekly, monthly, yearly, and instantaneous flow totals for each flowmeter. Make each flow totalizer resettable from the OIT.
   f. Provide a timer that will reset a disabled alarm after an operator adjustable time.
   g. Provide operator alarm disable.
3. OIT Functions:
   a. Display and log scaled analog instrument values.
   b. Display alarm status and alarm setpoint values.
   c. Provide operator entry to adjust alarm setpoint values.
   d. Provide trend display of analog instrument values.
   e. Display flow totals developed in the PLC.
   f. Provide totalizer reset push buttons.
   g. Provide operator control for alarm disable.
   h. Provide operator entry for adjustable alarm disable reset time.

B. Standard Discrete Alarm Functions:

1. Functions: Provide individual alarms and a common alarm for abnormal process conditions.
2. PLC Functions:
   a. Receive alarm inputs.
   b. Provide operator entered adjustable time delay to prevent nuisance alarm notification. 5 seconds minimum.
   c. Provide operator alarm disable.
   d. Provide a timer that will reset a disabled alarm after an operator adjustable time.

3. OIT Functions:
    a. Display, log, and annunciate alarms.
    b. Provide operator adjustable alarm and time delay setpoints.
    c. Provide operator control for alarm disable.
    d. Provide operator entry for adjustable alarm disable reset time.

PROPOSED ENTRANCE ROAD WATER TANK

A. LIT-401A/B Entrance Road Water Tank Level:

1. P&ID: 08Y606.
2. Function: Entrance Road Water Supply Tank.
3. PLC Functions:
    a. Provide Standard Analog Instrument Functions.
    b. User selectable for displaying, logging, and alarming:
        1) Average of 2 Signals.
        2) Signal A only.
        3) Signal B only.
4. OIT Functions:
    a. Provide Standard Analog Instrument Functions.
    b. Log Level.

B. FIT-411 Entrance Road Water Tank Supply Flow:

1. P&ID: 08Y605.
2. Function: Entrance Road Water Supply Flow.
3. PLC Functions: Provide Standard Analog Instrument Functions.
4. OIT Functions:
    a. Provide Standard Standard Analog Instrument Functions.
    b. Log Level.

C. LCV-412 Entrance Road Water Tank Level Control Valve:

1. P&ID: 08Y605.
2. Function: Valve to control level of Entrance Road Water Supply Tank.
3. PLC Functions:
    a. Provide Standard Discrete I/O Functions.
    b. Open valve on OPEN VALVE setpoint.
    c. Close valve on CLOSE VALVE setpoint.
4. OIT Functions:
    a. Provide setpoints:
        1) OPEN VALVE setpoint.
        2) CLOSE VALVE setpoint.

D. ZS-416 Canyon Mechanical Building Intrusion:

1. P&ID: 08Y605.
2. Function: Canyon Mechanical Building Intrusion.
3. PLC Functions: Provide Standard Discrete Alarms Functions.
4. OIT Functions: Provide Standard Discrete Alarms Functions.

E. TIT-411 Canyon Mechanical Building Temperature:

1. P&ID: 08Y605.
2. Function: Canyon Mechanical Building Temperature.
3. PLC Functions: Provide Standard Analog Instrument Functions.
4. OIT Functions:
   a. Provide Standard Standard Analog Instrument Functions.
   b. Log Level.

F. RM-400 Entrance Road Water Tank Remote Monitoring:

1. P&ID: 08Y605.
2. Function: Entrance Road Water Remote Monitoring.
3. PLC Functions:
   a. Analog Signals:
      1) LI-401 Level.
      2) FI-411 Flow.
      3) TI-417 Temperature
   b. Discrete Signals: ZS-416 Building Intrusion.

CONTROL PANEL SCHEDULE

Rev.	NEW PANELS	PLC/RM's	DESCRIPTION	LOCATION	NEMA RATING	UPS Required	NOMINAL DIMENSION (HxWXD inches)	Approximate Weights	NOTES
	NIP-100		Field Operations Center Fiber Patch Panel	FOC	NEMA 12	YES	16" X 12" X 10"	30 lbs	See drawing 08Y608
	LCP-210	RM-210	Main Lift Station Remote Monitor	Main Lift Station	NEMA 1	YES	12" X 12" X 4"	5 lbs	Mission Communications M851
	LCP-300	RM-300	Abert's Squirrel Loop Remote Monitor	Highway 4	NEMA 1	YES	12" X 12" X 4"	5 lbs	Mission Communications M851
	LCP-400	PLC-400 RM-400	Entrance Road Water Tank PLC/Network Switch	Mechanical Building	NEMA 12	YES	42" X 24" X 12"	150 lbs	See drawing 08Y609
	LCP-420	RM-420	PRV Vault	Agoyo Lane Entrance	NEMA 4X	YES	14" X 14" X 7"	7.5 lbs	Mission Communications M852
	NIP-500		Park Entrance Fiber Patch Panel	Park Entrance	NEMA 12	YES	16" X 12" X 10"	30 lbs	See drawing 08Y610

INSTRUMENT LIST

ISA Tag	Loop Number	Tag Number	Comp Code	Component Title	Options	P&ID	Inst. Detail
PI	304	PI-304	P04	Pressure Gueate	Range: 0 - 120 psi	08Y603	4,5
PI	305	PI-305	P04	Pressure Gueate	Range: 0 - 120 psi	08Y603	4,5
FIT	411	FIT-411	F04	Flow Transmitter, Electromagnetic	Range: 0 - 600 gpm	08Y605	2
PI	411	PI-411	P04	Pressure Gueate	Range: 0 - 120 psi	08Y605	4,5
PI	412	PI-412	P04	Pressure Gueate	Range: 0 - 120 psi	08Y605	4,5
LT	401A	LT-401A	L42	Level Transmitter, Submersible	Range: 0 - 15 ft	08Y606	3
LT	401B	LT-401B	L42	Level Transmitter, Submersible	Range: 0 - 15 ft	08Y606	3
ZS	412	ZS-412	M43	Intrusion Switch	N/A	08Y605	1
TIT	417	TIT-417	T03	Temperature Transmitter, RTD	Range: 0 - 600 gpm	08Y605	6
PIT	301	PIT-301	P09	Pressure Transmitter	Range: 0 – 240 in H2O	08Y603	4,5
PIT	422	PIT-422	P09	Pressure Transmitter	Range: 0 – 120 psi	08Y607	4,5
FSH	423	FSH-423	P09	Flow Switch High	Range: 9.5 gpm	08Y607	7

Reference 08Y701 for Detail Drawings

PLC INPUT/OUTPUT LIST

Item	P&ID	PLC/RM	Instrument Type	Loop	IO Tag Number	IO Descriptor	Type	Range	Notes
1	08Y602	RM-210	XA	200	XA-200	Main Lift Station General Alarm	DI		
2	08Y602	RM-210	LAHH	200	LAHH-200	Main Lift Station Level Alarm High High	DI		
3	08Y602	RM-210	XS	211	XS-211	Main Lift Station Pump 1 Running	DI		
4	08Y602	RM-210	XS	212	XS-212	Main Lift Station Pump 2 Running	DI		
5	08Y603	RM-300	PIT	301	PIT-301	Existing Main Blue Water Tank Pressure	AI	0 - 240 inch H2O	
6	08Y605	PLC-400	LI	401	LI-401	Entrance Road Water Tank Level to RM-400	AO	0 - 15 ft	
7	08Y605	PLC-400	FIT	411	FIT-411	Entrance Road Water Supply Flow	AI	0 - 600 gpm	
8	08Y605	PLC-400	FI	411	FI-411	Entrance Road Water Tank Flow to RM-400	AO	0 - 600 gpm	
9	08Y605	PLC-400	LY	412	LY-412	Entrance Road Water Tank Level Valve Open	DO		
10	08Y605	PLC-400	ZA	416	ZA-416	Canyon Mechanical Building Intrusion to RM-400	DO		
11	08Y605	PLC-400	ZS	416	ZS-416	Canyon Mechanical Building Intrusion	DI		
12	08Y605	PLC-400	TIT	417	TIT-417	Canyon Mechanical Building Temperature	AI	(-20)-120 degF	
13	08Y605	PLC-400	TI	417	TI-417	Canyon Mechanical Building Temperature	AO	(-20)-120 degF	
14	08Y606	PLC-400	LIT	401A	LIT-401A	Entrance Road Water Tank Level A	AI	0 - 15 ft	
15	08Y606	PLC-400	LIT	401B	LIT-401B	Entrance Road Water Tank Level B	AI	0 - 15 ft	
16	08Y607	RM-420	PIT	422	PIT-422	PRV Vault Pressure	AI	0 - 120 psi	
17	08Y607	RM-420	FSH	423	FSH-423	PRV Vault Flow Switch High	DI	9.5 gpm	

JACOBS **LOOP STATUS REPORT—EXAMPLE FORMAT** **Rev.06.05.92**

Project Name: *Newport News WTP*	Project No. *WDC23456.C1*

FUNCTIONAL REQUIREMENTS:	
1. Measure, locally indicate, and transmit RAS flow to LP-10.	
2. At LP-10 indicate flow and provide flow control by modulation of FCV-10-2.	
3. Provide high RAS flow alarm on LP-10.	

COMPONENT STATUS (Check and initial each item when complete)

Tag Number	Delivered	Tag ID Checked	Installation	Termination Wiring	Termination Tubing	Calibration	
FE/FIT-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Feb-7-90 DWM*	*Mar-5-90 DWM*	*N.A.*	*May-6-90 VDA*	
FIC-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-4-90 VDA*	
FSH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FAH-10-2	*Jan-12-90 DWM*	*Jan-12-90 DWM*	*Mar-5-90 DWM*	*Apr-4-90 DWM*		*May-7-90 VDA*	
FCV-10-2	*Mar-2-90 DWM*	*Mar-2-90 DWM*	*Apr-20-90 DWM*	*Apr-30-90 DWM*		*May-16-90 VDA*	

REMARKS: None.

Loop Ready for Operation	By: *D.W. Munzer*	Date: *May-18-90*	Loop No.: *10-2*

JACOBS **INSTRUMENT CALIBRATION SHEET—EXAMPLE—ANALYZER/TRANSMITTER** Rev.06.05.92

COMPONENT	MANUFACTURER		PROJECT
Code: *A7*	Name: *Leeds & Northrup*		Number: *WDC30715.B2*
Name: *pH Element & Analyzer/Transmitter*	Model: *12429-3-2-1-7*	Serial #: *11553322*	Name: *UOSA AWT PHASE 3*

FUNCTIONS

	RANGE	VALUE	UNITS	COMPUTING FUNCTIONS? N	CONTROL? N
Indicate? Y Record? N	Chart:			Describe:	Action? direct / reverse Modes? P / I / D
	Scale:	*1-14*	*pH units*		SWITCH? N Unit Range:
Transmit/	Input:	*1-14*	*pH units*		Differential: fixed/adjustable
Convert? Y	Output:	*4-20*	*mA dc*		Reset? automatic / manual

ANALOG CALIBRATIONS							DISCRETE CALIBRATIONS					Note No.
REQUIRED			AS CALIBRATED				REQUIRED			AS CALIBRATED		
Input	Indicated	Output	Increasing Input		Decreasing Input		Number	Trip Point	Reset Pt.	Trip Point	Reset Pt.	
			Indicated	Output	Indicated	Output		(note rising or falling)		(note rising or falling)		
1.0	*1.0*	*4.0*	*1.0*	*4.0*	*1.0*	*3.9*	*1.*	*N.A.*		*N.A.*		
2.3	*2.3*	*5.6*	*2.2*	*5.5*	*2.3*	*5.6*	2.					*1.*
7.5	*7.5*	*12.0*	*7.5*	*11.9*	*7.5*	*12.0*	3.					
12.7	*12.7*	*18.4*	*12.7*	*18.3*	*12.6*	*18.3*	4.					
14.0	*14.0*	*20.0*	*14.0*	*20.0*	*14.0*	*20.0*	5.					
CONTROL MODE SETTINGS:			P: *N.A.*	I:	D:		6.					

#	NOTES:	Component Calibrated and Ready for Start-up
	1. Need to recheck low pH calibration solutions.	By: *J.D. Sewell*
		Date: *Jun-6-92*
		Tag No.: *AIT-12-6*[pH]

JACOBS **I&C VALVE ADJUSTMENT SHEET—EXAMPLE** Rev.06.05.92

PARTS	Project Name: *SFO SEWPCP*	Project Number: *SFO10145.G2*
Body	Type: *Vee-Ball*	Mfr: *Fisher Controls*
	Size: *4-inch*	Model: *1049763-2*
	Line Connection: *159 # ANSI Flanges*	Serial #: *1003220*
Operator	Type: *Pneumatic Diaphragm*	Mfr: *Fisher Controls*
	Action: *Linear – Modulated*	Model: *4060D*
	Travel: *3-inch*	Serial #: *2007330*
Positioner	Input Signal: *3-15 psi*	Mfr: *Fisher Controls*
	Action: *Direct - air to open*	Model: *20472T*
	Cam: *Equal percentage*	Serial #: *102010*
Pilot	Action:	Mfr:
Solenoid	Rating: *None*	Model: Serial #:
I/P	Input: *4-20 mA dc*	Mfr: *Taylor*
Converter	Output: *3-15 psi*	Model: *10-T-576-3*
	Action: *Direct*	Serial #: *1057-330*
Position	Settings: *Closed / Open 5 deg, rising*	Mfr: *National Switch*
Switch	Contacts: *Close / Close*	Model: *1049-67-3*
		Serial #: *156 &157*
Power	Type: *Pneumatic*	Air Set Mfr: *Air Products*
Supply	Potential: *40 psi*	Model: *3210D*
		Serial #: *1107063*

ADJUSTMENTS	Initial	Date	**VERIFICATION**	Initial	Date
Air Set	*JDS*	*Jun-06-92*	Valve Action	*JDS*	*Jun-03-92*
Positioner	*JDS*	*Jun-06-92*	Installation	*JDS*	*Jun-03-92*
Position Switches	*JDS*	*Jun-06-92*	Wire Connection	*JDS*	*Jun-04-92*
I/P Converter	*JDS*	*Jun-07-92*	Tube Connection	*JDS*	*Jun-04-92*
Actual Speed	*JDS*	*Jun-07-92*			

REMARKS: *Valve was initially installed backwards.*	**Valve Ready for Start-up**
Observed to be correctly installed May-25-92	By: *J.D. Sewell*
	Date: *Jun-07-92*
	Tag No.: *FCV-10-2-1*

JACOBS PERFORMANCE TEST SHEET - EXAMPLE Rev.06.05.92

Project Name: *SFO SEWPCP Plant Expansion*	Project No.: *SFO12345.C1*

Demonstration test(s): For each functional Requirement of the loop:
(a) List and number the requirement. (b) Briefly describe the demonstration test.
(c) Cite the results that will verify the required performance. (d) Provide space for signoff.

