Grand Canyon National Park, National Park Services (Federal)

GRCA 318719 North Rim Temporary Wastewater Treatment Plant

Construction Documents
Project Manual

100% Final

6/10/2026

HDR Project No. 10414450

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SEALS AND SIGNATURES

Owner Name: Grand Canyon National Park, National Park Services (Federal)
Project Name: GRCA 319719 North Rim Temporary Wastewater Treatment Plant
Engineer: HDR

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Engineer's seal and signature does not apply to the documents that comprise Division 00, Bidding and Contracting Requirements.

It is a violation of applicable laws and regulations governing professional licensing and registration for any person, unless acting under the direction of the licensed and registered design professional(s) indicated above, to alter in any way the Specifications in this project manual.

END OF SEALS AND SIGNATURES

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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. Work Under Other Contracts
4. Government-Furnished Materials
5. Contractor Use of Site
6. Public Use of Site
7. Occupancy Requirements for Buildings
8. Conduct of Operations
9. Work Restrictions
10. Special Construction Requirements
11. Soils Investigation Report
12. Additional Reports

1.2 WORK COVERED BY CONTRACT DOCUMENTS

A. Project Location: The project is generally located at Grand Canyon National Park on the North Rim. The project areas and associated project volumes are as follows:

1. North Rim: Temporary Wastewater Treatment Plant
    a. North Rim Developed District – Wastewater Treatment Plant. An administrative area located within the south-west corner of the developed district adjacent to the National Park Service North Rim Helibase.

B. The scope of work:

1. Treatment System and Supporting Site Work and Utilities
    1) The item consists of grading and utilities installation in support of 90,000gpd membrane wastewater treatment package system that includes: 1) Equalization tank with aeration and pumping system to MBR treatment units; 2) two MBR treatment units rated 45,000gpd per/unit with influent screening, chemical dosing and pumping system for disposal, lightening protection system, covered conditioned membrane basins for winterization of cartridges; 3) treated effluent break tank and ultraviolet (UV) disinfection system.
    2) MBR Treatment Units
        a) Wastewater treatment units, basis of design Cloacina MPAC-R Generation 3, enclosed and partially conditioned to allow for winterization in-place of membrane cartridges. Remote chemical feed system (conditioned storage containers), lightening protection system, custom exterior finish: performance criteria per treatment unit
            (1) Minimum Daily Flow (MIN): 9,000gpd, 6.3gpm
            (2) Maximum Daily Flow (MDF): 45,000gpd, 31.3gpm
    3) Site grading provides for an estimated 63cy of excess cut to be stockpiled onsite, concrete pads for EQ tank and two MBR treatment units with crushed rock finish

for remainder of the operational site within the fenceline. Security fencing with multiple access gates.

4) Utilities - Locate existing utilities for connection of new utilities to include:
   a) Water: Dedicated service lateral with RPZ backflow device and meter.
   b) Power: Dedicated power service to include a manual transfer switch for backup generator power, generator provided by others (NIC).
   c) Sanitary: Septage receiving manhole; mechanical screening auger; two package lift stations: 1) Influent Lift Station, 2) Filtrate Lift Station; and overflow laterals.

2. Conditioned Storage and Lab
   1) Two 40ft long shipping containers outfitted as conditioned space for chemical storage and injection system, spare parts, and winter storage of membrane treatment unit cartridges. Includes fully conditioned space (HVAC) for year-round (summer/winter) operations. The Hypochlorite and Caustic Rooms will have a dedicated split system and an electric unit heater to maintain the required space-temperature setpoint. An instant electric water heater will be provided to supply tepid water to the emergency shower fixtures. The Citric Room will have an electric unit heater for space heating and an instant electric water heater supplying tepid water to the emergency shower fixture in the room. Underground chemical piping from chemical storage to package units. Lighting and switch package. Shipping containers with be CSC certified and meet ISO 668.2020 and ISO 1496 standards.
   2) One approximately 50ft long mobile wastewater certified conditioned lab with water, sewer, and power connections.
3. Commissioning and Operations
   1) Commissioning: Responsible for coordination with Arizona Department of Environmental Quality (ADEQ) for start-up and commissioning for approval to operate, issued by ADEQ.
   2) Operations: Provide licensed Arizona Grade 3 Wastewater Treatment Contract Operator for commissioning and operations of the wastewater treatment plant for six (6) months to include winterization and shut down of the plant in November; housing provided at no cost on the North Rim (less than ten minutes' drive from the wastewater treatment plant). Duty schedule includes 40 hours per week for a five day week to include one weekend day. The onsite utilities operator will shadow the operator for part of the week and operate the system under the direction of the contract operator the two days off for the contract operator.
4. Tank Pumping and Biosolids Removal: Pump and dispose off-site at end of first operating season:
   1) EQ Tank: Pump the equalization tank at the end of the first operating season, estimated 20,000 gallons.
   2) Two MBR Treatment Units: Pump the primary treatment unit tank at the end of the first operating season, estimated 53,100 gallons.
   3) Lift station pumping: Influent Lift Station and Filtrate Lift Station, estimated 5,000 gallons.
   4) Biosolids Removal: Removal of estimate 17,400 gallons of biosolids from wastewater treatment drying beds.

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

D. The Government has selected the following products and services as the basis of design for the package membrane treatment units

Cloacina – Portable Treatment Unit, 25MR50, Generation 3

Cloacina – Portable Equalization Tank with Integrated Pumping System, EQ-R IF70

1.3 WORK PHASES

A. The Work shall be conducted with the following phasing approach for permit authority ADEQ approval to operate the Temp WWTP no later than June 1, 2027.

1. Site Work and Utilities
   a. Site work and utilities connection to existing utilities, underground installation to membrane treatment site must be completed prior to mobilization of the membrane treatment units, conditioned storage units, and mobile lab.
2. Mobilization of Membrane Treatment Package Units, EQ Tank, Storage Containers, and lab
   a. Mobilization of the membrane treatment package units and storage containers must be coordinated with site access for delivery and set up.
3. Startup and Commissioning
   a. All utilities installed and connected to treatment system, storage containers, and lab.
4. Security Fencing
   a. Security fencing must be installed post-commissioning of the system.
5. Tank Pumping and Biosolids Removal
   a. End of first operating season before demobilization.

B. Tree removal shall occur between September 1 and March 31 to avoid bird nesting. Work outside this window may be requested and will require a NPS wildlife bird biologist to perform a nest survey. Surveys shall be conducted no more than five days prior to scheduled activity. If active nests or breeding behavior are detected during these surveys, no vegetation removal activities should be conducted until nestlings have fledged or the nest fails or breeding behaviors are no longer observed.

1.4 WORK UNDER OTHER CONTRACTS

A. General: Cooperate with separate contractors so work on those contracts may be carried out smoothly, without interfering with or delaying work under this Contract. Coordinate Work of this Contract with work performed under separate contracts.

B. Concurrent Work: Government has awarded separate contract(s) for the following construction operations at Project site. Those construction operations potentially will occur simultaneously with portions of work under this Contract.

1. Fire Recovery Operations: Hazard tree and debris removal from fire recovery operations on the North Rim and around the WWTP; estimated period of performance April 2026 thru November 2028.

2. Rehabilitation of water, power, wastewater infrastructure damaged in fire; estimated period of performance May 2026 thru November 2026.

3. GRCA 318719 Rehabilitation of North Rim Infrastructure (LRF): Rehabilitation of the North Rim and Inner-Canyon water and power system, estimated period of performance June 2027 thru November 2030.

4. Replacement of SR67 from Gate to NR lodge: The construction approach for the SR 67 project has identified the need for a temporary asphalt batch plant with a preliminary location being identified as Marble Flats; estimated period of performance June 2027 thru November 2028.

1.5 CONTRACTOR USE OF SITE

A. Limits of Construction (LOC): Contractor shall have limited use of site for construction operations.

1. Limit use of premises to areas within the Limits of Construction indicated on drawings. Do not disturb portions of the site beyond these areas. The Contractor shall clearly delineate the boundary of the Limits of Construction (LOC) prior to commencing work using fencing, flagging or other approved methods. Delineation shall be maintained for the duration of construction and shall correspond to the LOC shown on the drawings. Erosion and sediment control features (silt fence, wattles, etc) may be used to satisfy this requirement where they are installed at the LOC boundary.

2. Contractor may request deviations from the Limits of Construction but approval is not guaranteed. Generally, the approval process once all information has been provided is up to 90 days or longer if outside agency coordination is required.

B. Equipment and Material Staging: Confine storage of materials to staging areas shown on plans.

1. Equipment and material staging areas are intended for deliveries and storage of tools and equipment, material stockpiling, construction equipment parking, construction vehicle parking, construction administration trailers, and similar.

2. Confine stockpiling to equipment and material staging areas. Small stockpiles within limits of construction for use in localized trenching work is acceptable.

3. Areas within the limits of construction that are not designated for equipment and material staging shall not be used for this purpose.

4. Equipment and material staging areas should not be used for construction camps including camping units, trailer complexes for living areas, private vehicle parking, and similar.

C. Parking:

1. Private vehicles for construction personnel shall be parked at designated construction camps or outside the Park.

2. Parking for marked construction vehicles shall be limited to the following areas between April 15 and November 30 (visitor season):

a. WWTP RV sites or inside the fenceline

D. Preservation of Natural and Manmade Features:

1. Prevent damage to natural surroundings. Restore damaged areas, repairing or replacing damaged trees and plants with like species, at no additional expense to the Government.