1. MEASURE EFFLUENT FLOW

1.a With no flow, water level over weir should be zero and

FIT indicator should read zero. *Jun-20-92 BDG*

2. FLOW INDICATION AND TRANSMISSION TO LP & CCS

With flow, water level and FIT indicator should be related by expression

*Q(MGD) = 429*H**(2/3) (H = height in inches of water over weir).*

Vary H and observe that following.

2.a Reading of FIT indicator. *Jun-6-92 BDG*

2.b Reading is transmitted to FI on LP-521-1 *Jun-6-92 BDG*

2.c Reading is transmitted and displayed to CCS. *Jun-6-92 BDG*

H(measured)	*0*	*5*	*10*	*15*
Q(computed)	*0*	*47.96*	*135.7*	*251.7*
Q(FIT indicator)	*0*	*48.1*	*137*	*253*
Q(LI on LP-521-1)	*0*	*48.2*	*138*	*254*
Q(display by CCS)	*0*	*48.1*	*136.2*	*252.4*

Forms/Sheets Verified	By	Date	**Loop Accepted By Owner**
Loop Status Report	*J.D. Sewell*	*May-18-92*	By: *J.D. Smith*
Instrument Calibration Sheet	*J.D. Sewell*	*May-18-92*	Date: *Jun-6-92*
I&C Valve Calibration Sheet	*N.A.*		
Performance Test	By	Date	
Performed	*J. Blow MPSDC Co.*	*Jun-6-92*	
Witnessed	*B. DeGlanville*	*Jun-6-92*	Loop No.: *30-12*

SECTION 40 91 00
INSTRUMENTATION AND CONTROL COMPONENTS

PART 1 GENERAL

1.01 SUMMARY

A. This section gives general requirements for instrumentation and control components.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. ACIO-2020-002: Cybersecurity of Building Automation and Control Systems within NPS Facilities.
2. ASTM International (ASTM):
   a. A182/A182M, Standard Specification for Forged or Rolled Alloy and Stainless Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
   b. A276, Standard Specification for Stainless Steel Bars and Shapes.
   c. A312/A312M, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
   d. B32, Standard Specification for Solder Metal.
   e. B88, Standard Specification for Seamless Copper Water Tube.
3. NSF International (NSF):
   a. NSF/ANSI 61, Drinking Water System Components - Health Effects.
   b. NSF/ANSI 372, Drinking Water System Components - Lead Content.

1.03 SUBMITTALS

A. Refer to Section 40 90 00, Instrumentation and Control for Process Systems, Article Submittals for the requirements of the action and informational submittals.

PART 2 PRODUCTS

2.01 GENERAL

A. Article Mechanical Systems Components covers requirements of mechanical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

B. Article Electrical Components covers requirements for electrical PIC components that are not specifically referenced by Section 40 90 00, Instrumentation and Control for Process Systems, Instrument Lists or Data Sheets.

C. All other Part 2 articles cover components that are referenced by Instrument Lists or Data Sheets in Section 40 90 00, Instrumentation and Control for Process Systems, or by specific component numbers in other PIC subsections.

D. Components and Materials in Contact with Water for Human Consumption: Comply with the requirements of the Safe Drinking Water Act and other applicable federal, state, and local requirements. Provide certification by manufacturer or an accredited certification organization recognized by the Authority Having Jurisdiction that components and materials comply with the maximum lead content standard in accordance with NSF/ANSI 61 and NSF/ANSI 372.

1. Use or reuse of components and materials without a traceable certification is prohibited.

2.02 MECHANICAL SYSTEMS COMPONENTS

A. Flow Element, Rotameter, Purge:

1. Physical Characteristics:
   a. Materials: Glass tube, fiberglass body, stainless steel float, nylon ball check valve.
2. Functional Characteristics:
   a. For air or water service, unless otherwise noted.
   b. Integral inlet needle valves.
   c. Integral differential pressure regulators:
      1) For water service.
      2) For air service for level ranges greater than 10 feet of water.
3. Performance Characteristics:
   a. Direct-Reading Scale Length: 2-1/2 inches, minimum.
   b. Scale Ranges: 0 scfh to 2.5 scfh for air service or 0 gph to 10 gph for water service.

B. Manifold, Three-Valve Equalizing:

1. Physical Characteristics:
   a. Materials: Stainless steel.
2. Functional Characteristics: For isolation and equalization of differential pressure transducers.
3. Performance Characteristics: None.

C. Pressure Gauge: For other than process variable measurement.

1. Physical Characteristics:
   a. Dial Size: Nominal 2.5-inch dial size.
   b. Connection: 1/4-inch NPT through bottom, unless otherwise noted.
2. Functional Characteristics: None.
3. Performance Characteristics:
   a. Accuracy: 2 percent of span.
   b. Scale Range: Such that normal operating pressure lies between 50 percent and 80 percent of scale range.

D. Valve, Needle:

1. Physical Characteristics:
   a. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
   b. Size: 0.020-inch orifice.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

E. ON/OFF Valves:

1. Physical Characteristics:
   a. Type: Ball valve.
   b. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
2. Functional Characteristics: Ball valve.
3. Performance Characteristics: None.

F. Regulating Valves:

1. Physical Characteristics:
   a. Materials: Brass, stainless steel, PVC, or CPCV, as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
2. Functional Characteristics: Needle valves, with regulating stems and screwed bonnets.
3. Performance Characteristics: None.

G. Valve, Three-Way:

1. Physical Characteristics: Materials: Brass or stainless steel with nylon handle as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
2. Functional Characteristic: Ball valve.
3. Performance Characteristics: None.

H. Valve, Four-Way:

1. Physical Characteristics:
   a. Materials:
      1) Body and Stem: Type 316 stainless steel.
      2) Handle: Black nylon.
      3) Packing Gland: Polytetrafluoroethylene (PTFE).
   b. Ball and stem bed, one-piece assembly.
   c. Machined handle stops and directional nameplates.
2. Functional Characteristic: Four-way, two-position ball valve.
3. Performance Characteristics: None.

I. Spool Valve:

1. Physical Characteristics:
   a. Materials: Aluminum construction with Polytetrafluoroethylene (PTFE) impregnated aluminum spool, stainless steel spring, and Nitrile rubber O-rings.
   b. Port Connection: 1/4-inch outside diameter tube fittings.
2. Functional Characteristic: Five-port arrangement as shown, two-position, push-to-operate knob attached to the spool stem, and spring return.
3. Performance Characteristics: None.

J. Solenoid Valve, Two-Way:

1. Physical Characteristics:
      1) Body: Brassed or stainless steel globe valves as recommended by manufacturer for designated service, unless otherwise shown on the Drawings.
      2) Valve Seat: Nitrile rubber.
   b. Size: Normally closed or opened, as noted.
   c. Coil: 115V ac, unless noted otherwise.
   d. Solenoid Enclosure: NEMA 4.
2. Functional Characteristics: Globe valve directly actuated by solenoid and not requiring minimum pressure differential for operation.
3. Performance Characteristics: None.

K. Pressure Regulator, Air:

1. Physical Characteristics:
   a. Provide air at reduced pressures, as shown, constant to within plus or minus 10 percent for flows from 0 scfh to 300 scfh with 100 psi supply pressure.
   b. Setscrew for outlet pressure adjustment.
   c. Integral filter and relief valve.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

L. Pressure Regulator, Water:

1. Physical Characteristics:
   a. Materials:
      1) Body: Bronze.
      2) Spring Case: Cast iron.
      3) Seat Rings: Brass.
      4) Valve Disk and Holder: Nitrile rubber and bronze.
      5) Diaphragm: Nitrile rubber diaphragm.
2. Functional Characteristics: None.
3. Performance Characteristics: Sizing: For maximum of 7 psi offset pressure.

M. Copper Tubing and Fittings:

1. Physical Characteristics:
   a. Type K hard copper, ASTM B88, with commercially pure wrought copper solder joint fittings. Make joints with 95-5 wire solder, ASTM B32, Grade 95 TA. Do not use cored solder.
   b. Alternatively, Type K, soft temper copper tubing, ASTM B88, with brass compression type fittings may be used where shown on the Drawings.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

N. Plastic Tubing and Fittings:

1. Physical Characteristics:
   a. Tubing: Polyethylene capable of withstanding 190 psig at 175 degrees F.
   b. Fittings:
      1) Type: Brass compression.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

O. Stainless Steel Tubing:

1. Physical Characteristics: ASTM A312/A312M, Type 316, 0.065-inch wall, seamless, soft annealed.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

P. Stainless Steel Fittings:

1. Physical Characteristics:
   a. Compression Type:
      1) Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, flareless.
   b. Socket Weld Type:
      1) Materials: Type 316 stainless steel, ASTM A182/A182M forged bodies or ASTM A276 barstock bodies, 3,000 psi maximum working pressure, safety factor 4:1.
2. Functional Characteristics: None.
3. Performance Characteristics: None.

2.03 ELECTRICAL COMPONENTS

A. Terminal Blocks for Enclosures:

1. General:
   a. Physical Characteristics:
      1) Connection Type: Screw compression clamp.
      2) Compression Clamp:
         a) Complies with DIN-VDE 0611.
         b) Hardened steel clamp with transversal grooves that penetrate wire strands providing a vibration-proof connection.
         c) Guides strands of wire into terminal.
      3) Screws: Hardened steel, captive, and self-locking.
      4) Current Bar: Copper or treated brass.
      5) Mounting:
         a) Standard DIN rail.
         b) Terminal block can be extracted from an assembly without displacing adjacent blocks.
         c) End Stops: Minimum of one at each end of rail.
      6) Wire Preparation: Stripping only permitted.
      7) Jumpers: Allow jumper installation without loss of space on terminal or rail.

8) Marking System:
a) Terminal number shown on both sides of terminal block.
b) Allow use of preprinted and field marked tags.
c) Terminal strip numbers shown on end stops.
d) Mark terminal block and terminal strip numbers as shown on panel control diagrams and loop diagrams.
e) Fuse Marking for Fused Terminal Blocks: Fuse voltage and amperage rating shown on top of terminal block.
9) Test Plugs: Soldered connections for 18 AWG wire.
a) Pin Diameter: 0.079 inch.
b) Quantity: Two plugs per test meter.
b. Functional Characteristics: None.
c. Performance Characteristics:
1) Insulation:
a) Thermoplastic rated for minus 55 degrees C to plus 110 degrees C.
b) Two funneled shaped inputs to facilitate wire entry.
2. Terminal Block, General Purpose:
a. Physical Characteristics:
1) Wire Size: 24 AWG to 10 AWG.
2) Rated Wire Size: 10 AWG.
3) Color: Gray body.
4) Spacing: 0.25 inch, maximum.
5) Test Sockets: One screw test socket 0.079-inch diameter.
b. Functional Characteristics: None.
c. Performance Characteristics:
1) Rated Voltage: 600V ac.
2) Rated Current: 30 amp.
3. Terminal Block, Ground:
a. Physical Characteristics:
1) Wire Size: 24 AWG to 10 AWG.
2) Rated Wire Size: 10 AWG.
3) Color: Green and yellow body.
4) Spacing: 0.25 inch, maximum.
5) Grounding: Electrically grounded to mounting rail.
b. Functional Characteristics: None.
c. Performance Characteristics: None.
4. Terminal Block, Blade Disconnect Switch:
a. Physical Characteristics:
1) Wire Size: 22 AWG to 10 AWG.
2) Rated Wire Size: 10 AWG.
3) Color: Gray body, orange switch.
4) Spacing: 0.25 inch, maximum.
b. Functional Characteristics: None.

c. Performance Characteristics:
    1) Rated Voltage: 600V ac.
    2) Rated Current: 10 amp.

5. Terminal Block Diode:
    a. Physical Characteristics:
        1) Wire Size: 16 AWG.
    b. Functional Characteristics: None.
    c. Performance Characteristics:
        1) Rated Voltage: 24V dc.
        2) Rated Current: 30 mA.

6. Terminal Block, Fused, 24V dc:
    a. Physical Characteristics:
        1) Wire Size: 22 AWG to 10 AWG.
        2) Rated Wire Size: 10 AWG.
        3) Color: Gray body.
        4) Fuse: 0.25 inch by 1.25 inches.
        5) Indication: LED diode 24V dc.
        6) Spacing: 0.512 inch, maximum.
    b. Functional Characteristics: None.
    c. Performance Characteristics:
        1) Rated Voltage: 600V dc.
        2) Rated Current: 25 amp.

7. Terminal Block, Fused, 120V ac:
    a. Physical Characteristics:
        1) Wire Size: 22 AWG to 10 AWG.
        2) Rated Wire Size: 10 AWG.
        3) Color: Gray body.
        4) Fuse: 0.25 inch by 1.25 inches.
        5) Indication: Neon lamp, 110V ac.
        6) Leakage Current: 1.8 mA, maximum.
        7) Spacing: 0.512 inch, maximum.
    b. Functional Characteristics: None.
    c. Performance Characteristics:
        1) Rated Voltage: 600V ac.
        2) Rated Current: 25 amp.

8. Terminal Block, Fused, 120V ac, High Current:
    a. Physical Characteristics:
        1) Wire Size: 18 AWG to 8 AWG.
        2) Rated Wire Size: 8 AWG.
        3) Color: Gray.
        4) Fuse: 13/32 inch by 1.5 inches.
        5) Spacing: 0.95 inch, maximum.
    b. Functional Characteristics: None.
    c. Performance Characteristics:
        1) Rated Voltage: 600V ac.
        2) Rated Current: 35 amps.

B. Relays:

1. General:
   a. Physical Characteristics:
      1) Relay Mounting: Plug-in type socket.
      2) Relay Enclosure: Furnish dust cover.
      3) Socket Type: Screw terminal interface with wiring.
      4) Socket Mounting: Rail.
      5) Provide holddown clips.
   b. Functional Characteristics: None.
   c. Performance Characteristics: None.
2. Signal Switching Relay:
   a. Physical Characteristics:
      1) Type: Dry circuit.
      2) Contact Arrangement: 2 Form C contacts.
      3) Contact Rating: 5 amps at 28V dc or 120V ac.
      4) Contact Material: Gold or silver.
      5) Indication Type: Neon or LED indicator lamp.
      6) Seal Type: Hermetically sealed case.
   b. Functional Characteristics:
      1) Expected Mechanical Life: 10,000,000 operations.
      2) Expected Electrical Life at Rated Load: 100,000 operations.
   c. Performance Characteristics:
      1) Coil Voltage: As noted or shown.
      2) Coil Power: 0.9 watt dc, 1.2VA ac.
3. Control Circuit Switching Relay, Nonlatching:
   a. Physical Characteristics:
      1) Type: Compact general purpose plug-in.
      2) Contact Arrangement: 3 Form C contacts.
      3) Contact Material: Silver cadmium oxide alloy.
      4) Indication Type: Neon or LED indicator lamp.
   b. Functional Characteristics:
      1) Push-to-test button.
      2) Expected Mechanical Life: 10,000,000 operations.
      3) Expected Electrical Life at Rated Load: 100,000 operations.
   c. Performance Characteristics:
      1) Contact Rating: 10A at 28V dc or 120V ac, and 6.6A at 240V ac.
      2) Coil Voltage: As noted or shown.
      3) Coil Power: 1.8 watts dc, 2.7VA ac.
4. Control Circuit Switching Relay, Latching:
   a. Physical Characteristics:
      1) Type: Dual coil mechanical latching relay.
      2) Contact Arrangement: 2 Form C contacts.
      3) Contact Rating: 10A at 28V dc or 120V ac.
      4) Contact Material: Silver cadmium oxide alloy.

b. Functional Characteristics:
1) Expected Mechanical Life: 500,000 operations.
2) Expected Electrical Life at Rated Load: 50,000 operations
c. Performance Characteristics:
1) Coil Voltage: As noted or shown.
2) Coil Power: 2.7 watts dc, 5.3VA ac.
5. Control Circuit Switching Relay, Time Delay:
a. Physical Characteristics:
1) Type: Adjustable time delay relay.
2) Contact Arrangement: 2 Form C contacts.
3) Contact Material: Silver cadmium oxide alloy.
4) Adjustment Type: Integral potentiometer with knob external to dust cover.
b. Functional Characteristics:
1) Delay Time Range: Select range such that time delay setpoint fall between 20 percent to 80 percent of range.
2) Time Delay Setpoint: As noted or shown.
3) Mode of Operation: As noted or shown.
c. Performance Characteristics:
1) Repeatability: Plus or minus 2 percent.
2) Operating Temperature: Minus 10 degrees C to 55 degrees C.
3) Coil Voltage: As noted or shown.
4) Contact Rating: 10A at 30V dc or 277V ac.

C. Surge Suppressors:

1. General:
a. Physical Characteristics:
1) Construction: First-stage, high-energy metal oxide varistor and second-stage, bipolar silicon avalanche device separated by series impedance; includes grounding wire, stud, or terminal.
2) Enclosure Mounted: Encapsulated inflame retardant epoxy.
b. Functional Characteristics: None.
c. Performance Characteristics:
1) Response: 5 nanoseconds maximum.
2) Recovery: Automatic.
3) Temperature Range: Minus 20 degrees C to plus 85 degrees C.
2. Suppressors on 120V ac Power Supply Connections:
a. Physical Characteristics:
1) First-Stage Clamping Voltage: 350 volts or less.
2) Second-Stage Clamping Voltage: 210 volts or less.

3) Power Supplies for Continuous Operation:
a) Four-Wire Transmitter or Receiver: Minimum5 amps at 130V ac.
b) All Other Applications: Minimum 30 amps at 130V ac.
b. Functional Characteristics: None.
c. Performance Characteristics:
1) Occurrences: Tested and rated for a minimum of 50 occurrences of IEEE C62.41 Category B test waveform.
3. Suppressors on Analog Signal Lines:
a. Physical Characteristics:
1) Test Waveform: Linear 8-microsecond rise in current from 0 amps to a peak current value followed by an exponential decay of current reaching one-half the peak value in 20 microseconds.
b. Functional Characteristics: None.
c. Performance Characteristics:
1) Surge Rating: Tested and rated for 50 occurrences of 2,000-amp peak test waveform.
a) dc Clamping Voltage: 20 percent to 40 percent above operating voltage for circuit.
b) dc Clamping Voltage Tolerance: Plus or minus 10 percent.
c) Maximum Loop Resistance: 18 ohms per conductor.

D. Uninterruptible Power Supply (UPS):

1. Physical Characteristics:
a. Major Parts: Rectifier, inverter, battery charger, sealed batteries, automatic bypass, control, and monitor electronics.
b. Enclosures:
1) Tower for LCPs.
2) Rack mount for NIPs.
3) Unless otherwise noted.
2. Functional Characteristics:
a. Provides isolated, regulated uninterrupted ac output power during a complete or partial interruption of incoming line power.
b. Type: Continuous-duty, online, double conversion, power isolated.
3. Performance Characteristics:
a. Capacity:
1) LCPs: 1,500 VA/1,350W minimum.
2) NIP: 300VA/2,880W minimum.

b. Input Power:
   1) 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
   2) Connections: Manufacturer's standard, unless otherwise noted.
c. Output Power:
   1) 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
   2) Connections: Manufacturer's standard, unless otherwise noted.
d. Online Efficiency: 85 percent minimum, unless otherwise noted.
e. Backup Runtime:
   1) Full Load: 60 minutes minimum, unless otherwise noted.
   2) Half Load: 120 minutes minimum, unless otherwise noted.
f. Include provisions for future expansion of battery capacity via manufacturer's standard battery packages.
g. Continuous no-break power with no measurable transfer time.
h. Sine-Wave Output Voltage Total Harmonic Distortion (THD): Plus or minus 6 percent or less.
i. Input Voltage Range: Plus 15 percent, minus 20 percent.
j. Output Voltage Regulation: Plus or minus 3 percent nominal.
k. Operating Temperature: 0 degree C to 40 degrees C (32 degrees F to 104 degrees F).
l. Operating Relative Humidity: 5 percent to 95 percent without condensation.
m. Features:
   1) Provide output contacts rated 5 amperes at 120V ac for communicating the following statuses and alarms to the plant control system:
      a) On Utility Power status.
      b) On Battery Power status.
      c) UPS FAIL Alarm.

E. Maintenance Bypass Switches:

1. Physical Characteristics:
   a. Hand switch for mode toggle, UPS/Bypass.
   b. Power distribution unit, four or more outlets.
   c. Mounting: 19-inch rack mount, or wall mount.
2. Functional Characteristics: Hot-swap maintenance bypass switch that will completely isolate power from the UPS without interruption of power to the loads being served.

3. Performance Characteristics:
    a. Input Power: 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
    b. Output Power: 120V ac, single phase, three-wire, 60-Hz, unless otherwise noted.
    c. Operating Temperature: 0 degree C to 60 degrees C (32 degrees F to 140 degrees F).

F. Power Supplies:

1. Manufacturers and Products:
    a. Extreme Networks 16807.
    b. Or equal.
2. Physical Characteristics:
    a. Furnish as required to power instruments requiring external dc power, including two-wire transmitters and dc relays. Provide dual power supplies with diode auctioneered outputs.
    b. Enclosures: NEMA 1.
    c. Mount such that dissipated heat does not adversely affect other components.
3. Functional Characteristics:
    a. Convert 120V ac, 60-Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.
    b. Provide output over voltage and over current protective devices to:
        1) Protect instruments from damage due to power supply failure.
        2) Protect power supply from damage due to external failure.
4. Performance Characteristics:
    a. Fuses: For each dc supply line to each individual two-wire transmitter.
        1) Type: Indicating.
        2) Mount so fuses can be easily seen and replaced.

G. Intrinsic Safety Barriers:

1. Physical Characteristics: None.
2. Functional Characteristics:
    a. Intrinsically Safe Relays: Monitor discrete signals that originate in hazardous area and are used in a safe area.
    b. Intrinsically Safe Barriers: Interface analog signals as they pass from hazardous area to safe area.
3. Performance Characteristics: None.

2.04 I&C COMPONENTS

A. F4 Flow Element and Transmitter, Electromagnetic:

1. Manufacturer and Products:
   a. Endress + Hauser, Inc. Flow Measuring System: Promag W400.
   b. Or equal.
2. Physical Characteristics:
   a. Element:
      1) Process Connection:
         a) Meter Size (diameter inches): As noted.
         b) Connection Type: 150-pound ANSI raised-face flanges; AWWA C207, Table 2 Class D; or wafer style depending on meter size, unless otherwise noted.
         c) Flange Material: Carbon steel, unless otherwise noted.
      2) Meter Tube Material: Type 304 or Type 316 stainless steel, unless otherwise noted.
      3) Liner Material:
         a) Polyurethane, unless otherwise noted.
         b) NSF 61 Drinking Water Approval.
      4) Liner Protectors: Covers (or grounding rings) on each end to protect liner during shipment.
      5) Electrode Type: Flush or bullet nose as recommended by the manufacturer for the noted stream fluid.
      6) Electrode Material: Type 316 stainless steel or Hastelloy C, unless otherwise noted.
         a) Grounding Ring.
         b) Required, unless otherwise noted.
         c) Quantity: Two, unless otherwise noted.
         d) Material: Type 316 stainless steel, unless otherwise noted.
      7) Enclosure: NEMA 4X, minimum, unless otherwise noted.
   b. Analyzer/Transmitter:
      1) Mounting: Surface (wall), unless otherwise noted.
      2) Display: Required, unless otherwise noted.
         a) Digital LCD display, indicating flow rate and total.
         b) Bi-directional Flow Display: Required, unless otherwise noted.
            (1) Forward and reverse flow rate.
            (2) Forward, reverse, and net totalization.
      3) Enclosure: NEMA 4X, minimum, unless otherwise noted.
      4) Analog Output:
         a) Isolated 4 mA dc to 20 mA dc for load impedance from 0 ohm to at least 500 ohms minimum for 24V dc supply.

b) Supports Superimposed Digital HART protocol: If noted.

c. Accessories:

1) Cables:

a) Types: As recommended by manufacturer.

b) Lengths: As required to accommodate device locations.

3. Functional Characteristics: Measure, indicate, and transmit the flow of a conductive process liquid in a full pipe.

4. Performance Characteristics:

a. Element:

1) Electromagnetic flowmeter, with operation based on Faraday's Law, utilizing the pulsed dc type coil excitation principle with high impedance electrodes.

2) Full bore meter with magnetic field traversing entire flow-tube cross-section.

3) Insertion magmeters or multiple single point probes inserted into a spool piece are not acceptable.

4) Stream Fluid: As noted in Instrument Index.

5) Operating Temperature:

a) Ambient: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.

b) Process: Minus 5 degrees F to 140 degrees F, typical, unless otherwise noted.

6) Flow Range: As noted in Instrument Index.

7) Accuracy: Plus or minus 0.5 percent of rate for all flows resulting from pipe velocities of 2 feet to 30 feet per second.

8) Turndown Ratio: Minimum of 10 feet to 1 when flow velocity at minimum flow is at least 1 foot per second.

9) Inlet/Outlet Runs: Certified for 0 x DN Full bore.

10) Features:

a) Zero stability feature to eliminate the need to stop flow to check zero alignment.

b) No obstructions to flow.

c) Very low pressure loss.

d) Measures bi-directional flow.

b. Analyzer/Transmitter

1) Parameter Adjustments: By keypad or non-intrusive means.

2) Empty Pipe Detection:

a) If noted.

b) Drives display and outputs to zero when empty pipe detected.

3) Built-in Diagnostic System:

a) Features:

(1) Field programmable electronics.

(2) Self-diagnostics with troubleshooting codes.

(3) Ability to program electronics with full scale flow, engineering units, meter size, zero flow cutoff, desired signal damping, totalizer unit digit value.
(4) Initial flow tube calibration and subsequent calibration checks.

4) Factory Calibration:
a) Calibrated in an ISO 9001 and NIST certified factory.
b) Factory flow calibration system must be certified by volume or weight certified calibration devices.
c) Factory flow calibration system shall be able to maintain calibration flow rate for at least 5 minutes for repeatability point checks.

5) Factory Ready for Future In situ Verifications: If noted.
a) Original meter parameter values available from vendor by request.

B. F127 Flow Switch, Paddle:

1. Manufacturer and Products:
a. Dwyer Instruments: V10SS.
b. Or equal.
2. Physical Characteristics:
a. Type: Paddle
b. Body Material: Type 303 stainless steel.
c. Process Connection: 1/2 inch NPT.
d. Enclosure Rating: NEMA 4X.
e. Switch Type: SPST, Adjustable for NO or NC.
f. Electrical Rating: 1.5A at 24V dc.
g. Electrical Connection: 19 inch PVC Jacketed cable.
3. Functional Characteristics: None.
4. Performance Characteristics:
a. Actuation Flow Setpoint: 9.5 gpm.