2. Provide temporary barriers to protect existing trees and plants and root zones.

3. Provide temporary construction protection mats for all areas where construction may impact a wetland. All areas that are disturbed must be restored per Specification 01 35 05.

4. Do not remove, injure, or destroy trees or other plants without prior approval. Consult with Contracting Officer (CO) and remove agreed-on roots and branches that interfere with

construction. Contractor shall follow Grand Canyon vegetation guidelines related to pruning and root cutting.

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.

E. Driveways and Entrances: Keep driveways, trails, and entrances serving NPS and concessionaire premises clear and available to Government employees, and emergency vehicles at all times.

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.

F. Construction Camp: Establishment of a camp will be permitted at WWTP, as shown on drawings and specified in 01 73 60 “Construction Camps”. Provide utilities as specified in Section 01 50 00 "Temporary Facilities and Controls". Adhere to park rules, animal deterrent policies, cleanliness policies, and return site to previous condition at completion of work.

G. 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 Contractor of liability for damage which may result from moving of equipment.

1. State Route 67 is heavily used for visitor traffic and park operations. Contractor shall not impede flow of traffic for equipment and material deliveries at any time, unless otherwise approved by the Contracting Officer.

2. Contractor shall use the North Rim park entrance gate. Contractor personnel providing identification of employment with the Contractor or in a marked vehicle are not required to pay Park entrance fees. Contractor shall not use other entrance roads into the Park.

H. State Route 67 Restrictions: Contractor shall identify jurisdictions, load restrictions, permit requirements, time and calendar restrictions as required for use of State Route 67. Contractor shall be responsible for obtaining any permits with Arizona Department of Transportation and Coconino County as required.

1.6 PUBLIC USE OF SITE

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

B. Road restrictions (one lane must be passable with traffic control) may be permitted, when required, upon specific approval of Contracting Officer for a maximum of 8 hours within a single day; within park boundaries.

C. The North Rim District will be closed or limited access to visitors due to limited utilities available to the North Rim District during post fire recovery operations. Those conditions will change over time and it is unknown the exact number of visitor services that will be active during construction activities of this contract. The WWTP location is administrative and thus expects minimal impact to construction activities under this contract as visitor services change to the district.

1.7 OCCUPANCY REQUIRMENTS 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.

2. 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.

1.8 CONDUCT OF OPERATIONS

A. 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.

B. 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.

1.9 WORK RESTRICTIONS

A. On-Site Work Hours:

1. North Rim: Work on the North Rim shall be generally performed during the hours of 6 a.m. to 6 p.m., Monday through Friday.
2. Night Work Hours: Work outside established work hours can be requested by contractor.

B. Work on Federal holidays may not be performed without prior consent from the CO. Submit requests 5 business days in advance of the work to the CO for approval.

C. Existing Utilities

1. Utility Locating:
   a. Notify Contracting Officer and utility companies of proposed locations and times for excavation. NPS will not be responsible for clearance or locating NPS owned utilities. Contractor shall utilize a third party locator and potholing services as required to clear utilities prior to excavation.
   b. Contractor shall be responsible for locating and preventing damage to known utilities. If damage occurs, repair utility at no additional expense to the Government.
   c. If damage occurs to an unknown utility, repair utility. An equitable adjustment will be made in accordance with the Changes clause of the contract.

2. Maintenance of Utility Operations
   a. North Rim Wastewater Collections and Treatment
      1) North Rim wastewater collections and treatment shall remain operational between April 1 and October 31 each year.

3. Existing Utility Interruptions:

a. 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:
b. Notify Contracting Officer not less than fourteen (14) days in advance of proposed utility interruptions.
c. Do not proceed with utility interruptions without Contracting Officer's written permission.
d. Hours and length of Utility Shutdowns: 8 hours.

D. Nonsmoking Building/Tobacco Use/Vaping: Smoking is not permitted within building or within 25 feet of entrances, operable windows, or outdoor air intakes.

1. Smoking is not permitted in buildings.
2. Due to concern of wildland fires, smoking is allowed only in a single designated outside area of no larger than 500 sf within designated construction staging areas. This area shall be clear of exposed vegetation and have adequate means for disposal of trash and flammable materials.

1.10 SPECIAL CONSTRUCTION REQUIREMENTS

A. Project Website: A project website administered by NPS will be used for purposes of managing communication and documents during construction stage.

1. See Section 01 31 00 "Project Management and Coordination" for requirements on using Project Website.

B. The North Rim has a seasonal shutdown of visitor services that varies each year. Typically the shutdown to overnight visitors begins on October 15 and the shutdown to day visitors begins on November 30. The North Rim typically reopens to visitor services on or around May 15.

C. Vehicle traffic is often impassable due to snow accumulation and other weather events on State Route 67 from Jacob Lake to the North Rim Lodge and on other North Rim roadways from the first Monday of the first full week in December (December 7, 2026) through- April 1.

D. Hazardous Materials: Work is in proximity to damaged structures from the Dragon Bravo Wildfire and contractor shall take reasonable action to reduce risk to employees while executing scope of work in this contract.

E. The Contractor shall not construct permanent structures or install permanent utilities at staging areas or Contractor camps unless specifically shown in the Contract Documents or authorized in writing by the Contracting Officer. Any proposal for permanent structures or utilities at these locations must be submitted to the Contracting Officer for review and acceptance prior to construction.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 11 00

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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: 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):

1. Rent
2. Utilities
3. Furnishings
4. Office equipment
5. Executive and management staff not exclusively assigned to the project
6. Support, accounting, and administrative staff
7. Preparation of cost proposals, estimating, and schedule analyses connected with Modifications
8. Estimating and preconstruction services
9. Mortgage costs
10. Real estate and corporate taxes
11. Automobile maintenance and travel costs for home office personnel
12. Home office insurances i.e. structure, automotive, umbrella, flood, etc.
13. Depreciation of equipment and other assets
14. Home office supplies (paper, staples, etc.)
15. Legal services
16. Accounting and data processing
17. Professional fees/registration

B. General Conditions (Field Office Overhead): 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:

1. Project Manager (PM), Assistant Project Manager
2. Superintendent, Assistant Superintendent

3. Quality Control, Safety Officer, Environmental Manager, etc.
4. Engineers
5. Travel, lodging, and per diem (as established by Federal Travel Regulations)
6. Scheduling
7. Field Office Trailers and associated temporary utilities
8. Field office supplies
    a. Mailing and couriers
    b. Reproduction costs
    c. Storage
    d. Phones
    e. Computers
    f. Copiers
    g. Construction camp supplies.
9. Personal vehicles i.e. Superintendent Pickup trucks

C. General Requirements: 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:

1. Hoisting
2. Material handling
3. Temporary fencing
4. Port-a-lets
5. Trash removal, dumpsters
6. Barricades
7. Small tools
8. Safety supplies
9. Scaffolding
10. Daily cleaning
11. Traffic control
12. Temporary signage
13. Temporary 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 maximum 60-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: 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:

1) Social Security
2) Medicare
3) Workers Compensation – Policy and company calculation to be made available.
4) Federal Unemployment Tax Act (FUTA) - Cap Rate and percentage to be proportionally allocated over one year.
5) State Unemployment Tax Act (SUTA) - Cap Rate and percentage to be proportionally allocated over one year.
6) Union agreement costs - Other costs required under an enforceable collective bargaining agreement.

c. Fringe Benefits: Various non-wage compensations provided to employees such as:
1) Health Care Insurance Premiums
2) Cell Phone
3) Clothing
4) 401K and Pensions
5) Vehicle allowances
6) Gas allowance
7) Life insurance premiums
8) Disability insurance
9) 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. 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, 2, 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 five 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 five 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 31which 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:

Overhead……10%
Profit……8.00%

2. Total aggregate limit of markup (OH&P) for Contractor and Subcontractors on modification work shall not exceed 25%. 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

PART 3 - EXECUTION

END OF SECTION 01 26 01

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 (CLIN).

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

C. Contract Line Item costs shall be developed such that individual Work Item prices, as defined in Section 3.1, can be determined by the Contracting Officer.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 LIST OF CONTRACT LINE ITEMS

A. Contract Line Item Number 1 (CLIN 1): Site Work, Utilities, Septage Receiving, Screening, Influent Lift Station, Filtrate Lift Station

1. This item consists of Work shown in drawings.
   a. Utilities installation in support of the whole wastewater treatment system. Work includes power, water, sewer utilities, two lift stations (influent and filtrate), septage receiving manhole, mechanical screening, and finished effluent manhole.
   b. All site grading, concrete pads, crushed rock, and security fence.
2. Measurement for payment will be in percentage complete.
3. Payment will be made at the contract lump sum price.

B. Contract Line Item Number 2 (CLIN 2): Two Storage Containers and Mobile Wastewater Lab

1. This item consists of Work shown in drawings
   a. The item consists of two conditioned storage units and mobile lab, includes all equipment and interior mechanical systems. Exterior work within two feet of the units included; beyond two feet is part of CLIN 1 site utilities.
2. Measurement for payment will be in percentage complete.
3. Payment will be made at the contract lump sum price.