C. L42 Level Element and Transmitter: Submersible.

1. Manufacturer and Products:
a. E&H; FMX21.
b. Or equal.
2. Physical Characteristics:
a. Element:
1) Silicon pressure-sensing element.
2) External Diaphragm: Flush type, coated with fluoro-polymer.

3) Titanium or Type 316 stainless steel pressure module assembly, unless otherwise noted.
a) For Titanium Sensors Only: 5-year corrosion warranty, replace sensor if it fails due to corrosion: If noted.
4) NEMA 6/IP 68 rating (submersible).
5) Temperature compensation.
6) Dimensions, Nominal:
a) Diameter: 1.2 inches.
b) Length: 5 inches.
7) Loop powered, 9V dc to 30V dc.
b. Cable:
1) Length: As required.
2) Polyurethane sheathed, unless otherwise noted.
3) Kevlar strain relief cord.
4) Integral vent tube.
c. Accessories:
1) Aneroid Bellows: If noted.
a) Bellows shall be suitable for application.
2) Desiccant Module: Required, unless otherwise noted.
3) Spare Desiccant Modules: If noted.
a) Quantity: As noted.
4) Cable Hanger, Kellems Type Grip: Required, unless otherwise noted.
5) Lightning Protection:
a) Internal (protects against water lightning strike): If noted.
b) External (protects 4 mA to 20 mA dc output): Required, unless otherwise noted.
6) Anchor Assembly: If noted.
a) Marine anchor, clamps, Type 316 stainless steel cable or chain, length as required, nominally 3 feet longer than interconnecting cable.
3. Functional Characteristics: Measure and transmit signal proportional to level.
4. Performance Characteristics:
a. Type: Totally submersible pressure sensor (loop powered).
b. Process Range:
1) As noted.
2) Provide fixed factory range such that noted process range is between 40 percent and 80 percent of fixed factory range.
c. Accuracy: 0.25 percent of full scale.
d. Temperature, Operating: Minus 4 degrees F to plus 140 degrees F.
e. Overpressure:
1) Proof: At least 1.5 times full scale.
2) Burst: At least 2.0 times full scale.

f. Certification(s):
    1) Class I, Division 1, Groups A, B, C, and D.
    2) Class II, Division 1, Groups E, F, and G.
    3) Class III, Division 1.

D. M43 Intrusion Switch:

1. Manufacturers and Products:
    a. George Risk Industries; 410P.
    b. Or equal.
2. Physical Characteristics:
    a. Sensor:
        1) Industrial surface-mount suitable for door.
        2) Include door mounting kit.
        3) Include sensing magnet.
        4) Sensing Gap: 3.25 inches.
    b. Cable: 36-inch armored cable.
3. Functional Characteristics: Monitor intrusion of entry points such as doors, overhead doors, and chain link gates.
4. Performance Characteristics:
    a. Signal Interface: DPDT.
    b. Contact Rating: 5W.
    c. Max Switching Voltage: 175V dc.
    d. Max Switching Current: .250 A.

E. P04, Pressure Gauge:

1. Manufacturers and Products:
    a. Ashcroft; Duragauge Model, 1279 PLUS!
    b. Or equal.
2. Physical Characteristics:
    a. Element:
        1) Dial: 4-1/2-inch diameter.
        2) Case Material: Black thermoplastic, unless otherwise noted.
        3) Materials of Wetted Parts (including element, socket/process connection, throttling device (if specified) and secondary components): Stainless steel, unless otherwise noted.
        4) Pointer: Adjustable by removing ring and window.
        5) Window: Glass or acrylic, unless otherwise noted.
        6) Threaded reinforced polypropylene front ring.
        7) Case Type: Solid front with blow-out back.
        8) Process Connection:
            a) Mounting: Lower stem, unless otherwise noted.
            b) Size: 1/2-inch MNPT, unless otherwise noted.

b. Accessories:
1) Throttling Device: Required, unless otherwise noted.
a) Type suitable for the intended service.
b) Install in gauge socket bore.
3. Functional Characteristics: Local pressure indication.
4. Performance Characteristics:
a. Type: Bourdon tube element.
b. Scale Range: As noted.
c. Accuracy: Plus or minus 0.50 percent of full scale.

F. P09, Pressure Transmitter:

1. Manufacturer and Products:
a. E&H; PMP71.
b. Or equal.
2. Physical Characteristics:
a. Element:
1) Wetted Metallic Parts: Type 316 stainless steel, unless otherwise noted.
a) Includes drain/vent valves; process flanges and adapters, and process isolating diaphragm.
2) Bolts and Nuts (if required): Type 316 stainless steel, unless otherwise noted.
3) Fill Fluid: Silicone, unless otherwise noted.
4) Process Connections:
a) Line Size: 1/2 inch.
b) Connection Type: FNPT.
c) Direct/remote Diaphragm Seal: If and as noted.
b. Transmitter:
1) LCD indicator, unless otherwise noted.
a) Display in either percent or engineering units, field configurable.
2) Signal Interface: 4 mA dc to 20 mA dc output with digital signal based on HART protocol.
3) Enclosure:
a) Type: NEMA 4X.
b) Materials: Coated aluminum, unless otherwise noted.
c. Accessories:
1) Mounting bracket, unless otherwise noted.
a) Bracket and Accessories: Stainless steel; suitable for mounting transmitter to panel or 2-inch pipe.
2) Two-valve (isolate and vent) Stainless Steel Manifold: If noted.
3. Functional Characteristics: Measure pressure and transmit signal proportional to pressure.

4. Performance Characteristics:
    a. Type:
        1) Gauge pressure, unless otherwise noted.
        2) Electronic variable capacitance or silicon strain gauge.
        3) Two-wire transmitter; “smart electronics”.
    b. Range: As noted.
        1) Select transmitter’s factory upper range limit (URL) such that upper boundary of noted range is as close as possible to 80 percent of factory URL, but does not exceed it.
    c. Accuracy: Plus or minus 0.075 percent of span, unless otherwise noted.
    d. Ambient Operating Temperature: Minus 40 degrees F to plus 175 degrees F, with integral meter.
    e. Process Operating Temperature: Minus 40 degrees F to plus 250 degrees F.
    f. Humidity: 0 percent to 100 percent relative humidity.
    g. Hazardous Location Certifications: If and as noted.
    h. Adjustable damping.

G. T3 Temperature Element and Transmitter, Resistance:

1. Manufacturer and Products:
    a. E&H; TMT142B.
    b. Or equal.
2. Physical Characteristics:
    a. Rated for non-hazardous area.
    b. Element:
        1) Three-wire, RTD.
        2) Platinum, 100 ohm nominal at 0 degree C.
    c. Transmitter:
        1) Integral to Element.
        2) Enclosure:
            a) Materials: Aluminum.
            b) Type: NEMA 4X.
            c) Mounting: Wall.
        3) Indicator: Backlit display.
        4) Two-wire, powered by remote power supply.
        5) Signal Interface: 4 mA dc to 20 mA dc with Hart.
        6) NPT 1/2-inch female cable entry.
3. Functional Characteristics: Measure temperature and transmit signal proportional to temperature.

4. Performance Characteristics:
   a. Element:
      1) Type: Three-wire RTD.
      2) Sensor Accuracy for 900 degrees F and Below: Plus or minus 0.5 degree F or plus or minus 0.25 percent of reading, whichever is larger.
   b. Transmitter:
      1) Temperature: Minus 40 degrees F to 176 degrees F.
      2) Digital Accuracy: Greater of plus or minus 0.09 degree F or plus or minus 0.01 percent of span.
      3) Response Time: 1.2 second 90 percent response time for 80 percent input step, with minimum damping.

2.05 PLC PANEL COMPONENTS

A. Panel:

1. Panel Fabrication:
   a. Panels, equipment, and devices shall be braced to prevent damage from specified forces. Equipment panels shall be capable of operation following a disturbance.
   b. Nameplates with tag number and equipment description shall identify face-mounted instruments. Instruments shall be mounted for access to components and ease of removal. Cutouts for future equipment shall be blanked off with suitable covers. Instrument tag numbers shall be identified on the panel rear.
   c. Face-mounted equipment shall be flush or semi-flush with flat-black escutcheons. Face-mounted instruments that are more than 6 inches deep, weigh more than 10 pounds, or exert more than a 4-foot-pound moment force on the face of the panel shall be supported underneath at the rear by a 1-inch by 1/8-inch thick steel angle.
   d. Panels less than 60 inches high shall be provided with floor stands to raise the top of the panel to 60 inches above the floor or work platform. Panels that weigh less than 100 pounds may be wall-mounted.
   e. Panels with specified requirements including stainless steel or aluminum mounting requirements that are indicated on the Drawings or on the Contract Details take precedence over the panel types or panel features indicated herein.
2. Panel Layout:
   a. Provide 20 percent spare contiguous sub-panel area for future expansion.
   b. Provide minimum of 20 percent spare terminal blocks, with a minimum of 10 analog, discrete, power.

c. Provide minimum of 12 inches clear space from the bottom of the panel to the bottom of the subpanel.
d. Separation between the power components (over 120V ac) and the control/instrument components (120V ac and less) by locating the power components and the control/instrument components in separate sections of the cabinet enclosure.
e. Power cabinet section and the control/instrument cabinet section with separate door handles.
f. Separation between the power components and the control/instrument components using barriers.
g. External lockable circuit breaker handle for the main panel disconnect.
h. Individual power and control components with internal circuit breakers, as required.
i. Motor controllers, as required by the equipment specifications.
j. Displays with door-in-door construction accessible by opening the cabinet outer door.
k. Face-mounted equipment flush or semi-flush with flat-black escutcheons.
l. Panel Tops of Wall-mounted Panels: Mounted at the same elevation.
m. Panel inner door contains a copy of the record elementary and wiring diagrams, or reference as allowed per NEC Article 409.
n. Panel inner door contains a drawing holder.
o. Panel drawings enclosed in a transparent, protective jacket.
p. Panel functions as specified.
q. Panels with floor stands, to raise the top of the panel to 60 inches above the floor or work platform.
r. Wall-mounting of panel weighs less than 100 pounds, where wall space is available.

3. Enclosures:
   a. Physical Characteristics:
      1) Panel enclosures shall comply with the requirements of NEC Article 409 and NEMA 250.
      2) Enclosure rating and material requirements shall be in accordance with the Area Classification Table and Material Selection Table on the Drawings.
   b. Functional Characteristics: None.
   c. Performance Characteristics: None.
4. Heating, Ventilating, and Cooling:
   a. Physical Characteristics:
      1) Forced air ventilation shall be provided for panels if the cabinet’s heat load calculations indicate that the interior temperature of the cabinet will exceed the rating of the device with the lowest temperature for that device within the enclosure, under worst case conditions.

2) Ventilation for panel racks shall be venturi fans provided on 5-1/2-inch high-notched panel. Ventilation for consoles shall be similar to that for panel racks except EIA RS-310 mounting is not required. Fans shall be equipped with UL-approved washable filters and provide at least 240 cubic feet per minute (cfm). Fans shall be thermostatically controlled. Noise level at 3 feet from exterior wall and 30 degrees off axis shall not exceed 60 NC units.

b. Functional Characteristics: None.

c. Performance Characteristics: None.

5. Nameplates:

a. Physical Characteristics:

1) External door-mounted components and the panel description shall be identified with phenolic nameplates. Machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

2) The machine engraved laminated black phenolic nameplates with white lettering shall be provided for panel-mounted equipment. Nameplate engraving shall include the instrument tag number and description in 3/32-inch minimum size lettering.

3) The machine embossed metallic adhesive labels shall identify tag number of instruments inside panels. Nameplates shall be attached to panel surfaces, not to instruments.

4) The nameplates shall be attached to the panel with a minimum of two self-tapping Type 316 stainless steel screws. Provide RTV sealant for nameplates for NEMA 4X stainless steel panels.

5) The nameplate wording may be changed without additional cost or time prior to commencement of engraving. Submit nameplate legend with the panel submittal, as described in Section 40 90 00, Instrumentation and Control for Process Systems.

6. Panel Features:

a. Physical Characteristics:

1) Interconnection Wiring:

a) Panel Control Wiring: Single conductor stranded copper NEC rated Type MTW 16 AWG minimum (rated 10 A per NFPA 79, Table 12.5.1), with an exception for factory-supplied PLC wiring harnesses that are U.L. approved.

b) Panel Instrument Wiring: Twisted 16 AWG shielded pair or tri conductors.

c) Panel Power Wiring: Conductors specified in Division 26, Electrical and meet the NEC requirements for power including phase, grounded, and grounding conductors.
d) Wiring shall be supported independently of terminations by lacing to panel support structure or by slotted flame-retardant plastic wiring channels.
e) Wiring channels shall comply with UL 94, Type V.
f) Plastic wireway with covers shall be used to route groups of wires. Wireway fill shall be sized to provide 50 percent maximum fill.
g) Plastic spiral wrap shall be used for exposed wires. Wires that cross door hinges shall be enclosed in plastic spiral wrap.
h) Wiring color conventions and standards shall comply with the requirements in Division 26, Electrical.

7. Wire Markers:
   a. Physical Characteristics: Wire marker shall comply with the requirements specified in Division 26, Electrical.
8. Conductor Identification:
   a. Physical Characteristics:
      1) Conductor identification shall comply with the requirements specified in Division 26, Electrical.
      2) Wiring shall be tagged at terminations with machine-printed plastic sleeves with three-part wire numbers for instrument and control panel internal conductors:
         a) Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
         b) Part-2: Code letter and wire colors per the following tables.
         c) Part-3: Number that identifies individual circuit conductor Terminal Number.

Code	120V ac Conductor	Color
L	Power	Black
C	Control	Red
N	Neutral	White
PG	Ground	Green

Code	V dc Conductor	Color
PS	24V dc Power	Blue
PS	12V dc Power	Violet

Code	V dc Conductor	Color
S+	Signal (+)	Black
SG	Signal Ground	White
EG	Equipment Ground	Green
FV	Panel Foreign Voltage	Yellow

3) Conductor Identification:
   a) Wiring shall be tagged at terminations with machine-printed plastic sleeves with three-part wire numbers for instrument and control panel internal conductors:
      (1) Part-1: Prefix of the wire number shall be the instrument loop number or equipment tag number.
      (2) Part-2: Code letter and wire colors per panel standard.
      (3) Part-3: Number that identifies individual circuit conductor Terminal Number.

9. Conductor Installation and Protection:
   a. Physical Characteristics:
      1) Power and control wiring shall be carried in covered channels separate from low voltage signal circuits. An interior steel barrier shall be provided between AC control devices and the electronic equipment.
      2) Terminal blocks shall be strap screw type rated for 600 volts. Each terminal trip shall have a unique identifying alphanumeric code at one end and a vinyl-marking strip running the entire length of the terminal strip with a unique number for each terminal. Numbers shall be machine printed and 1/8 inch high.
      3) No more than two connections shall be made to one terminal.
      4) Wire connectors shall be locking fork tongue or ring tongue insulated crimp type terminals.
   b. Functional Characteristics: None.
   c. Performance Characteristics: None.
10. Field Wiring: Field wiring shall be connected to separate dedicated terminal blocks in a dedicated part of the panel where the field cables enter the panel. Provide a dedicated raceway on the field side of the terminal block for field wiring use only.
11. Fuse and Fuse Holders:
   a. Physical Characteristics:
      1) Fuses for 120V ac circuits shall have a minimum of 12,000 amperes interrupting capacity and blown fuse indicators.

2) Fuses for 24V dc circuits shall be fast-acting glass tube type rated 1/8 amp or 1/10 amp for 4 mA to 20 mA loops.
3) Fuses for 24V dc circuits shall be 1/2 amp for the power supply to individual instruments.
4) Fuse holders shall be tip-out or draw-out type.

12. Control Power:
    a. Physical Characteristics:
        1) One 120V ac, UPS supplied circuit, for control power source: Dual, redundant with diode auctioneered outputs and automatic-switching between power sources, one for PLC and DC power and one for PLC output and input control power.
        2) Provide control power transformers, as required for the load.
        3) Provide direct current power supplies, as required for the load.
        4) UPS power source for PLC and derived loop power as defined above, supplied to each control panel.
13. Panel Utility Power Source:
    a. Physical Characteristics:
        1) One 120V ac circuit, non-UPS, for all auxiliary systems within the panel including the panel light, receptacle, heating, fan, and other similar items as required.
        2) Non-UPS circuit supplied to each control panel.
14. Accessories:
    a. Physical Characteristics:
        1) Panels greater than 24 inches high by 24 inches wide shall include GFCI convenience receptacles and fluorescent utility lights.
        2) Receptacles and utility lights shall not be powered by the UPS, where included.
        3) Print pocket.
        4) Fold-up shelf of sufficient size, sufficient weight capacity, and the proper angle for supporting a laptop computer.
15. Fail-Safe Wiring:
    a. Physical Characteristics: Fail-safe wiring of control relay or other on/off device or instrument provides the condition that will occur upon loss-of-power or internal failure in the device such that the relay is de-energized in the failure or loss-of-power condition such that the control relay contact operation provides for equipment failing in a safe mode.
16. Control Devices: Control devices shall comply with Division 26, Electrical.
17. Indicating Lights: Physical Characteristics: Indicating lights shall be equipped with colored lenses as specified in Division 26, Electrical.

18. 24V dc Power Supply and Conditioning Equipment:
    a. Physical Characteristics:
        1) Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems. Diode isolation shall be provided for redundant direct current supply units, and the power supply negative output terminal shall be grounded.
        2) Alternating Current (AC) Voltage Regulators:
            a) Regulators shall be of the solid-state tap-changing type, insensitive to line frequency variations between 47 Hz and 63-Hz. Ferroresonant units are not acceptable. Output regulation for input voltage variation from 85 volts to 125 volts shall not exceed 3.3 percent. Output regulation for load variation from 0 percent to 100 percent shall not exceed 1.0 percent. Response time shall be 1.0 cycles or less. Voltage regulators serving panelboards and control panels shall have a load capacity not less than 200 percent of the connected load. Voltage regulators serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the regulator shall not exceed 2 percent of the regulator capacity, and harmonic distortion introduced by the regulator shall not exceed 0.1 percent. Regulator output shall be fully protected against internal faults, external overloads and short circuits. Three-phase units shall be 4-wire, wye-connected, and capable of supporting 100 percent unbalanced load.
        3) Noise-Suppression Isolation Transformers:
            a) Isolation transformers shall be provided for AC-powered instrumentation loads containing solid state circuitry where such is not included within the instrument. Isolation transformers shall be of the triple box shield type. Each coil shall be completely enclosed in a grounded conductive faraday shield, and the overall transformer enclosed in a faraday shield. Common mode noise attenuation between primary and secondary shall exceed 140 dB at 1.0 kHz. Isolation transformer dielectric strength shall be 2,500 volts minimum. Isolation transformers serving panelboards and control panels shall have a load

capacity not less than 200 percent of the connected load. Isolation transformers serving individual instruments shall have a load capacity not less than 125 percent of the connected load. Power loss in the isolation transformer shall not exceed 2 percent of the maximum load rating. Harmonic distortion introduced by the isolation transformer shall not exceed 0.1 percent. Three-phase units shall be 4-wire, wye-connected and capable of supporting 100 percent unbalanced load.

b. Direct-Current Power Supplies:

1) Physical Characteristics:

a) Except for power supply units which form an integral part of an individual piece of equipment, all power supply and conditioning equipment shall comply with UL 1012 and shall be approved by UL, CSA, or FM for the application. All power supply equipment shall be provided in redundant configurations such that failure of a single unit will not disable all or any part of the instrumentation and communication systems. Provide DIN rail mount dual power supplies with DIN rail mount automatic switching power supply redundancy manager between power supplies. The power supply negative output terminal shall be grounded.

b) Furnish as required to power instruments and control circuits requiring dc power, including two-wire transmitters, relays, PROFIBUS panels, PROFIBUS instruments, PROFIBUS networks, and internal panel control devices.

c) Supplier shall provide sizing calculations for each power supply in submittals, as described in Section 40 90 00, Instrumentation and Control for Process Systems.

d) Convert 120V ac, 60 Hz power to dc power of appropriate voltage(s) with sufficient voltage regulation and ripple control to assure that instruments being supplied can operate within their required tolerances.

2) Provide output over voltage and over current protective devices to:

a) Protect instruments from damage due to power supply failure.

b) Protect power supply from damage due to external failure.

3) Enclosures: NEMA 1.

4) Mount such that dissipated heat does not adversely affect other components.
5) Fuses: For each dc supply line to each individual two-wire transmitter.
6) Type: Indicating.
7) Mount so fuses can be easily seen and replaced.
8) Nominal 24V dc instrumentation and control power supply:
   a) Convection-cooled linear type or switching type.
   b) Line Regulation: 0.4 percent for line variations from 105 volts to 132 volts.
   c) Load Regulation: 0.4 percent for load variations from 0 to full load.
   d) Ripple and Noise: Not exceed 100 mV peak-to-peak.
   e) Hold-up Time at Maximum Load: Not less than 16 milliseconds.
   f) Continuous duty from 0 degree C to 50 degrees C at rated load.
   g) Output electronically current limited.
   h) Over-voltage crowbar shutdown.
   i) Output Voltage: Rated 28V dc.
9) Adjustable plus or minus 5 percent.
10) Set to provide 26.4 volts to the panel direct current bus.
   a) Provide dry contact for failure alarm. Dry contact to be wired as input to PCS.
11) Candidate Suppliers:
   a) Phoenix Contact.
   b) TDK-Lambda; LZSA series.
   c) Or equal.

19. Surge Protection:
   a. Provide primary surge protectors, per NEC Article 800.90 on all signal conductors entering the panel. Surge protectors shall be multi-stage, plug-in type selected to protect the equipment, and listed per ANSI/UL 497. Surge protectors shall be removable without changing the impedance of the circuit.
   b. Provide Type 1 surge protective devices, per NEC Article 285, at the power feed to the panel. Surge Protective Devices (SPD) shall be designed to provide transient voltage protection for a service entrance panelboard. SPD units shall comply with UL 1449 3rd Edition, and shall be listed for such use. SPD units shall be rated for the voltage and phase service of the panel at 120 kA per phase. SPD units shall have a built-in diagnostic package with flashing trouble indicator, a display for the status of each phase, and a counter and display to indicate the number of surges that have caused the device to operate.
      1) SPD units shall be Eaton Clipper Power System, Visor Series, Circuit Components Inc., SPD-Series Equal.

c. Surge arrestors and capacitors shall be provided on the primary winding of isolation transformers supplying power to solid state systems. Surge protectors shall be mounted in a separate, NEMA 1 enclosure adjacent to the transformer and the incoming line passed through this enclosure.

20. Panel Grounding:
    a. Each panel shall be provided with two copper ground bars.
        1) One bar (NEC required) shall be bonded to the panel or panel frame or back-plate and to the facility grounding system.
        2) Second (signal) ground bar shall be mounted on insulated stand-offs and shall be bonded to the panel ground bar only at one point.
    b. Signal circuits, signal cable shields, and low-voltage DC power supply commons shall be bonded to the signal ground bar.
    c. Field analog wiring shields shall only be grounded at the signal ground bar. Test to verify that single ground point at panel signal ground bar.
    d. Surge protectors and separately derived AC power supplies shall be bonded to the frame ground bar.
    e. Panels exceeding 36 inches width shall contain ground bars shall be 1/4-inch by 1-inch copper bars extending the entire length of the panel interior at the bottom of the panel.
21. Interlocks: Critical interlocks shall not rely on soft interlocks derived from analog instruments or software logic but must be discrete switches that are hardwired to the motor control circuit directly. These interlocks shall be identified and submitted to the Contracting Officer on motor elementary drawings.
22. Panel Drawing Protection: Provide a complete set of panel-wiring diagrams and schematics for each panel in a plastic bag or plastic container to avoid water damage and aging.

B. Programmable Logic Controllers:

1. Physical Characteristics:
    a. The PLC processors shall be sized with sufficient memory to process the package control system application control strategies, including all hardwired I/O, all PCSI monitoring and control I/O, while also providing memory for a 100 percent expansion of processing and memory capacity. Provide latest version at time of bid with processor memory sized for twice the tested and completed PLC program.
    b. Each PLC power supplies shall be sized for the PLCs and connected devices.
    c. PLC I/O: All discrete and analog I/O modules shall be individually isolated inputs and outputs.

d. Discrete I/O:
    1) Inputs shall be 24V dc. Discrete outputs shall be rated for 2 amps at 24V dc, minimum. Each input and output shall have an LED ON/OFF status indicator.
    2) Outputs for interface to external equipment and systems: Provide dry contact interface using one of the following methods:
        a) Provide relay type discrete output module.
        b) Power interposing relay to generate dry contact.
        c) Interposing relay is required for all digital outputs that control motor contactors.
e. Analog Inputs and Outputs: 4 mA dc to 20 mA dc per channel.
f. Provide a minimum of 25 percent spare I/O of each type.
g. All spare I/O shall be wired to panel terminal blocks.
h. Provide a minimum of 20 percent empty slots in PLC racks/chassis, with a minimum of one each I/O card type.
i. PLC Rack Mounted Communication Modules: Provide quantity as shown on the block diagrams on the Drawings, or as required by the package system specifications.
j. All PLC control logic and HMI configuration programs shall provide the functionality, content, format and documentation specified in equipment specifications.
k. Minimum of 25 percent, wired, excess capacity for inputs, outputs, internal memory, and other necessary functions.
l. Supplier and Product:
    1) PLC: Provide latest version at time of bid with processor memory sized for twice the tested and completed PLC program.

2. Functional Characteristics: None.
3. Performance Characteristics: None.

C. Operator Interface Terminal

1. Manufacture and Products:
    a. Allen-Bradley Panelview Plus 7 Standard.
    b. Or equal.
2. Physical Characteristics:
    a. 4 Inch Display.
    b. Color Graphics.
    c. Touchscreen.
    d. NEMA 12.
    e. Ethernet 10/100BASE-TX: RG-45 ports.
    f. Input Power 24V dc.
3. Functional Characteristics: None.
4. Performance Characteristics: None.

D. Network Switches:

1. Manufacturers and Products:
   a. Extreme Networks 16804.
   b. Or equal.
2. Physical Characteristics:
   a. Ports:
      1) 10/100/1000BASE-TX: RJ-45 ports.
      2) Small Form-Factor Pluggable (SFP) Gigabit Ethernet ports.
      3) Provide SFP modules as required for connectivity.
   b. DIN Rail Mount.
   c. Operating Temperature: minus 40 degrees C to plus 75 degrees C.
   d. Input Power: 9V dc to 60V dc.
   e. Protection Class: IP30.
3. Functional Characteristics:
   a. General:
      1) This specification is provided to indicate minimum quality of components provided.
      2) Full compliance with IEEE 802.3.
      3) Supports Ethernet/Fast/Gig Ethernet 10/100/1000BASE-TX.
      4) Provide network switching for at least eight Ethernet ports within a single chassis.
      5) Provide fiber uplink and copper port distribution as required per facility.
4. Performance Characteristics:
   a. Management: Web interface, SNMP v3.
   b. Diagnostics:
      1) Log File.
      2) Port mirroring.
      3) Remote Switch Port Analyzer (RSPAN).
      4) Embedded remote monitoring software - RMON (statistics, history alarms, events).
   c. Authentication and Security:
      1) Secure Shell (SSH).
      2) Port security (MAC based and IP based).
      3) SNMP V3 (no encryption).
      4) RADIUS and TACACS+.
      5) Configurable Security Levels: Low, medium, and high.
      6) IEEE 802.1x Port Security:
         a) Dynamic port-based security.
         b) Dynamic VLAN assignment.
         c) Identity based ACLs.
      7) DHCP snooping.
      8) IP source guard.

d. Other Services:
    1) QoS 4 queues, port prioritization (IEEE 802.1D/p), VLAN (802.1Q).
    2) VLAN Trunking Protocol (VTP).
    3) Multicast (IGMP Snooping/Querier).
    4) Flow Control (IEEE 802.3x SNTP).
    5) Cisco Discovery Protocol.
e. Redundancy:
    1) MRP, REP, RSTP.
    2) Link Aggregation.
    3) Power Input.
f. Approvals: UL 60950-1.