C. Contract Line Item Number 3 (CLIN 3): Membrane Package Treatment System with EQ and UV Disinfection System

1. This item consists of Work shown in drawings.

   a. Complete Integrated System Includes: 1) Equalization tank with aeration and pumping system to MBR treatment units; 2) Two (2) MBR treatment units rated 45,000gpd per/unit with influent screening, chemical dosing and pumping system for disposal, lightening protection system, covered conditioned membrane basins for

winterization of cartridges; 3) Treated effluent break tank and ultraviolet (UV) disinfection system.

b. MBR Treatment Units

1) Wastewater treatment unit, basis of design Cloacina MPAC-R Generation 3, enclosed and partially conditioned to allow for winterization in-place of membrane cartridges. Remote chemical feed system (conditioned storage containers), lightening protection system, custom exterior finish with insulation package: performance criteria per unit

2) Minimum Daily Flow (MIN): 9,000gpd, 6.3gpm

3) Maximum Daily Flow (MDF): 45,000gpd, 31.3gpm

c. Spare parts package per manufactures recommendation, two year parts package.

2. Measurement for payment will be in percentage complete.
3. Payment will be made at the contract lump sum price.

D. Contract Line Item Number 4 (CLIN 4): Startup, Commissioning, Operate, Winter Shut Down

1. This item consists of Work shown in drawings.
   a. Startup and Commissioning: Responsible for coordination with Arizona Department of Environmental Quality (ADEQ) for start-up and commissioning for approval to operate, issued by ADEQ.
   b. Operations: Provide licensed Arizona Grade 3 Wastewater Treatment Operator for commissioning and operations of the wastewater treatment plant for six months to include winterization and shut down of the plant in November; housing provided at no cost on the North Rim (less than ten minutes' drive from the wastewater treatment plant).
   c. Provide all chemicals and durables for six month operating season.
2. Measurement for payment will be in percentage complete.
3. Payment will be made at the contract lump sum price.

E. Contract Line Item Number 5 (CLIN 5): End Season Pumping and Off-Site Haul Off Disposal

1. This item consists of tank pumping and biosolids removal: Pump and dispose off-site at end of first operating season:
   a. EQ Tank: Pump the equalization tank at the end of the first operating season, estimated 20,000 gallons.
   b. One MBR Treatment Units: Pump the primary treatment unit tank at the end of the first operating season, estimated 26,550 gallons.
   c. Lift station pumping: Influent Lift Station and Filtrate Lift Station, estimated 5,000 gallons.
   d. Biosolids Removal: Removal of estimate 17,400 gallons of biosolids from wastewater treatment drying beds.
2. Measurement for payment will be in percentage complete.
3. Payment will be made at the contract lump sum price.

END OF SECTION 01 27 00

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. Project Website
7. Project Meetings
8. Environmental Coordination
9. Permits

B. Related Requirements:

1. Section 01 32 16 "Construction Schedule" for preparing and submitting Contractor's construction schedule.
2. Section 01 35 05 "Environmental Protection and Special Controls" for coordinating environmental requirements of the Contract.
3. Section 01 73 40 "Execution" for procedures for coordinating general installation and field-engineering services, including establishment of benchmarks and control points.
4. Section 01 75 10 "Checkout and Start-up Procedures for Wastewater Treatment Facilities" for coordinating start-up requires at the North Rim WTP and related facilities.
5. Section 01 77 00 "Closeout Procedures" for coordinating closeout of the Contract.
6. Section 01 79 00 "Demonstration and Training" for coordinating training requirements for Government staff on new equipment.

1.2 DEFINITIONS

A. Agency with Jurisdiction: An Agency that has been granted legal authority over a location, action, or resource. This authority includes the ability to issue a permit or other legal permission document.

B. Construction Permits – Contractor Provided: Permits obtained by the Contractor based on the means and methods to conduct the work. Construction Permits are typically issued by the Agency to the Contractor and not to the National Park Service. Examples of typical Contractor Provided Permits are: National Pollutant Discharge Elimination System (NPDES) Construction Permit (ground disturbance), dewatering permit, permit for work in a roadway (with traffic management plan), temporary utility tap permit, etc.

C. Government Furnished Permits: Obtained by NPS, usually through the Architect/Engineer (A/E), during the design process and are usually concerned with impacts to resources protected by federal law. However, GF permits can include other permits that are obtained for the convenience of the Government during design. GF permits are "furnished" to the Contractor in the Request for Proposal (RFP) and as part of the final contract documents. The Contractor must comply with GF permit provisions.

1.3 CONSTRUCTION COORDINATION

A. Coordination: Coordinate construction operations included in different Sections of 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 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: Coordinate scheduling and timing of required administrative procedures with other construction activities and activities of other contractors to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to:

1. Preparation of Contractor's Construction Schedule
2. Preparation of the Schedule of Values
3. Installation and removal of temporary facilities and controls
4. Delivery and processing of submittals
5. Progress meetings
6. Permit requirements
7. Pre-installation conferences
8. Project closeout activities
9. 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: 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:

a. Indicate functional and spatial relationships of components of architectural, structural, civil, mechanical, and electrical systems.
b. Indicate dimensions shown on Contract 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.

c. Indicate space requirements for routine maintenance and anticipated replacement of components during the life of the installation.
d. Show location and size of access doors required for access to concealed dampers, valves, and controls.
e. 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: Organize coordination drawings as follows:

1. 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.
2. 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 Drawings. Indicate areas of conflict between light fixtures and other components.
3. Mechanical Rooms: Provide coordination drawings for mechanical rooms showing plans and elevations of mechanical, plumbing, fire-protection, fire-alarm, and electrical equipment.
4. Structural Penetrations: Indicate penetrations and openings required for all disciplines.
5. 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.
6. Mechanical and Plumbing Work:

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

7. Electrical Work:

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

8. Fire-Protection System:

a. Locations of standpipes, mains piping, branch lines, pipe drops, and sprinkler heads.

9. Review: Contracting Officer will review coordination drawings to confirm Work is being coordinated; details of coordination are Contractor's responsibility. If Contracting Officer determines coordination drawings are not prepared in scope or detail, or are otherwise

deficient, Contracting Officer will inform Contractor, who shall make changes and resubmit.

C. Coordination Digital Data Files: Prepare coordination digital data files according to:
   1. File Submittal Format:
      a. AutoCad.dwg, Version 2018, operating in Microsoft Windows operating system
      b. Submit or post coordination drawing files using Portable Document Format (PDF) file format.
   2. Contracting Officer will furnish Contractor one set of digital data files (AutoCad.dwg) of Drawings for use in preparing coordination digital data files.

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

D. Division 1 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 (SWPP or UPPP)
   11. Contractors Commissioning Plan
   12. 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 one month 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 Contractor and all Subcontractors.

1.5 REQUESTS FOR INFORMATION (RFIs)

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

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

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

1. RFI number, numbered sequentially
2. Date
3. RFI subject
4. Specification Section number and title and related paragraphs, as appropriate.
5. Drawing number and detail references, as appropriate.
6. Field dimensions and conditions, as appropriate.
7. Contractor's suggested resolution: If Contractor's suggested resolution impacts Contract Time or Contract Sum, Contractor shall state impact in RFI.
8. Contractor's signature
9. Requested date for response
10. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.

    a. 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 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 WEB SITE

A. Use website based construction management software, provided by the NPS or their Construction Management Representative (CMR) designee, for communication throughout 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. Drawing and specification document hosting, viewing, and updating
12. Online document collaboration
13. Reminder and tracking functions
14. Archiving functions
15. Notification of submittal and RFI statuses and current responsible party
16. Permits and addendums

B. Some documents are not suitable to be shared using the construction management software website. Documents containing Personal Identifying Information (PII) (i.e. certified payrolls), cybersecurity related access, or similar shall not be shared using construction management software website and shall be coordinated with the Project team as appropriate.

1.7 PROJECT MEETINGS

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

1. Roles & Responsibilities / Lines of Authority
2. Park rules and regulations
3. Jobsite Safety
4. Resolution of comments on required Division 1 documents
5. Coordination of Subcontractors
6. Labor law application
7. Modifications
8. Payments to Contractor
9. Payroll reports
10. Contract time
11. Liquidated damages
12. Contractor Performance Evaluation
13. Display of Hotline posters
14. Notice to proceed
15. Correspondence procedures
16. NPS/DSC Project website
17. Acceptance/rejection of work
18. Progress meetings
19. Submittal procedures
20. NPS Final Accessibility Inspection
21. Environmental requirements
22. Permit requirements
23. As-constructed drawings/operation and maintenance (O&M) manuals.
24. Saturday, Sunday, holiday and night work.
25. Reference materials
26. Value engineering
27. Schedule of Values

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

1. Attendees: In addition to Government Representatives, each 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: Review and correct or approve minutes of previous progress meeting. Review other items of significance that could affect progress. Meeting agenda will include:

    a. Approval of minutes of previous meetings
    b. Submittal status
    c. Review of off-site fabrication and delivery schedules.
    d. Requests for information (RFI) and other issues.
    e. Modifications
    f. Work in progress and projected.
        1) Status of required inspections (Special Inspections, Accessibility, etc.)
    g. Inspections of work in progress and projected (Special inspections, Accessibility, etc.)
    h. Construction Schedule update (provide updated Critical Path Method (CPM)).
    i. Status of Project Record Drawings and O&M manuals.
    j. Other business relating to work.
    k. 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: Review progress of other construction activities and preparations for particular activity under consideration, including requirements for:

    a. Contract Documents
    b. Options
    c. Related RFIs
    d. Related Change Orders
    e. Purchases
    f. Deliveries
    g. Submittals
    h. Review of mockups
    i. Possible conflicts
    j. Compatibility requirements
    k. Time schedules
    l. Weather limitations
    m. Manufacturer's written instructions
    n. Warranty requirements
    o. Compatibility of materials
    p. Acceptability of substrates
    q. Temporary facilities and controls
    r. Space and access limitations
    s. Regulations of agency(ies) with jurisdiction
    t. Testing and inspecting requirements
    u. Installation procedures
    v. Coordination with other work
    w. Required performance results
    x. Protection of adjacent work
    y. 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. Contractor's Environmental Manager: Designate on-site party responsible for overseeing 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; familiar with environmental regulations applicable to construction operations.