2.06 REMOTE MONITORING SYSTEM

A. Remote Monitoring:
    1. Manufacturers and Products:
        a. Mission Communications; MyDro 850.
            1) Panel Mount: M853.
            2) NEMA 1: M851.
            3) NEMA 4X: M852.
            4) Analog Option Board: OP465.
        b. Or equal.
    2. Physical Characteristics:
        a. NEMA Rating: As Noted.
        b. Digital Inputs: 8.
        c. Analog Inputs:
            1) Integral: 2.
            2) Optional Board: 4.
        d. Input Power: 120V ac.
        e. Operating Temperature: Minus 4 degrees F to 140 degrees F.
        f. 18 hours of battery backup.
    3. Functional Characteristics:
        a. Email, Text Messages, Voice Phone Calls when an alarm is detected.
        b. Ethernet Connectivity.
        c. Cell Modem option.
    4. Performance Characteristics:
        a. Web-based Interface.
        b. Cloud based configuration.
        c. Cloud based datalogging.
        d. Mobile app capable.

PART 3 EXECUTION (NOT USED)

END OF SECTION

SECTION 40 95 60
TELEMETRY SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This section gives the general requirements to the Remote Monitoring System as part of the overall PIC.

B. Major Work Items: Includes but is not limited to the engineering, furnishing, installing, testing, documenting, starting up and training for a complete system.

1. Specifying and providing a Remote Monitoring System for the following locations:
   a. Abert's Squirrel Loop Comfort Loop Station.
   b. Canyon Mechanical Building.
   c. PRV Vault.
   d. Main Lift Station.
2. Conduct a Continuous wave test at each site before installation of the Remote Monitoring System.

1.02 REFERENCES

A. The following is a list of standards which may be referenced in this section:

1. Alliance for Telecommunications for Industry Solutions (ATIS): O5.1, Specifications and Dimensions (for Wood Poles).
2. American Association of State Highway and Transportation Officials (AASHTO):
   a. T99, Standard Method of Test for the Moisture-Density Relations of Soils Using a 2.5-kg (5.5-lb) Rammer and a 305-mm (12-in.) Drop.
   b. T310, Standard Specification for In-place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
3. American Wood Preservers Association (AWPA).
4. ASTM International:
   a. D1556, Standard Test Method for Density and Unit Weight of Soil In Place by the Sand-Cone Method.
   b. D2167, Standard Test Method for Density and Unit Weight of Soil In Place by the Rubber-Balloon Method.
   c. D2937, Standard Test Method for Density of Soil In Place by the Drive-Cylinder Method.
5. Federal Aviation Administration (FAA).

6. Federal Communications Commission (FCC).
7. Institute of Electrical and Electronics Engineers, Inc. (IEEE): C37.90, Standards for Relays and Relay Systems Associated with Electric Power Apparatus.
8. International Society of Automation (ISA): 50-00.01, Compatibility of Analog Signals for Electronic Industrial Process Instruments.
9. National Electrical Manufacturers Association (NEMA): 250, Enclosures for Electrical Equipment (1,000 Volts Maximum).
10. Rural Utilities Service (RUS): Bulletin 1728F-700, Specification for Wood Poles, Stubs, and Anchor Logs.
11. Telecommunications Industry Association/Electronic Industries Association (TIA/EIA):
    a. 222-G, Structural Standards for Steel Antenna Supporting Structure and Antennas.
    b. 222-G-1, Structural Standards for Steel Antenna Towers and Antenna Supporting Structure.
    c. 232, Interface Between Data Terminal Equipment and Data Circuit-Terminating Equipment Employing Serial Binary Data Interchange.
    d. 603, Land Mobile FM or PM – Communication Equipment – Measurement and Performance Standards.

1.03 DEFINITIONS

A. Abbreviations:

1. CW: Continuous Wave.
2. LDPA: Long Periodic Dipole Array.
3. PIC: Process Instrumentation and Control.
4. RSRP: Reference Signal Received Power.
5. RSRQ: Reference Signal Received Quality.
6. RMS: Remote Monitoring System.
7. RTU: Remote Terminal Unit
8. SCADA: Supervisory control and data acquisition.

B. Remote Monitoring System includes a RTU, an antenna, and an antenna mast.

C. Article Definitions in Section 40 90 00, Instrumentation and Control for Process Systems, apply to this section.

1.04 SUBMITTALS

A. Refer to Section 40 90 00, Instrumentation and Control for Process Systems, Article Submittals for the requirements of the action and informational submittals.

B. Test Plan: Continuous Wave test plan shall include, but not be limited to describe schedule of events, set up, equipment cutsheets, and Continuous Wave Report.

C. Continuous Wave Report: Report summarizing the Continuous Wave test performed at each site.

PART 2 PRODUCTS

2.01 SYSTEM PERFORMANCE

A. Cellular 4G and 5G systems radio frequencies are measured by the two following signal readings:

1. RSRP: Reference Signal Received Power. A cellular phone or another Long Term Evolution (LTE)-equipped device displays signal strength in RSRP.
2. RSRP Signal Power Overview:

RSRP	Signal Power
> -90 dBm	Excellent
-90 dBm to –105 dBm	Good
-106 dBm to –120 dBm	Fair
<-120 dBm	Poor

3. RSRQ: Reference Signal Received Quality. In 4G LTE networks, RSRQ is a measure of the signal quality of a cellular connection.
4. RSRQ Signal Quality Overview

RSRQ	Signal Quality
> -9 dB	Excellent
-9 dB to –12 dB	Good
<-13 dB	Poor

2.02 REMOTE TERMINAL UNIT

A. Manufacturers and Products:

1. Mission Communications; MyDro 850.
   a. Panel Mount: M853.
   b. NEMA 1: M851.
   c. NEMA 4X: M852.
   d. Analog Option Board: OP465.
2. No or equal.

B. Physical Characteristics:

1. NEMA Rating: As Noted.
2. Digital Inputs: 8.
3. Analog Inputs:
   a. Integral: 2.
   b. Optional Board: 4.
4. Input Power: 120V ac.
5. Operating Temperature: Minus 4 degrees F to 140 degrees F.
6. 18 hours of battery backup.

C. Functional Characteristics:

1. Email, Text Messages, Voice Phone Calls when an alarm is detected.
2. Ethernet Connectivity.
3. Cell Modem option.
   a. Radios make live, continuous, encrypted TCP socket connections.
   b. Payload is end–to–end acknowledged.
   c. Penta band (850, 900, 1700, 1900, 2100 MHz).
   d. Verizon: LTE.

D. Performance Characteristics:

1. Web-based Interface.
2. Cloud based configuration.
3. Cloud based datalogging.
4. Mobile app capable.

2.03 ANTENNA:

A. Physical Characteristics:

1. Type (Best Fit):
   a. Omnidirectional.
   b. Yagi.
   c. LDPA.
2. Mounting: Pole Mounting.

B. Functional Characteristics: None.

C. Performance Characteristics:

1. RSRP: Greater than 105 dBm.
2. RSRQ: Greater than 12 Db.

2.04 ANTENNA MASTS

A. Physical Characteristics:

1. 2 inch rigid conduit.
2. Height: Best fit as per electrical drawings.
3. Mounting: Best fit as per electrical drawings.

B. Functional Characteristics: None.

C. Performance Characteristics: None.

PART 3 EXECUTION

3.01 CONTINUOUS WAVE TEST

A. The Contractor or their qualified Subcontractor shall perform Continuous Wave Testing to demonstrate adequate coverage throughout the project limits. Testing shall be coordinated and scheduled not to impact travel roadways or Public areas.

B. Continuous Wave test shall be for a period of 1 day at each site prior to procuring all of the RTU'S. Continuous wave test entails temporarily installing An RTU with multiple antenna configurations (height, type, and direction) to determine the setup for the strongest and most stable signal. Mission Communications may provide a demonstration unit for the test.

C. Record the following at each of the sites:

1. GPS Coordinates.
2. RTU used.
3. Antenna type used.
4. Antenna Mast used
5. Antenna Direction.
6. RSRP.
   a. Minimum.
   b. Maximum.
   c. Average.
7. RSRQ.
   a. Minimum.
   b. Maximum.
   c. Average.

3.02 INSTALLATION

A. Material and Equipment Installation: Follow manufacturers' installation instructions, unless otherwise indicated or directed by Engineer.

B. Wiring connected to RTU, including power wiring in accordance with requirements in Section 26 05 05, Conductors.

3.03 TESTING

A. Prior to Facility Startup and Performance Evaluation period for each facility, inspect, test, and document that associated PIC equipment is ready for operation.

B. Preparation for Testing: Documentation that the resultant punch lists have been completed.

C. Loop/Component Inspections and Tests:

1. These inspections and tests will be spot checked by Contracting Officer.
2. Check for proper installation, calibration, and adjustment on loop-by-loop and component-by-component basis.

D. Functional Test: As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

E. Required Test Documentation: As defined in Section 40 90 00, Instrumentation and Control for Process Systems.

END OF SECTION

SECTION 40 95 80
FIBER OPTIC COMMUNICATION SYSTEM

PART 1 GENERAL

1.01 REFERENCES

A. The following is a list of standards that may be referenced in this section:

1. Electronic Components, Assemblies, and Materials Association (ECA): 310-E, Cabinets, Racks, Panels, and Associated Equipment.
2. Institute of Electrical and Electronic Engineers, Inc. (IEEE): 802.3, Telecommunications and Information Exchange Between Systems—Local and Metropolitan Networks.
3. Insulated Cable Engineers Association (ICEA):
   a. S-83-596, Optical Fiber Premises Distribution Cable.
   b. S-87-640, Optical Fiber Outside Plant Communications Cable.
   c. S-104-696, Indoor-Outdoor Optical Fiber Cable.
4. International Organization for Standardization (ISO): 9001, Quality Management Systems—Requirements.
5. International Telecommunication Union (ITU): T G.652, Characteristics of a Single-mode Optical Fibre and Cable.
6. National Fire Protection Association (NFPA): 70, National Electrical Code (NEC).
7. QuEST Forum (QF): TL 9000, Quality Management Systems.
8. Rural Development Utilities Programs (RDUP):
   a. 7 CFR 1755.902, Minimum Performance Specification for Fiber Optic Cables.
   b. 7 CFR 1755.903, Fiber Optic Service Entrance Cables.
9. Telecommunications Industry Association (TIA):
   a. 526-7, OFSTP-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant.
   b. 526-14, OFSTP-14 Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
   c. 568-C.1, Commercial Building Telecommunications Cabling Standards.
   d. 568-C.3, Optical Fiber Cabling Components Standard.
   e. 598, Optical Fiber Cable Color Coding.
   f. 606, Administration Standard for Commercial Telecommunications Infrastructure.
10. Telecommunications Industry Association/Electronics Industry Association (TIA/EIA):
    a. 455-78, FOTP-78 - IEC 60793-1-40 Optical Fibres Part 1-40: Measurement Methods and Text Procedures – Attenuation.

b. 455-133, FOTP-133 IEC-60793-1-22 Optical Fibres Part 1-22: Measurement Methods and Test Procedures Length Measurement.
c. 492AAAA, Detail Specification for 62.5-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
d. 492AAAB, Detail Specification for 50-Micrometer Core Diameter/125-Micrometer Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
e. 492AAAC, Detail Specification for 850-nm Laser-Optimized, 50-um Core Diameter/125-um Cladding Diameter Class Ia Graded-Index Multimode Optical Fibers.
f. 492CAAA, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers.
g. 492CAAB, Detail Specification for Class IVa Dispersion-Unshifted Single-Mode Optical Fibers with Low Water Peak.
h. 604-2, FOCIS-2 Fiber Optic Connector Intermateability Standard, Type ST.
i. 604-3, FOCIS-3 Fiber Optic Connector Intermateability Standard, Type SC and SC-APC.
j. 604-12, FOCIS-12 Fiber Optic Connector Intermateability Standard, Type MT-RJ.
k. 942, Telecommunications Infrastructure Standard for Data Centers.
l. TSB-140, Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems-Contains Color.

11. UL: 94, Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.

1.02 DEFINITIONS

A. ATM: Asynchronous Transfer Mode.

B. AUI: Attachment Unit Interface.

C. dB: Decibel.

D. DNI: Desktop Network Interface.

E. EMB: Effective Modal Bandwidth.

F. ETL: Electrical Test Laboratories.

G. FDDI: Fiber Distributed Data Interface.

H. FIM: Facilities Information Management.

I. Flux Budget: Difference between transmitter output power and receiver input power required for signal discrimination when both are expressed in dBm.

J. FOCS: Fiber Optic Communication System.

K. FOIRL: Fiber Optic Inter Repeater Link.

L. Fusion Splice: Connecting ends of two fibers together by aligning fiber ends and applying electric arc to fuse ends together.

M. Hybrid Cable: Cable containing more than one type of fiber.

N. LAN: Local Area Network.

O. LIMS: Laboratory Information Management System.

P. m: Micrometer.

Q. Mbps: Megabits per Second.

R. Mechanical Splice: Connecting ends of two fibers together by means other than fusion.

S. Megahertz (MHz): One million cycles per second.

T. MHz: Megahertz.

U. micro: x 10^{-6}.

V. Micron: Micrometer or one millionth meter.

W. MIS: Management Information System.

X. n, nano: x 10^{-9}.

Y. N: Newton.

Z. nm: Nanometer—unit of measure equal to one billionth meter.

AA. OFL: Over-filled Launch.

BB. OFN: Nonconductive Optical Fiber Cable.