2. Responsibilities: Responsibilities shall include:

a. Compliance with applicable Federal, State, and local environmental regulations, including maintaining required documentation.
b. Implementation of Waste Management Plan (WMP).
c. Implementation of Storm Water Pollution Prevention Plan (SWPPP).
d. Present overview of environmental issues and summarize site specific procedures relating to management plans at Preconstruction conference.
e. Training for Contractor personnel in accordance with position requirements.
f. Monitoring and documentation of environmental procedures.

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

1. Quality Requirements
2. Regulatory Requirements
3. Noise and Acoustics Management
4. Temporary Storm Water Pollution Prevention Environnemental Management
5. Construction Waste Management

C. Contractor's Environmental Training Program: Contractor shall provide environmental training for workers performing work on project site. Training shall include:

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:

a. Construction Waste Management
b. Noise and Acoustics Management
c. Temporary Storm Water Pollution Prevention

4. Pollution Prevention (P2) practices: Submit evidence of participation in P2 programs illustrating familiarity with P2 practices.
5. Compliance with environmental regulations: As specified in Regulatory Requirements. Submit 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: 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. Contractor shall also be responsible for damages to persons or property that occur as a result of 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, Contractor will not be considered an agent of the Government. Contractor shall comply with appropriate Federal, State and local laws.

B. Government Furnished Permits: During development of the project's design, permits listed below were negotiated and agreed to by the Government. Terms and provisions of these permits shall be adhered to for the duration specified in each permit.

1. Arizona Department of Environmental Quality (ADEQ)
    a. Aquifer Protection Permit (APP)
        1) North Rim Wastewater Treatment
    b. Arizona Pollutant Discharge Elimination System (AZPDES) Permit
        1) North Rim Wastewater Treatment

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 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 Contractors' responsibility to determine means and methods and obtain required permits. Contractor shall obtain all permits required to legally conduct work.

1. Arizona Department of Transportation
    a. Class A or C Oversize/Overweight Permit
2. Arizona Department of Environmental Quality
    a. AZPDES Construction Activity General Permit (CGP) for Stormwater with accompanying SWPPP
3. Garkane Energy
    a. Notice of Intent for temporary utilities

D. Coordination with Agency(ies) with Jurisdiction Issuing Permits

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

E. 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 construction management software website when permits are obtained.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 00

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.

B. Purpose: The Construction Schedule ensures adequate planning, coordination, scheduling, and reporting during execution of the work by the Contractor. It shall assist the Contractor and Contracting Officer (CO) in monitoring the progress of the work, evaluating proposed changes, and processing 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 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/DSC management software website in native electronic file formats. 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 2 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 3 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 2 paper copies of a Time Impact Analysis. Incorporate a Fragmentary Network (Fragnet) into currently accepted Construction Schedule that demonstrating how Contractor proposes to incorporate a modification, change, delay, or Contractor request.

1.4 QUALITY ASSURANCE

A. 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 work stages, area separations, interim milestones, and partial Government occupancy/substantial completions.
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. 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 5 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 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 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 a Draft Construction Baseline Schedule with a focused view of the first 120-days of construction within 15 days after date established for the Notice of Award.

2. Develop and finalize Construction Baseline Schedule so it can be accepted for use no later than 45 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 Contractor from completing work within applicable completion dates, regardless of Governments acceptance of schedule.

3. 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 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. Contractor shall limit use of lead or lag duration's between schedule activities.
d. Project Calendars: Develop and incorporate the following calendars:

1) 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.).
2) 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 work days in work week.
3) 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 requiring a cycle of more than 60 calendar days and including major items listed below as separate activities in the schedule. Procurement cycle activities can include submittals, approvals, purchasing, fabrication, and delivery.
1) Wastewater - Membrane Wastewater Treatment Package Unit
2) Electrical – Transformer
3) General - Storage Container

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 30 days for startup and testing and commissioning activities.
i. Substantial Completion: Allow time for Government administrative procedures necessary for certification of Substantial Completion. (For more information, refer to Specification 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 construction season.
b. Work Restrictions: Show effect of the following on the schedule:

1) Coordination with existing operations
2) Limitations of continued occupancies
3) Uninterruptible visitor services
4) Partial occupancy before Substantial Completion
5) Use of premises restrictions
6) Provisions for future construction
7) Seasonal variations and associated weather related access to the site
8) Environmental control
9) Permit provisions

c. Other Constraints:
   1) Endangered Species, migration, and nesting activities identified in the NEPA documents.
   2) Tree removal can only occur from September 1 to March 31.

d. 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) Building flush-out.
   13) Building commissioning activities.

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

C. Joint Review, Revision, and Acceptance:

1. Within seven calendar days of receiving Contractor's proposed Construction Baseline Schedule, Contracting Officer shall review initial Construction Baseline Schedule.
2. Within seven calendar days after review, Contractor shall revise and resubmit Construction Baseline Schedule in accordance with comments presented from review.
3. In the event the 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 Contractor or Contracting Officer, shall be corrected by Contractor within seven 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 Contractor's monthly applications for payment based upon information developed at monthly Construction Schedule update meeting.

D. Cost Correlation/Cost Loaded Schedule: Within 45-days of acceptance of the Construction Baseline Schedule, submit a Cost Loaded Schedule. In the heading of the Construction Baseline 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. 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 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. Use Microsoft Project or Primavera, for Windows 7 and newer.

PART 3 - EXECUTION

3.1 CONSTRUCTION SCHEDULE UPDATES

A. Progress Meeting Updates: Provide a 4 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: 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: Concurrent schedule revisions, prepare tabulated reports showing:

    a. Identification of activities that have changed
    b. Changes in early and late start dates
    c. Changes in early and late finish dates
    d. Changes in activity durations in workdays
    e. Changes in the critical path
    f. Changes in total float or slack time
    g. 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 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 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 Contractor shall submit, a revision to the Construction Schedule. Contractor may also request reasonable revisions to currently accepted Construction Schedule in event the Contractor's planning for the work is revised. If Contractor desires to make changes, 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, 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 Contractor, who shall respond in writing within seven calendar days.
3. Reports: Concurrent with making revisions to schedule, prepare tabulated reports showing:

a. Identification of activities changed
b. Changes in early and late start dates
c. Changes in early and late finish dates
d. Changes in activity durations in workdays
e. Changes in critical path
f. Changes in total float or slack time

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

1. Requirements: When contract modifications or changes are initiated, delays experienced, or Contractor desires to revise currently accepted Construction Schedule, Contractor shall submit to Contracting Officer a written time impact analysis illustrating the influence of modification, change, delay, or Contractor request on contract time.
2. 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 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.

3. 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.
4. 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 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 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.
5. 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 01 32 16

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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: Submit images electronically within 7 days of taking the image. Include:

1. Date, time and number (sequentially number all images) in filename.
2. Description of vantage point, indicating location, direction (by compass point), and elevation or story of construction.
3. 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 on Digital Video Disc (DVD).

1. Provide index as separate file on Disc. 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. Media: DVD-R Archival Gold

B. Media Labels: Archival DVD labeling markers, archival labels, or direct print.

C. Images: Provide sRGB color images in JPEG format. Minimum sensor size of 8 megapixels, and at an image resolution of not less than 3,200 by 2,400 pixels.

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 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 twenty separate images for each reference to show existing conditions before starting Work.
    a. Locations
        1) Lindberg Hill construction camp (20)
        2) Lindberg Hill access (10)
        3) WWTP construction camp (20)
        4) WWTP staging/construction LOCs (40)

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

D. 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.

E. Use of Unmanned Aerial Vehicles (UAVs) / drones for imagery or other purposes is prohibited.

END OF SECTION 01 32 33

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

C. 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.

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 in drawings. Types of submittals are indicated in individual specific sections.

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 Specification 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 time for submittal review, including time for re-submittals, as follows. Time for review shall commence when e-mail notification is received by Contracting Officer (or designee) indicating submittal has been posted on NPS management software website and is ready for review. When Contracting Officer has completed review, e-mail notification will be sent to Contractor indicating submittal has been processed. No extension of Contract Time will be authorized because of failure to transmit submittals in advance of Work to permit processing, including re-submittals.

1. Action Submittals

    a. Initial Review: Allow 14 days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required.
    b. Re-submittal Review: Allow 7 days for review of each re-submittal.

2. Informational submittals

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

3. Requests for Information (RFI)
    a. Initial Review: Allow 14 days for initial review of each RFI. Allow additional time if coordination with subsequent RFI is required.
    b. Re-submittal RFI Review: Allow 7 days for review of each RFI re-submittal.

E. Approved Equals:

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

    a. Drawings and samples as appropriate.
    b. Comparison of the 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 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. Electronic Submittals: Identify and incorporate information in each electronic submittal file as follows:

1. Transmittal Form (CM-16): All submittals shall be transmitted using National Park Service Transmittal Form (CM-16). The form can be downloaded from the DSC Workflows website's Submittal Review page and completed on the NPS/DSC

management software website. No action will be taken on a submittal item unless accompanied by this Transmittal Form.

a. Complete the general information at the top of form.
b. Provide all required information based on submittal type
c. Attach all related documents.
d. Sign the Contractor section at bottom of the Transmittal Form (CM-16).