CC. OFNP: Nonconductive Optical Fiber Plenum Cable.

DD. OFNR: Nonconductive Optical Fiber Riser Cable.

EE. OLTS: Optical Loss Test Sets.

FF. OTDR: Optical Time Domain Reflectometer.

GG. OVD: Outside Vapor Deposit.

HH. PIC: Process Instrumentation and Control.

II. Plenum: Air return path of central air handling system, such as open space above suspended ceiling.

JJ. RLM: Restricted Mode Launch.

KK. ROL: Reverse Oscillation Lay.

LL. SPC: Super Physical Contact.

MM. UPC: Ultra Physical Contact.

NN. UPS: Uninterruptible Power Supply.

OO. V ac: Volts Alternating Current.

PP. WAN: Wide Area Network.

1.03 SYSTEM DESCRIPTION

A. Function of FOCS is to transmit digital data between network nodes. Requirements listed identify minimum acceptable system performance.

B. Provide a FOCS based on referenced standards for use in the following local and wide area networks:

1. Ethernet.

C. Network(s) will be used by PIC to distribute data and coordinate Contractor's operations.

1.04 SUBMITTALS

A. Action Submittals:

1. Site Layout Diagram Showing:
   a. Access holes, with identification.
   b. Above grade cable routings, with pole and cable identification.
   c. Below grade conduit routings between access holes and buildings, with conduit counts and identification.

d. Belowgrade innerduct routings through conduits, with innerduct counts and identification.
e. Cable routings through innerducts and to patch panels, fiber centers, or network nodes, with cable and node identification.

2. Cable Schedule Showing:
   a. Cable identification.
   b. Fiber counts for each cable and identification of used fiber pairs.
   c. Cable length and attenuation, with two connector pairs and no splice(s), based on TIA 568-C.3, Annex H.
3. Component Data:
   a. Manufacturer and model number.
   b. General data and description.
   c. Engineering specifications and data sheet.
   d. Scaled drawings and mounting arrangements.

B. Informational Submittals:

1. Manufacturer's statement that installer is certified to perform installation Work.
2. Subcontractor Qualifications:
   a. FOCS Subcontractor: Minimum of 5 years' experience providing, integrating, installing, and commissioning of similar systems.
      1) Statement of Experience: List of at least three fiber optic data communications systems comparable to system specified which have been furnished and placed into operation. For each system, provide following information:
         a) Contracting Officer's name, address, telephone number, and name of current operations supervisor or other contact.
         b) Description of system hardware configuration, including major equipment items, number of nodes, and communication standards implemented.
         c) System block diagram.
         d) Dates when contract was signed, equipment was delivered, and system was accepted by Contracting Officer. Also, include originally scheduled completion date and if different from actual date, explain why.
         e) Approximate value of listed FOCS provided in dollars.
         f) Detailed horizontal and riser routing.
         g) Distribution frame arrangements.
         h) Fiber and termination identification, including spares.
   b. FOCS Subcontractor's Site Representative: Minimum of 5 years' experience installing similar systems.

c. Qualification of Personnel:
   1) Resumes identifying management and technical qualifications of supervisory, local service representative, and key personnel.
   2) Qualification data of firm and persons to demonstrate capabilities and experience in the following areas:
      a) Fiber optic cable handling and placement techniques.
      b) Fiber optic splicing and installation of connections.
      c) Attenuation testing procedures.
d. Contracting Officer acceptance of FOCS Subcontractor does not exempt FOCS Subcontractor or Contractor from meeting Contract Document requirements nor does it give prior acceptance of subsystems, equipment, materials, or services.
e. Sample of Network Test Report, minimum 10 pages, that Contractor generated in a previous project.
f. Testing and acceptance plan, 30 days prior to beginning of testing.
g. Fiber test results. Documentation covering fiber facility testing, not later than 2 days after testing, showing:
   1) Manufacturer's tag of attenuation per fiber as recorded from OTDR reading before shipment.
   2) Attenuation of each fiber upon delivery to Site.
   3) Attenuation of each fiber plus connector after installation as recorded from OTDR with tracing.
   4) Flux Budget calculations with comparison to measured attenuation for each run verifying adequate optical signal strength.
h. For each maintenance organization, identify location of base of service and how required coverage will be achieved.

3. Manufacturer's Certificate of Compliance.
4. Manufacturer's suggested installation practice.
5. Operation and Maintenance Data: As specified in Section 01 78 23, Operation and Maintenance Data.

1.05 ENVIRONMENTAL REQUIREMENTS

A. Optical Fiber Cable and Cable Splice Centers:

1. Outside, Underground/Submerged: Minus 20 degrees C to 40 degrees C.
2. Outside, Overhead: Minus 40 degrees C to 80 degrees C.
3. Outside, Aboveground in Conduit: Minus 40 degrees C to 80 degrees C.
4. Inside: 0 degree C to 40 degrees C.

B. Equipment:

1. Outside, Aboveground: Minus 40 degrees C to 80 degrees C.
2. Control Rooms, Equipment Rooms, and Telecommunications Closets: 30 percent to 55 percent relative humidity, 18 degrees C to 24 degrees C.
3. Other Interior Areas: 0 percent to 100 percent relative humidity, 5 degrees C to 35 degrees C.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications:

1. Cable:
   a. ISO 9001 or QF TL 9000 registered, whichever applies to material.
   b. Minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance.
2. Housing: ISO 9001 and QF TL 9000 registered.
3. Connector:
   a. ISO 9001 or QF TL 9000 registered.
   b. Minimum 10-year history of manufacturing and supporting connector technology that does not require epoxy or polishing in field.
4. Jumper Cable: ISO 9001 and QF TL 9000 registered.

B. Installer Qualifications:

1. Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.
2. Certified by fiber cable manufacturer.

C. Tester Qualifications: Individuals with at least 3 years of experience with projects utilizing fiber optic cable in compliance with TIA 568-C.3.

1. Technician: Successfully attended training program, which includes testing with an OLTS and an OTDR and have obtained a certificate as proof thereof. Certificate may have been issued by the following organizations or an equivalent organization:
   a. Manufacturer of fiber optic cable and fiber optic connectors.
   b. Manufacturer of test equipment used for field certification.
   c. Other independent training organizations acceptable to Contracting Officer.

D. Provide connectors/coupling, splicing enclosures, mounting hardware, and miscellaneous accessories for fibers by same manufacturer.

1.07 EXTRA MATERIALS

A. Furnish, tag, and box for shipment and storage the 25 percent spare parts:

PART 2 PRODUCTS

2.01 FIBER OPTIC CABLE

A. Single-Mode: 8.3/125-micron Class IVa dispersion-unshifted optical fibers for use in the backbone distribution subsystem shall meet or exceed requirements of TIA 568-C.3, including the following specifications:

1. Physical Characteristics:
   a. Chromatic Dispersion:
      1) Zero-Dispersion Wavelength: Between 1,302 nm and 1,322 nm.
      2) Maximum value of dispersion slope at zero dispersion wavelength shall be no greater than 0.093 ps per km-nm2.
   b. Mode Field Diameter: Nominal 8.7 microns to 10 microns, with a tolerance of plus or minus 0.5 micron at 1,300 nm.
   c. Maximum Attenuation:
      1) Outside and Indoor-Outdoor Optical Fiber Cable:
         a) 0.5 dB per km at 1,310 nm.
         b) 0.5 dB per km at 1,550 nm.
      2) Inside Optical Fiber Cable:
         a) 1 dB per km at 1,310 nm.
         b) 1 dB per km at 1,550 nm.
   d. Cutoff Wavelength of Cabled Fiber: Less than 1,260 nm.
   e. TIA 492 CAAA (OS1) compliant.
   f. Distance Capacity per IEEE 802.3:
      1) 1 Gbit Ethernet, 1,300 nm Laser Minimum Distance: 5000 m.
      2) 10 Gbit Ethernet: 10 km at 850 nm and 40 km at 1,310 nm.
2. Functional Characteristic: None.
3. Performance Characteristic: None.

B. Type 8.3/250, Backbone for Underground Conduit Installation:

1. Physical Characteristics:
   a. Individual Fibers: 8.3/125/250 microns.
   b. Assembly:
      1) Nonmetallic, gel-free, dry water blocked, loose-tube fiber core with dielectric strength member enclosed by nonmetallic cross-ply sheath; requires buffer tubing.
      2) Cable: Comply with ICEA S-87-640 and RDUP 7 CFR 1755.902 for backbone, feeder and distribution cables and RDUP 7 CFR 1755.903 for service entrance or

drop cable with 12 strands or less used having a distance of 100 m or less (fiber-to-the-home applications).

c. NEC/UL Listing: None; not approved for general use within building, except when installed in metallic conduit.
d. Protective Covering: Black, antifungus, UV-resistant, polyethylene jacket with rip-cord.
e. Minimum Short Term Pull Strength: 600 lbf.

2.02 FIBER PATCH PANELS

A. Closet Connector Housing Panel:

1. Manufactured from 18-gauge powder coated painted steel.
2. Designed to accommodate applications requiring specified labeling.
3. Offered in 24-fiber version.
   a. LC duplex connectors.
4. Capable of being used with field-installable connectors or in applications where preconnectorized cables are routed directly from equipment to interconnect hardware.

2.03 CONNECTORS

A. General:

1. Comply with TIA/EIA 604-2, TIA/EIA 604-3, TIA/EIA 604-12, and TIA 568-C.3.
2. LC connectors.
3. Pull Strength: 0.2 N minimum.
4. Durability: Sustain minimum 500 mating cycles without violating other requirements.
   a. Ferrules: Free-floating low loss ceramic.
   b. Polarizing key on duplex connector systems.
5. Attenuation:
   a. In accordance with TIA 568-C.3.
   b. Maximum of 0.75 dB per connector pair.

2.04 PATCHCORDS

A. General:

1. In accordance with TIA 568-C.3.
2. Function: Connect fiber centers to network nodes, such as computer workstations.
3. Fiber Characteristics: In accordance with requirements for fiber optic cable.

4. Cable Configuration:
    a. Individual tight-buffer thermoplastic, fibers single or multimode, to match fibers being jumpered on.
    b. Protected with kevlar strength members and enclosed in thermoplastic jacket.
5. Length: Standard, to meet requirements shown, plus minimum 3 meters at workstations.
6. Connectors:
    a. As required by Article Connectors.
    b. On-axial Pull Strength: 33 N.
    c. Normal-to-Axial Pull Strength: 22 N.
7. Cable Rating: OFNR or OFNP.
8. Color: Per standards or as indicated.
9. Measured for insertion loss with the following values for each connector:
    a. Typical of 0.3 dB and maximum of 0.5 dB (LC typical of 0.1 dB and maximum of 0.3 dB).

2.05 ACCESSORIES

A. Hardware: Provide cable clamps, strain reliefs, blocking and grommet kits, closures, and fan outs for complete installation.

PART 3 EXECUTION

3.01 PREPARATION

A. Conduit:

1. Ensure installed conduit system conforms to fiber optic system requirements, including:
    a. Conduits and Innerducts: Size and number.
    b. Access Holes, Handholes, and Pull Boxes: Location and size, to ensure cables and innerducts may be installed without exceeding manufacturer’s limitations.
    c. Outlet Boxes: Size to coordinate with outlet cover plates for adequate volume and bend radius.
2. Spare Conduit:
    a. No cables shall be pulled into spare conduit.
    b. 100 percent spare conduit capacity required for buried conduit only. For example, for every conduit with one or more cables in it, there shall be one spare equal-size conduit with no cables.
3. Expansion Plugs: Seal conduit to stop ingress of water and grit with fabricated expansion plugs.
4. Ensure duct bank, conduit, and other confined routing is free and clear of debris before cable placement.

3.02 INSTALLATION

A. Fiber Optic Cable:

1. Specified fiber counts, routing, origination, and terminating points are indicated on the Drawings.
2. Installation by manufacturer's certified installer.
3. Install cables in accordance with manufacturer's requirements.
4. Install cable directly from shipping reels. Ensure that cable is:
   a. Not dented, nicked, or kinked.
   b. Not subjected to pull stress greater than manufacturer's specification.
   c. Not bent to a radius below manufacturer's minimum bend radius.
   d. Not subjected to treatment that may damage fiber strands during installation.
5. Cables per Conduit or Innerduct: In accordance with NFPA 70 NEC conduit fill limitations.
6. Connector: Insertion loss on multimode connections exceeding 0.5 dB and 0.4 dB on single-mode connections not permitted.
7. Identification:
   a. Identify cable on both ends, in access holes, and pull points.
   b. In accordance with TIA 606.
8. Arrange cable, equipment, and hardware to provide neat appearance and accessibility for servicing.

B. Cable Terminations:

1. In accordance with TIA 568-C.3.
2. Fan out fiber cable to allow direct connectorization of connectors.
   a. Sleeve over individual fibers with transparent furcation tubes.
   b. At point of convergence of furcation tubes, provide strain relief with metal or high density plastic fan-out collar.
3. Break-out Kits:
   a. Terminate cables using manufacturer-supplied break-out kits.
   b. Terminate in accordance with manufacturer's recommendations.
4. Slack:
   a. Fiber Centers, Hubs, and Switches: Minimum, 3-meter slack fiber at each end, coiled neatly in cable management equipment.
   b. Communications Management Outlets: Minimum, 1-meter slack fiber, coiled neatly in outlet box.
5. Connectors:
   a. Terminate 100 percent fibers in each cable to specified connector.
   b. Connect into fiber management system.

C. Conduit: Install in accordance with Section 26 05 33, Raceway and Boxes for Electrical Systems.

3.03 LABELING CONVENTIONS

A. Conform to TIA 606 or to requirements specified by Contracting Officer.

3.04 FIELD QUALITY CONTROL

A. General:

1. Advise Contracting Officer at least 24 hours in advance of each test. Contracting Officer shall have option to witness and participate actively in tests.
2. Provide equipment, instrumentation, supplies, and skilled staff necessary to perform testing.
3. Outlets, cables, patch panels, and associated components shall be fully assembled and labeled prior to field testing.
4. Testing performed on incomplete systems shall be redone on completion of the Work.
5. Test 100 percent of installed strands.
6. Document Test Results:
   a. Confirm each cable has at least specified number of fibers that meet standards, in accordance with As-Built Fiber Optic Cable Installation form included as Supplement to this section.
7. Confirm quantities and sizes of conduit and innerduct, in accordance with As-Built Conduit/Innerduct Installation form included as Supplement to this section.

B. Inspect cable, material, and equipment for physical damage, continuity, and proper connections.

1. Verify identification and labeling for visibility, condition, legibility, and accuracy.
2. Confirm quantities and sizes of conduit and innerduct.

C. Test Reports and Documentation:

1. Test reports shall include the following:
   a. Project identification, testing firm, and test date.
   b. Scope of testing.
   c. List of test equipment with unique identifier and date of calibration.
   d. Names of technician(s) performing the tests.
   e. Cable identification as it is labeled according to the Specifications.
   f. Summary of test results with pass or fail for each strand.
   g. Individual test datasheets with cable and strand identification sufficient to correlate test result with installed cable.

2. Report Media:
   a. Prepare test reports and data sheets with reproducible quality printing on standard letter size paper.
   b. Electronic test reports and data sheets may be submitted in Adobe PDF format.

D. Test Equipment:

1. Field test instruments shall have latest software and firmware installed.
2. Field test instrument shall be within calibration period recommended by manufacturer.
3. Optical Loss Test Set (OLTS):
   a. Single-mode Optical Fiber Light Source:
      1) Provide dual laser light sources with central wavelengths of 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
      2) Output Power: Minus 10 dBm, minimum.
   b. Power Meter:
      1) Provide 850 nm, 1,300/1,310 nm, and 1,550 nm wavelength test capability.
      2) Power Measurement Uncertainty: Plus or minus 0.25 dB.
      3) Store reference power measurement.
      4) Save at least 100 results in internal memory.
      5) PC interface (serial or USB).
   c. Optional Length Measurement: Capable of measuring optical length of fiber using time-of-flight techniques.
4. Optical Time Domain Reflectometer (OTDR):
   a. Bright, color transmissive LCD display with backlight.
   b. Rechargeable for 8 hours of normal operation.
   c. Weight with battery and module of not more than 4.5 pounds and volume of not more 200 cubic inches.
   d. Internal nonvolatile memory and removable memory device with at least 16 MB capacity for results storage.
   e. Serial and USB ports to transfer data to PC.
   f. Single-mode OTDR:
      1) Wavelengths: 1,310 nm (plus or minus 20 nm) and 1,550 nm (plus or minus 20 nm).
      2) Event Dead Zone: 2 meters maximum at 1,310 nm and 2 meters maximum at 1,550 nm.
      3) Attenuation Dead Zone: 15 meters maximum at 1,310 nm and 15 meters maximum at 1,550 nm.
      4) Distance Range: Minimum 10,000 meters.
      5) Dynamic Range: Minimum 10 dB at 1,310 nm and 1,550 nm.

5. Fiber Microscope:
    a. Magnification: 250X or 400X for end-face inspection.
6. Integrated OLTS, OTDR, and Fiber Microscope: Test equipment that combines into one instrument such as OLTS, OTDR, and fiber microscope may be used.

E. Conduit Test:

1. Test and seal spare conduits.
2. Conduit and Innerduct Testing:
    a. Blow full-diameter mouse through each spare conduit and innerduct to verify they are unrestricted over full length.
    b. If conduit is restricted over full length, advise Contracting Officer.
3. Documentation: Confirm conduit test As-Built Conduit/Innerduct Installation form documentation includes details of innerducts.

F. Cable Testing:

1. Test procedures and field test instruments shall comply with applicable requirements of:
    a. LIA Z136.2.
    b. TIA/EIA 455-78.
    c. TIA/EAI 455-133.
    d. TIA 526-7.
    e. TIA 526-14.
    f. TIA 568-C.1.
    g. TIA 568-C.3.
    h. TIA TSB 140.
2. Test attenuation and polarity of installed cable plant with OLTS and installed condition of cabling system and its components with OTDR.
3. Verify condition of fiber end face.
4. Perform on each cabling link (connector to connector).
5. Perform on each cabling channel (equipment to equipment).
6. Do not include active devices or passive devices within link or channel other than cable, connectors, and splices. For example, link attenuation does not include such devices as optical bypass switches, couplers, repeaters, or optical amplifiers.
7. Document Tests:
    a. OLTS dual wavelength attenuation measurements for single-mode and multimode links and channels.
    b. OTDR traces and event tables for single-mode and multimode links and channels.

G. Fiber Testing Parameters:

1. Each cabling link shall be in compliance with the following test limits:
   a. Optical Loss Testing:
      1) Backbone (single-mode and multimode) Link:
         a) Calculate link attenuation by the formulas specified in TIA 568-C.1.
         b) Values for Attenuation Coefficient (dB/km) are listed in the table below:

Attenuation Coefficient				
Type of Optical Fiber	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**	**Wavelength (nm)**	**Attenuation Coefficient (dB/km)**
Single-mode (Inside plant)	1310	1.0	1550	1.0
Single-mode (Outside plant)	1310	0.5	1550	0.5

   b. OTDR Testing:
      1) Reflective Events: Maximum 0.75 dB.
      2) Nonreflective Events: Maximum 0.3 dB.
   c. Magnified Endface Inspection:
      1) Visually inspect fiber connections for end-face quality.
      2) Scratched, pitted, or dirty connectors shall be diagnosed and corrected.

H. Diagnosis and Correction:

1. Installed cabling links and channels shall be field tested and pass test requirements and analysis as described herein.
2. Link or channel that fails these requirements shall be diagnosed and corrected.
3. Document corrective action and follow with new test to prove corrected link or channel meets performance requirements.
4. Provide final and passing result of tests for links and channels.

I. Acceptance: Acceptance of test results shall be given in writing after Project is tested and completed in accordance with Contract Documents and satisfaction of Contracting Officer.

J. Test Execution:

1. Optical Fiber Cable Testing:
   a. Tests performed that use laser or LED in test set shall be carried out with safety precautions in accordance with LIA Z136.2.
   b. Link and channel test results from OLTS and OTDR shall be recorded in test instrument upon completion of each test for

subsequent uploading to a PC in which administrative documentation may be generated.

1) Record end-face images in memory of test instrument for subsequent uploading to a PC and reporting.

c. Perform Testing:

1) On each cabling segment (connector to connector).
2) On each cabling channel (equipment to equipment).
3) Using high-quality test cords of same fiber type as cabling under test.
   a) Test cords for OLTS testing shall be between 1 meter and 5 meters in length.
   b) Test cords for OTDR testing shall be approximately 100 meter for launch cable and at least 25 meters for receive cable.

2. Optical Loss Testing (OLTS):

a. Backbone Link:

1) Test single-mode at 1,310 nm and 1,550 nm in accordance with TIA 526-7, Method A.1, One Reference Jumper or equivalent method.
2) Test multimode at 850 nm and 1,300 nm in accordance with TIA 526-14A, Method B, One Reference Jumper or equivalent method.
3) Perform tests in both directions.

3. OTDR Testing:

a. Test backbone, horizontal, and centralized links at appropriate operating wavelengths for anomalies and to ensure uniformity of cable attenuation and connector insertion loss.

1) Single-mode: 1,310 nm and 1,550 nm.
2) Multimode: 850 nm and 1,300 nm.

b. Test each fiber link and channel in one direction.
c. Install launch cable between OTDR and first link connection.
d. Install receive cable after last link connection.

4. Length Measurement:

1) Record length of each fiber.
2) Measure optical length using OLTS or OTDR.

5. Polarity Testing:

a. Test paired duplex fibers in multifiber cables to verify polarity in accordance with subclause 10.3 of TIA/EIA 568-C.1.
b. Verify polarity of paired duplex fibers using OLTS.

6. Test Results Documentation:

a. Test results saved within field-test instrument shall be transferred into Windows-based database utility that allows for maintenance, inspection, and archiving of test records. These test records shall be uploaded to the PC unaltered. For example, “as saved in the field-test instrument.” The file format, CSV (comma separated

value), does not provide adequate protection of these records and shall not be used.

b. Available for inspection by Contracting Officer during installation period. Submit within 5 working days of completion of tests on cabling served by a telecommunications room or of backbone cabling.

c. Database for project, including twisted-pair copper cabling links, if applicable, shall be stored and delivered on CD-ROM prior to Contracting Officer acceptance of building. CD-ROM shall include software tools required to view, inspect, and print test reports.

d. Circuit IDs reported by test instrument shall match specified label identification.

e. Provide in electronic database for each tested optical fiber with the following information:

1) Identification of Site.
2) Name of test limit selected to execute stored test results.
3) Name of personnel performing test.
4) Date and time test results were saved in memory of tester.
5) Manufacturer, model, and serial number of field test instrument.
6) Version of test software and version of test limit database held within test instrument.
7) Fiber identification number.
8) Length for Each Optical Fiber: Optionally the index of refraction used for length calculation when using a length capable OLTS.
9) Test results to include OLTS attenuation link and channel measurements at appropriate wavelength and margin; difference between measured attenuation and test limit value.
10) Test results to include OTDR link and channel traces, and event tables at appropriate wavelength.
11) Length for each optical fiber as calculated by the OTDR.
12) Overall pass/fail evaluation of link-under-test for OLTS and OTDR measurements.

K. Drawings:

1. Record Copy: Provide at end of Project on CD-ROM.

a. CAD format and include notations reflecting as-built conditions of additions and variations from Drawings provided, such as to cable path and termination point.

b. CAD drawings are to incorporate test data imported from test instruments.

2. As-built Drawings:
   a. Include, but not limited to block diagrams, frame and cable labeling, cable termination points, equipment room layouts, and frame installation details.
   b. Include field changes made up to construction completion:
      1) Field directed changes to pull schedule.
      2) Field directed changes to cross connect and patching schedule.
      3) Horizontal cable routing changes.
      4) Backbone cable routing or location changes.
      5) Associated detail drawings.

3.05 SUPPLEMENTS

A. The supplements listed below, following “End of Section,” are a part of this specification:

1. On-Reel Fiber Optic Cable Test Summary Form.
2. Fiber Optic Attenuation Performance Test Form.
3. Post-Installation Fiber Optic Cable Test Summary Form.

END OF SECTION

ON-REEL FIBER OPTIC
CABLE TEST SUMMARY

PROJECT:							
CONTRACTOR:							
REFERENCE		**PRODUCT DESCRIPTION**			**TEST SUMMARY**		
ITEM	**ASSIGNED REEL ID**	**MANUFACTURER**	**CABLE TYPE**	**STRAND COUNT**	**OTDR PRINT-OUT LABEL**	**TEST DATE**	**PASS - FAIL**
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							

FIBER OPTIC
ATTENUATION PERFORMANCE TEST

Project Name:		**Project #**	

SEGMENT IDENTIFICATION

Cable Run Number:	**Source**	**Destination**
Building and Room		
Panel Identification		

TEST EQUIPMENT IDENTIFICATION

Attenuation Set	Calibration Date	Source Serial Number	Receiver Serial Number

FIBER SPECIFICATONS

Manufacturer:	
Part # & Fiber count:	
Core Diameter:	**uM**
Cladding Diameter:	**uM**
Max. Loss @ 850nm:	**3.5 dB/KM**
Max. Loss @ 1300nm	**1.5 dB/KM**
Grade:	**FDDI**

CALCULATED SEGMENT ATTENUATION

Segment Length:	**KM**			
		850 nm	**1300/1310 nm**	**1550 nm**
End-to-End loss:		**dB**	**dB**	**dB**
Splices:		**dB**	**dB**	**dB**
Mated Pair:	**1**	**0.50 dB**	**0.5 dB**	**0.50 dB**
Total Attenuation		**dB**	**dB**	**dB**

MEASURED SEGMENT ATTENUATION

Fiber Number	850nm Wavelength Measured at	1300mn Wavelength Measured at	Fiber Number	850nm Wavelength Measured at	1300mn Wavelength Measured at
1	dB	dB	13	dB	dB
2	dB	dB	14	dB	dB
3	dB	dB	15	dB	dB
4	dB	dB	16	dB	dB
5	dB	dB	17	dB	dB
6	dB	dB	18	dB	dB
7	dB	dB	19	dB	dB
8	dB	dB	20	dB	dB
9	dB	dB	21	dB	dB
10	dB	dB	22	dB	dB
11	dB	dB	23	dB	dB
12	dB	dB	24	dB	dB

Test Performed By:		Date:		
Test Submitted By:		Date:		
Test Approved By: (Resident Project Rep)		Date:		
Test Observed By: (Design)		Date:		

POST-INSTALLATION
FIBER OPTIC CABLE TEST SUMMARY

PROJECT: _____ CONTRACTOR: _____

ITEM #	REEL ID (see note)	CABLE SCHEDULE LABEL	CABLE ID ACCORDING TO SPECIFICATIONS	LENGTH (FT)	TEST DATE	PASS - FAIL
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						

Note: One line per cable segment. Enter reel ID from On-the-Reel summary report.

POST-INSTALLATION
FIBER OPTIC CABLE TEST SUMMARY

PROJECT:

CONTRACTOR:

DATE:

#	REEL ID	CABLE SCHEDULE LABEL	CABLE ID ACCORDING TO SPECIFICATIONS	LEN. (FT)	PASS - FAIL	#	REEL ID	CABLE SCHEDULE LABEL	CABLE ID ACCORDING TO SPECIFICATIONS	LEN. (FT)	PASS - FAIL
1						25					
2						26					
3						27					
4						28					
5						29					
6						30					
7						31					
8						32					
9						33					
10						34					
11						35					
12						36					
13						37					
14						38					
15						39					
16						40					
17						41					
18						42					
19						43					
20						44					
21						45					
22						46					
23						47					
24						48					

Note: One line per cable segment. Enter reel ID from On-the-Reel summary report.