2. Physical samples: Complete Transmittal Form (CM-16) on the NPS/DSC management software website as described above. Deliver physical sample to the Contracting Officer (or designee) on site for processing. All comments and actions will be documented on the Transmittal Form (CM-16) on the NPS/DSC management software website.

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

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

H. Re-submittals: Make re-submittals 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. Re-submit 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" 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 CONTRACTOR'S USE OF CAD/BIM FILES

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

1. Files provided as is; no format or other changes to files or changes to objects in the drawing will be done by the Government

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 , unless submittal of CAD/BIM Drawings is otherwise permitted.

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

a. Dimensions
b. Identification of products
c. Fabrication and installation drawings
d. Roughing-in and setting diagrams
e. Wiring diagrams showing field-installed wiring, including power, signal, and control wiring
f. Shopwork manufacturing instructions
g. Templates and patterns
h. Schedules
i. Notation of coordination requirements
j. Notation of dimensions established by field measurement
k. Relationship to adjoining construction clearly indicated
l. Seal and signature of professional engineer if specified
m. 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/DSC management software website for processing and documentation of action on submitted samples.
3. Identification: Attach label on unexposed side of Samples that includes:

a. Generic description of Sample
b. Product name and name of manufacturer
c. Sample source
d. 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: 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.

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

D. Construction Materials: Contractor is encouraged to submit products made out of recycled or environmentally responsible material. Every effort will be made by National Park Service 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 management software website.
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. 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: 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: Prepare written information documenting factory-authorized service representative's tests and inspections. As applicable, include:

1. Statement on condition of substrates and their acceptability for installation of product.
2. Summary of installation procedures being followed, compliance with requirements and, if not, what corrective action was taken.
3. 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 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 Contractor's approval.

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

B. Action Submittals: 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:

1. APPROVED: Acceptable with no corrections.

2. APPROVED WITH NOTATIONS: Minor corrections or clarifications required. Comments are clear and no further review is required. Contractor shall address review comments when proceeding with the work.
3. DISAPPROVED - RESUBMIT: Rejected as not in accordance with the contract or as requiring major corrections or clarifications. Contracting Officer will identify reasons for disapproval. 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.

END OF SECTION 01 33 23

SUBMITTAL LIST

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SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND	OTHER
01 11 00	1.8	SUMMARY OF WORK								
01 11 00	1.8	Communications Equipment Plan - Sattellite Communications		X						
01 31 00	1.4	DIVISION 01 DOCUMENTS								
01 31 00	1.4	Letter designating Project Superintendent				X				
01 31 00	1.4	Construction Schedule				X				
01 31 00	1.4	Schedule of Values				X				
01 31 00	1.4	Accident Prevention Plan				X				
01 31 00	1.4	List of Subcontractors				X				
01 31 00	1.4	Written Statement certifying compliance with labor standards	X							
01 31 00	1.4	Evidence of liability insurance	X							
01 31 00	1.4	Waste Management Plan				X				
01 31 00	1.4	Quality Control Plan				X				
01 31 00	1.4	Temporary Storm Water Pollution Prevention Plan (SWPP or UPPP)				X				
01 31 00	1.4	Contractors Commissioning Plan				X				
01 31 00	1.4	List of required Construction Permits				X				
01 32 16	1.3	CONSTRUCTION SCHEDULE				X				
01 32 33	1.3	Construction and Close Out Images								X
01 35 05	1.3	ENVIRONMENTAL PROTECTION AND SPECIAL								
01 35 05	1.3	Spill Prevention Plan		X						
01 35 05	1.3	Rehabiliation Plan		X		X				
01 35 10	1.3	TEMPORARY WASTEWATER TREATMENT MANAGEMENT PLAN	X	X						
01 35 13.22	1.3	Daily Work Schedule		X						
01 35 15	1.3	DISCHARGE EMERGENCY RESPONSE PLAN		X						
01 35 23	1.2	ACCIDENT PREVENTION PLAN (APP)		X						
01 35 73	1.3	DELEGATED DESIGN PROCEDURES				X				
01 35 91	1.3	HISTORIC PRESERVATION TREATMENT PROCEDURES								

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01 35 91	1.3	Historic Preservation Treatment Plan		X						
01 35 91	1.3	Photographs or Videotape				X				X
01 40 00	1.4	QUALITY CONTROL PLAN		X						
01 40 00	1.4	Qualification Data	X	X						
01 40 00	1.4	Daily Reports		X						
01 40 00	1.4	Test Reports	X	X						
01 40 00	1.4	Accessibility Inspection Report		X						
01 40 00	1.4	Off-Site Inspection Reports	X	X						
01 40 00	1.4	Permits, Licences, Certificates	X			X				
01 40 00.A-1	1.4	STATEMENT OF STRUCTURAL TESTS AND SPECIAL	X							
01 50 00	1.3	TEMPORARY FACILITIES AND CONTROLS								
01 50 00	2.3	Office Trailer Plan		X						
01 50 00	3.3	Traffic Control Plan & Signage Plan		X						
01 50 00	3.3	Dewatering Plan		X						
01 57 23	3.2	SWPPP NPDES Permit (Incluedes NOI: Notice of Intent, NOT: Notice of Termination)		X						
01 57 23	3.3	Temporary Storm Water Pollution Prevention Plan (Inspection Schedule, Products)		X						
01 61 03	1.4	EQUIPMENT - EXHIBIT A - Per Applicable Equipment		X		X				
01 67 00	1.3	PRODUCT REQUIREMENTS								
01 67 00	1.3	Affirmative Procurement Reporting Form				X				
01 67 00	1.3	Environmental Data (1.3 / A / 2 a thru z)				X				
01 67 00	1.3	Material Safety Data Sheets (a thru p)				X				
01 67 00	1.3	Chain of Custody Documentation				X				
01 71 21	3.2	SPECIALTY ENGINEERING REQUIREMENTS								
01 71 21	3.2	SSE Design Documentation Calculations		X		X				
01 73 20	1.2	OPENINGS AND PENETRATIONS IN CONSTRUCTION								
01 73 29	1.2	Shop Drawings				X		X		
01 73 40	1.2	EXECUTION								
01 73 40	1.2	Surveyor Certificates (A,C)				X				

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01 73 40	1.2	Landfill Receipts (B)				X				
01 73 40	1.2	Quantity Surveys (D)				X				
01 73 40	1.2	Utility Management Plan (G)								
01 73 60	1.2	CONSTRUCTION CAMPS								
2 73 60	1.4	NORTH RIM: Contractor Construction Camp Development Plan		X						
01 74 19	1.4	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL								
01 74 19	1.4	Waste Management Plan		X						
01 74 19	1.4	Progress Documentation				X				
01 74 19	1.4	Waste Reduction Calculations				X				
01 74 19	1.4	Records of Donations				X				
01 74 19	1.4	Records of Sales				X				
01 74 19	1.4	Recycling and Processing Facility Records				X				
01 74 19	1.4	Landfill and Incinerator Disposal Records				X				
01 74 19	1.4	Qualification Data				X				
01 74 19	1.4	Statement of Refrigerant Recovery				X				
01 74 19	1.4	Closeout Submittals				X				
01 77 00	1.3	CLOSEOUT PROCEDURES - Record drawing				X		X	X	X
01 77 00	1.3	Permit				X		X	X	X
01 77 00	1.3	Warranties				X		X	X	X
01 77 00	1.3	Substantial Completion				X		X	X	X
01 77 00	1.3	Testing and Balencing				X		X	X	X
01 78 23	1.2	OPERATION AND MAINTENANCE DATA		X	X			X	X	X
01 79 00	1.2	DEMONSTRATION AND TESTING		X		X				
01 81 10	1.7	WIND AND SEISMIC DESIGN CRITERIA Structural Calculations		X		X				X
01 81 13	1.3	FEDERAL SUSTAINABILITY DOCUMENTATION				X				
01 81 33	1.3	CYBERSECURITY REQUIREMENTS				X				
02 41 00	1.4	DEMOLITION								
02 41 00	1.4	Demolition and Removal Plan			X					

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02 41 00	1.4	Notification of Intended Demolition Start								
02 41 00	1.4	Field Quality Control Test Results		X						
02 41 00	1.4	Qualification Statements	X							
03 01 30	1.5	REPAIR AND REHABILITATION OF EXISTING CONSTRUCTION								
03 01 30	1.5	Rehabilitation Plan				X				
03 05 05	1.5	CONCRETE TESTING AND INSPECTION								
03 05 05	1.5	Shop Drawings						X		
03 05 05	1.5	Certifications	X							
03 05 05	1.5	Product Technical Data - Mix Design							X	
03 05 05	1.5	Pre-Inspection Report							X	
03 05 05	1.5	Post-Inspection/Break Report: 7 day							X	
03 05 05	1.5	Post-Inspection/Break Report: 14 day							X	
03 05 05	1.5	Post-Inspection/Break Report: 30 day							X	
03 11 13	1.4	FORMWORK								
03 11 13	1.4	Sample - Wood Form for Surfaces Exposed to View					X			
03 11 13	1.4	Sample - Void Form					X			
03 11 13	1.4	Sample - Metal/Wood Form for Surfaces Not Exposed to View					X			
03 11 13	1.4	Product Technical Data - Ties			X	X			X	
03 11 13	1.4	Product Technical Data - Form Release Material			X	X			X	
03 15 19	1.5	Shop Drawings						X		
03 15 19	1.5	Product Data - Cast in Place Anchor		X					X	
03 15 19	1.5	Product Data - Anchor Rods		X					X	
03 15 19	1.5	Product Data - Reinforcing Anchorage Adhesive		X					X	
03 15 19	1.5	Product Data - Post Installed Concrete Anchors		X					X	
03 15 19	1.5	Delegated Design Professional's Instruments of Service Submittals		X						X
03 15 19	1.5	Calculations by Delegated Design Professional								X
03 15 19	1.5	Field Quality Control Submittals	X							
03 15 19	1.5	Reports of Supplier's Visits to Site				X				

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03 21 00	1.3	REINFORCEMENT SHOP DRAWINGS AND PRODUCT DATA						X	X	
03 31 30	1.3	CONCRETE, MATERIALS AND PROPORTIONING								
03 31 30	1.3	Schedule of Concrete Materials	X	X	X					
03 31 30	1.3	Mix Designs		X						
03 31 30	1.3	Reinforcing Bars: Cast, Welded, Smooth Dowels, Proprietary Reinforcing Mechanical Splices, Headed Deformed Bars			X			X		
03 31 30	1.3	Welded Wire, Accessories: Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports			X			X		
03 31 30	1.3	Accessories: Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports			X			X		
03 31 30	1.3	Mill Certificates	X					X		
03 31 30	1.3	Welding Certification	X					X		
03 31 30	1.3	Shop Drawings						X		
03 31 30	1.3	CONCRETE, MATERIALS AND PROPORTIONING								
03 31 30	1.3	Schedule of Concrete Materials	X	X	X					
03 31 30	1.3	Mix Designs		X						
03 31 30	1.3	Reinforcing Bars: Cast, Welded, Smooth Dowels, Proprietary Reinforcing Mechanical Splices, Headed Deformed Bars			X			X		
03 31 30	1.3	Welded Wire, Accessories: Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports			X			X		
03 31 30	1.3	Accessories: Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports			X			X		
03 31 30	1.3	Mill Certificates	X					X		
03 31 30	1.3	Welding Certification	X					X		
03 31 30	1.3	Shop Drawings						X		
03 31 31	1.5	CONCRETE MIXING, PLACING, JOINTING, AND CURING								
03 31 31	1.5	Shop Drawings						X		
03 31 31	1.5	Project Data - Joint Fillers			X					X
03 31 31	1.5	Project Data - Curing Agents			X					X

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03 31 31	1.5	Project Data - Contruction Joint Bonding Adhesive			X					X
03 31 31	1.5	Project Data - Prefabricated waterstops			X					X
03 31 31	1.5	Supplier Site Visit Reports				X				
03 31 31	1.5	Delivery Tickets				X				
03 31 31	1.5	Special Procedure Submittals - Curing				X				
03 35 00	1.4	CONCTRETE FINISHING AND REPAIR OF SURFACE DEFECTS								
03 35 00	1.4	Finish and Repair Plan				X				
03 41 33	1.5	PRECAST AND PRESTRESSED CONCRETE								
03 41 33	1.5	Shop Drawings						X		
03 41 33	1.5	Project Data			X					X
05 50 00	1.3	METAL FABRICATION								
05 50 00	1.3	Product Data							X	X
06 10 00	1.3	ROUGH CARPENTRY								
06 10 00	1.3	Shop Drawings						X		
06 10 00	1.3	Product Data - Framing Lumber							X	X
06 10 00	1.3	Product Data - Structural Plywood							X	X
06 10 00	1.3	Product Data - Exterior Sheathing							X	X
06 10 00	1.3	Product Data - Non-Structural Plywood							X	X
06 10 00	1.3	Product Data - Treated Wood							X	X
06 10 00	1.3	Product Data - Fire-Retardant Treated Material (FRTM)							X	X
06 10 00	1.3	Product Data - Fasteners							X	X
06 10 00	1.3	Quality Control - Special Inspections, Quality Control Tests, Certification of Testing Quals	X			X				
07 21 00	1.3	BUILDING INSULATION								
07 21 00	1.3	Product Data - Building Insulation Rigid Extruded Polystyrene Board Insulation							X	X
07 21 00	1.3	Product Data - Building Insulation Rigid Polyiscocyanurate Foam Board Insulation							X	X
07 21 00	1.3	Product Data - Blanket or Batt Thermal Insulation							X	X
07 21 00	1.3	Product Data - Sound Control and Fire Safing Insulation							X	X
07 21 00	1.3	Product Data - Vapor Retarder							X	X

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07 21 00	1.3	Quality Control - Special Inspections, Quality Control Tests, Certification of Testing Quals	X			X				
07 21 00	1.3	BUILDING INSULATION								
07 84 00	1.6	FIRESTOPPING								
07 84 00	1.6	Project Data - Firestopping							X	X
07 84 00	1.6	Firestopping Schedule with Shop Drawings						X		X
07 84 00	1.6	Quality Control - Special Inspections, Quality Control Tests, Certification of Testing Quals	X			X				
07 84 00	1.6	Color Sample Mock-Up					X			X
07 92 00	1.6	JOINT SEALANTS								
07 92 00	1.6	Product Data - Compressible Sealent							X	X
07 92 00	1.6	Product Data - Expandable Foam Sealent							X	X
07 92 00	1.6	Product Data - Polyether Foam Sealent							X	X
07 92 00	1.6	Product Data - Polysulfide Rubber Sealent							X	X
07 92 00	1.6	Product Data - Polyurea Joint Filler							X	X
07 92 00	1.6	Product Data - Polyureetheane Sealents							X	X
07 92 00	1.6	Product Data - Silicone Sealents							X	X
07 92 00	1.6	Product Data - Fire Resistant Sealent							X	X
07 92 00	1.6	Product Data - Accessories: Back Rod, Cmpressible Filler, Primer, Joint Cleaner, Bond Breaker							X	X
07 92 00	1.6	Quality Control - Special Inspections, Quality Control Tests, Certification of Testing Quals	X			X				
07 92 00	1.6	Color Samples					X			X
08 70 00	1.4	FINISH HARDWARE								
08 70 00	1.6	Product Data							X	X
09 22 16	1.6	NON-STRUCTURAL METAL FRAMING								
09 22 16	1.6	Shop Drawings						X		
09 22 16	1.6	Product Data							X	X
09 29 00	1.6	GYPSUM BOARD								
09 29 00	1.6	Shop Drawings - Joint Control Layout						X		
09 29 00	1.6	Product Data - Installation Instructions - Manufactures							X	X
09 29 00	1.6	Product Data - Trims, Adhesive, Joint Treatment Compound and Tape							X	X

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09 29 00	1.6	Product Data - Gypsum Board							X	X
09 29 00	1.6	Product Data - Moisture Resistant Gypsum Wall Board							X	X
09 29 00	1.6	Product Data - Coated Tile Backer Gypsum Board							X	X
09 91 00	1.6	ARCHITECTUAL PAINTING								
09 91 00	1.6	Samples					X			X
09 91 00	1.6	Product Data - Paint Type 1							X	X
09 91 00	1.6	Product Data - Paint Type 2							X	X
09 91 00	1.6	Product Data - Paint Type 3							X	X
09 91 00	1.6	Certification	X						X	X
09 91 00	1.6	Test Results	X							
10 50 00	1.3	Temporary Lab Trailer						X	X	
22 05 03	1.3	Product Data - Pipe							X	X
22 05 03	1.3	Product Data - Pipe Fittings							X	X
22 05 03	1.3	Product Data - Flex Connections, Pressure Gauges, Wye Strainers							X	X
22 05 03	1.3	Product Data - Accessories							X	X
22 05 03	1.3	Testing Report								X
22 05 23	1.3	Product Data - General Duty Plumbing Valves							X	X
22 05 29	1.3	Product Data - Hangers and Supports for Plumbing Pipe and Equipment							X	X
22 20 00	1.3	Product Data - Plumbing Fixtures and Equipment							X	X
22 33 15	1.3	Product Data - Instantaneous Electric Safety Shower Water Heater							X	X
23 05 48	1.3	VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT								
23 05 48	1.3	Shop Drawings - Vibration Isolators by Type and Location						X		
23 05 48	1.3	Shop Drawings - Manufactures Drawings						X		
23 05 48	1.3	Shop Drawings - Piping and Ductwork						X		
23 05 48	1.3	Product Data - Vibration Isolators							X	X
23 05 48	1.3	Product Data - Vibration Isolator Connected Piping and Ductwork							X	X
23 05 93	1.3	HVAC SYSTEMS - BALENCING AND TESTING								
23 05 93	1.3	Product Data - Air Handling Units							X	X

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SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND	OTHER
23 05 93	1.3	Product Data - Fan Coil Units							X	X
23 05 93	1.3	Testing and Balencing Reports		X		X				
23 74 36	1.4	REFRIGERANT PIPING SYSTEM								
23 74 36	1.6	Product Data							X	X
23 74 36	1.6	Product Data							X	X
23 80 00	1.4	HVAC - EQUIPMENT								
23 80 00	1.6	Product Data							X	X
23 80 00	1.6	Product Data							X	X
26 05 00	1.4	ELECTRICAL								
26 05 00	1.4	Product Data - Electrical Equipment Support Pedestals / Racks							X	X
26 05 00	1.4	Product Data - Field Tough Up Zinc Rich Primer							X	X
26 05 00	1.4	Product Data - Modular Strut & Structural Members / Hardware							X	X
26 05 00	1.4	Product Data - Equipment Pads							X	X
26 05 13	1.4	MEDIUM VOLTAGE CABLE								
26 05 13	1.4	Pull Plan - Tensioning, Breakaway Swivel		X					X	X
26 05 13	1.4	Certification	X			X				
26 05 13	1.4	Cable Test Reports				X				X
26 05 13	1.4	Product Data - Medium Voltage Cable (Armored Wired Cable)							X	X
26 05 13	1.4	Product Data - Medium Voltage Cable (Non-Armored Wired Cable)							X	X
26 05 13	1.4	Product Data - Cable Terminations, Connections, Terminations and Splices							X	X
26 05 13	1.4	Product Data - Fault Indicators							X	X
26 05 13	1.4	Product Data - Multi-Point Cable Junctions							X	X
26 05 13	1.4	Product Data - Cable Shield Grounding Adapters							X	X
26 05 13	1.4	Product Data - Conduit							X	X
26 05 19	1.4	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES								
26 05 19	1.4	Pull Plan - Tensioning, Breakaway Swivel		X					X	X
26 05 19	1.4	Certification	X			X				
26 05 19	1.4	Cable Test Reports				X				X

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26 05 19	1.4	Product Data - Fiber Optic Cable							X	X
26 05 19	1.4	Product Data - Building Wire							X	X
26 05 19	1.4	Product Data - Power Cable							X	X
26 05 19	1.4	Product Data - Control Cables							X	X
26 05 19	1.4	Product Data - Shielded VFD Cable							X	X
26 05 19	1.4	Product Data - Instrumentation Cable							X	X
26 05 19	1.4	Product Data - Fiber Optic Cable							X	X
26 05 19	1.4	Product Data - Wire Connections							X	X
26 05 19	1.4	Product Data - Insulating Tape							X	X
26 05 19	1.4	Product Data - Pulling Lubricant							X	X
26 05 26	1.3	GROUNDING AND BONDING								
26 05 26	1.3	Product Data - Building/Tank Grounding System							X	X
26 05 26	1.3	Product Data - Grounding System							X	X
26 05 26	1.3	Product Data - Exothermic Weld Connections							X	X
26 05 26	1.3	Product Data - Prefabricated Composite Test Station							X	X
26 05 26	1.3	Product Data - Transformer Grounding System							X	X
26 05 43	1.4	ELECTRICAL - EXTERIOR UNDERGROUND								
26 05 43	1.4	Shop Drawing - Manholes and Handholes						X	X	X
26 05 43	1.4	Shop Drawing - Underground Conduit and Ductbank						X	X	X
26 05 43	1.4	Product Data - Manholes							X	X
26 05 43	1.4	Product Data - Handholes							X	X
26 05 43	1.4	Product Data - Underground Conduit and Ductbanks							X	X
26 05 48	1.3	ELECTRICAL SEISMIC RESTRAINT SYSTEMS								
26 05 48	1.3	Shop Drawing - Location by Type of Seismic Bracing						X	X	X
26 05 48	1.3	Calculations Report: Structural Calculations		X		X				X
26 05 48	1.3	Product Data - Bracing							X	X
26 05 73	1.3	Shop Drawing - Underground Conduit and Ductbank						X	X	X
26 05 73	1.3	Product Data - Underground Conduit and Ductbanks							X	X
26 08 13	1.3	ACCEPTANCE TESTING								
26 08 13	1.3	Plan - Acceptance Testing		X						

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26 09 13	1.3	ELECTRICAL METERING DEVICES								
26 09 13	1.3	Shop Drawing - Fabrication and Each Meter Layout						X	X	X
26 09 13	1.3	Product Data - Digital Metering Equipment: Type A,B,C, Data Logging							X	X
26 09 16	1.4	CONTROL EQUIPMENT ACCESSORIES								
26 09 16	1.4	Plan: Functional Test Plan		X					X	X
26 09 16	1.4	Shop Drawing - Fabrication and Layout Drawings: Operator Control Device						X	X	X
26 09 16	1.4	Shop Drawing - Fabrication and Layout Drawings: Control Devices						X	X	X
26 09 16	1.4	Shop Drawing - Fabrication and Layout Drawings: Industrical Control Panel						X	X	X
26 09 16	1.4	Shop Drawing - Fabrication and Layout Drawings: Operator Control Station						X	X	X
26 09 16	1.4	Product Data - Relays							X	X
26 09 16	1.4	Product Data - Contactors							X	X
26 09 16	1.4	Product Data - Photosensors and Time Clocks							X	X
26 09 16	1.4	Product Data - Alarm Devices - Audio and Visual							X	X
26 09 16	1.4	Product Data - Run Time Meter							X	X
26 09 16	1.4	Product Data - Control Power Transformer							X	X
26 09 16	1.4	Product Data - Actuated Sensor Interface Asi							X	X
26 09 16	1.4	Product Data - Termination Equipment: Standard Type Block, Bladed Type Disconnect Block, Grounded Type Block, Fuse Holder							X	X
26 09 16	1.4	Product Data - Enclosures: Industrial Control Panel, NEMA 4X Rated, NEMA 7 and 9 Rated, NEMA 12 Enclosure, Control Panel Misc							X	X
26 09 16	1.4	Product Data - Operator Control Devices: Selector Switch, Pushbuttons, Indicator Lights							X	X
26 09 16	1.4	Product Data - Control Devices: Timers, Relays, Contactors							X	X
26 09 16	1.4	Product Data - Industrial Control Panel							X	X
26 09 16	1.4	Product Data - Operator Control Station							X	X
26 12 19	1.4	DISTRIBUTION TRANSFORMERS NETWORKED LIGHTING CONTROL SYSTEM								
26 12 19	1.4	Shop Drawing - Transformer: Three Phase						X	X	X
26 12 19	1.4	Shop Drawing - Transformer: Single Phase						X	X	X
26 12 19	1.4	Shop Drawing - Single Phase Shunt Reactor						X	X	X

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26 12 19	1.4	Shop Drawing - Insulating Secondary Cover						X	X	X
26 12 19	1.4	Shop Drawing - Surge Arrestor						X	X	X
26 12 19	1.4	Product Data - Three Phase Transformer							X	X
26 12 19	1.4	Product Data - Single Phase Transformer							X	X
26 12 19	1.4	Product Data - Single Phase Shunt Reactor							X	X
26 12 19	1.4	Product Data - Insulating Secondary Cover							X	X
26 12 19	1.4	Product Data - Surge Arrestors							X	X
26 12 19	1.4	Sample - Color					X			X
26 13 23	1.3	SECTIONALIZING EQUIPMENT								
26 13 23	1.3	Testing Data	X		X					
26 13 23	1.3	Shop Drawing						X	X	X
26 13 23	1.3	Shop Drawing						X	X	X
26 22 13	1.3	LOW-VOLTAGE DISTRIBUTION TRANSFORMERS								
26 22 13	1.3	Testing Data	X		X					
26 22 13	1.3	Shop Drawing - Low Voltage Distrobution Transformers - Dry-Type 1,000kVA or Less						X	X	X
26 22 13	1.3	Product Data - Low Voltage Distrobution Transformers - Dry-Type 1,000kVA or Less							X	X
26 24 13	1.4	SWITCHBOARDS								
26 24 13	1.4	Testing Data	X		X					
26 24 13	1.4	Shop Drawing - Branch Circuit Panelboard 400A or Less						X	X	X
26 24 13	1.4	Product Data - Branch Circuit Panelboard 400A or Less							X	X
26 24 16	1.4	PANELBOARDS								
26 24 16	1.4	Testing Data	X		X					
26 24 16	1.4	Shop Drawing - Branch Circuit Panelboard 400A or Less						X	X	X
26 24 16	1.4	Product Data - Branch Circuit Panelboard 400A or Less							X	X
26 27 26	1.3	WIRING DEVICES								
26 27 26	1.3	Shop Drawing - Type by Location						X	X	X
26 27 26	1.3	Product Data - Wall Switch							X	X
26 27 26	1.3	Product Data - Recepticles							X	X
26 27 26	1.3	Product Data - Device Wall Plate and Coverplates							X	X
26 28 00	1.3	OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES								

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26 28 00	1.3	Report - Ground Fault Protection System Test Field Reports				X		X	X	X
26 28 00	1.3	Product Data - Low Voltage Circuit Breakers							X	X
26 28 00	1.3	Product Data - Low Voltage Fuses							X	X
26 28 02	1.4	COORDINATED POWER SYSTEM PROTECTION								
26 28 02	1.4	Report - Coordinated System Protection Study: Short Circuit, Protection, Arc-Flash, Circuit Breaker Protective Device Settings				X		X	X	X
26 28 16	1.3	SAFETY SWITCHES								
26 28 16	1.3	Report - Summary Table				X		X	X	X
26 28 16	1.3	Product Data - Safety Switchs							X	X
26 29 23	1.5	VARIABLE FREQUENCY DRIVES - LOW VOLTAGE								
26 29 23	1.5	Shop Drawings						X	X	X
26 29 23	1.5	Certifications	X						X	X
26 41 13	1.5	LIGHTNING PROTECTION SYSTEM								
26 41 13	1.5	Shop Drawings - Building System						X	X	X
26 41 13	1.5	Certifications	X						X	X
26 41 13	1.5	Product Data - Grounding System							X	X
26 41 13	1.5	Product Data - Rods, Wire and Mounting Hardare							X	X
26 43 13	1.5	SURGE PROTECTION DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS								
26 43 13	1.5	Shop Drawings - Surge Protection System						X	X	X
26 43 13	1.5	Certifications	X						X	X
26 43 13	1.5	Product Data - Surge Protection Equipment							X	X
26 50 00	1.4	INTERIOR AND EXTERIOR LIGHTING								
26 50 00	1.4	Shop Drawings - Lighting Type by Location						X	X	X
26 50 00	1.4	Certifications	X						X	X
26 50 00	1.4	Product Data - Interior Lighting							X	X
26 50 00	1.4	Product Data - Exterior Lighting							X	X
31 10 00	1.4	SITE CLEARING								
31 10 00	1.4	Product Data - Filter Fabric and Burlap							X	X
31 10 00	1.4	Product Data - Drainage Fill							X	X

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31 10 00	1.4	SITE CLEARING Geographic Clearence Mobilization Plan Volume 1		X						X
31 22 00	1.4	SITE GRADING	X				X		X	
31 22 00	1.4	Testing and Certifications	X							
31 22 00	1.4	Import Material Clearence	X	X						X
31 23 00	1.4	EARTHWORK	X			X	X	X	X	
31 23 00	1.4	Structural Fill Compliance Submission	X							X
31 23 00	1.4	Non-Structural Fill Compliance Submission	X							X
31 23 00	1.4	Granular Fill under Building Slabs, Electrical Equipment Pads, Manholes and Handholes	X							X
31 23 00	1.4	Geotex Filter Fabric	X							X
31 23 00	1.4	Expansive Demolition Grout	X							X
31 23 00	1.4	Testing and Certifications	X							
31 23 33	1.4	UTILITIES - TRENCHING AND BACKFILLING						X	X	X
31 23 33	1.4	Excavation and Compaction Plan - North Rim		X						
31 23 33	1.4	Third Party Testing Agency	X			X				
31 25 00	1.4	SOIL EROSION AND SEDIMENT CONTROL						X	X	
31 25 00	1.4	Product Data - Erosion Control Logs, Wattles, Matts			X					
31 25 00	1.4	Product Data - Silt Fence			X					
31 25 00	1.4	Product Data - Synthetic Filter Fabric			X					
31 25 00	1.4	Product Data - Wood/Steel Fence Posts			X					
31 25 00	1.4	Product Data - Wire Fencing Support			X					
31 68 13	1.4	ROCK FOUNDATION ANCHORS						X		X
31 68 13	1.4	Shop Drawings						X		
31 68 13	1.4	Product Data			X				X	X
32 15 40	1.6	CRUSHED STONE SURFACING			X		X		X	
32 15 40	1.6	Product Data - Stone Source Information - Sieve Analysis	X		X	X			X	X
32 15 40	1.6	Sample 1QT								X
32 15 40	1.6	Product Data - Geotext Filter Fabric	X		X	X			X	X
32 15 40	1.6	Subgrade and Subbase Compaction Results	X		X	X				
32 31 13	1.4	CHAIN LINK FENCE AND GATES								
32 31 13	1.4	Shop Drawings						X	X	X
32 31 13	1.4	Sample		X						X
32 31 13	1.4	Product Data - Fence Mesh Panel							X	X
32 31 13	1.4	Product Data - Posts - Line, Corner, Gate, Braces and Rails							X	X

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32 31 13	1.4	Product Data - Hardware							X	X
32 31 13	1.4	Product Data - Automatic Gate System							X	X
32 31 13	1.4	Product Data - Manual Gate System							X	X
32 91 13	1.4	FINISH GRADING		X						X
32 91 13	1.5	Report				X				
32 92 21	1.2	NATIVE GRASS SEEDING Product Data - Mulch Plan - Seeding Mix		X		X				X
33 05 31.11	1.5	POLYVINYL CHLORIDE GRAVITY SEWER PIPE						X	X	
33 05 31.11	1.5	Certifications, Statements of Qualification, Calculations	X						X	X
33 05 31.11	1.5	Shop Drawing - Pipe Layout						X		
33 05 31.11	1.5	Fabrication Report		X				X		
33 05 31.11	1.5	Product Data - Pipe							X	X
33 05 31.11	1.5	Product Data - Fittings (Couplings, Flanges)							X	X
33 05 31.11	1.5	Product Data - Wall Sleeves							X	X
33 05 31.11	1.5	Field Reports - Testing Results							X	X
33 05 31.11	1.5	Plan - Field Testing Plan								
33 05 31.11	1.5	POLYVINYL CHLORIDE GRAVITY SEWER PIPE Plan - Field Testing Plan		X						X
33 05 33.23	1.5	POLYETHYLENE PRESSURE PIPE AND TUBING (AWWA C901 AND AWWA C906)			X			X	X	
33 05 33.23	1.5	Certifications, Statements of Qualification, Calculations	X						X	X
33 05 33.23	1.5	Shop Drawing - Pipe Layout						X		
33 05 33.23	1.5	Fabrication Report		X				X		
33 05 33.23	1.5	Product Data - Pipe							X	X
33 05 33.23	1.5	Product Data - Fittings: Adaptor Fittings							X	X
33 05 33.23	1.5	Product Data - Fittings: Backup Flanges (include nuts, bolts, and gasgets)							X	X
33 05 33.23	1.5	Product Data - Wall Sleeves							X	X
33 05 33.23	1.5	Field Reports - Testing Results							X	X
33 05 33.23	1.5	Plan - Field Testing Plan		X						
33 05 61	1.3	CONCRETE MANHOLES								
33 05 61	1.3	Shop Drawings						X	X	X
33 05 61	1.3	Boyance Calculations						X	X	X

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33 05 61	1.3	Product Data - Sanitary Sewer Manholes and Appurtenances							X	X
33 05 61	1.3	Product Data - Drain Manholes and Appurtenances							X	X
33 05 61	1.3	Product Data - Sealents / Compounds							X	X
33 31 11	1.3	GRAVITY SEWER PIPELINE AND MANHOLE CONSTRUCTION		X	X				X	
33 31 11	1.3	Testing Plan		X				X	X	X
33 31 11	1.3	Testing Reports		X				X	X	X
33 32 13	1.3	PACKAGE SEWAGE PUMPING STATION	X					X	X	
33 32 13	1.3	Testing Plan		X				X	X	X
33 32 13	1.3	Shop Drawings - Package Lift Station System						X	X	X
33 32 13	1.3	Product Data - Package Lift Station		X					X	X
40 05 00	1.4	PIPE AND PIPE FITTINGS - BASIC REQUIREMENTS								
40 05 00	1.4	Testing and Disinfection Plan							X	X
40 05 00	1.4	Shop Drawings - Process Piping System						X	X	X
40 05 00	1.4	Product Data - Process Piping System		X					X	X
40 05 07	1.4	PIPE SUPPORT SYSTEMS								
40 05 07	1.4	Shop Drawings						X	X	X
40 05 07	1.4	Product Data - Hot Dipped Galvanized Fittings		X					X	X
40 05 07	1.4	Product Data - Dissimilar Fittings		X					X	X
40 05 07	1.4	Product Data - FRP: Channels, Pipe Clamps, Clevis Hangers, Beam Clamps, Column Base		X					X	X
40 05 07	1.4	Product Data - Concrete Inserts for Hanger Rods, Hanger Rods, MSS SP-58, Trapeze Hangers, Verticle Pipe Supports, Lateral Retraints, Expanding Pipe Supports, Pipe Saddles, Riser Stanchions, Base Plates, Wall Brackets, Pipe Anchors, Seismic Restraints, Pipe Guilds		X					X	X
40 05 23	1.4	PIPE -STAINLESS STEEL PIPE AND TUBING								
40 05 23	1.4	Shop Drawings						X	X	X
40 05 23	1.4	Product Data - Tubing, Pipe, Fittings, Flanges, Nuts/Bolts/Washers, Expansion Joints, Flex Metal Hose, Gaskets		X					X	X
40 05 25	1.4	PIPE - UNDERGROUND, PREFABRICATED, INSULATED AND JACKETED								
40 05 25	1.4	Shop Drawings						X	X	X
40 05 25	1.4	Product Data - Insulation, Jacket,		X					X	X

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40 05 31	1.4	PIPE - PLASTIC								
40 05 31	1.4	Shop Drawings						X	X	X
40 05 31	1.4	Product Data - PVC/CPVC Pipe and Fittings, Tubing, Unions, Flanges, Flex Couplings, Seals/O Rings		X					X	X
40 05 51	1.4	PROCESS AND UTILITY VALVES								
40 05 51	1.4	Shop Drawings						X	X	X
40 05 51	1.4	Product Data - Valves		X					X	X
40 05 57	1.4	Actuators for Process Valves and Gates				X		X		
40 05 57	1.4	Shop Drawings						X	X	X
40 05 57	1.4	Product Data		X					X	X
40 05 62	1.4	PLUG VALVES							X	X
40 05 63	1.4	BALL VALVES							X	X
40 05 64	1.4	BUTTERFLY VALVES							X	X
40 05 66	1.4	CHECK VALVES							X	X
40 41 13	1.4	HEAT TRACING CABLE	X			X		X		X
40 41 13	1.4	Shop Drawings						X	X	X
40 41 13	1.4	Product Data		X					X	X
40 42 00	1.4	PIPE, DUCT AND EQUIPMENT INSTALLATION	X			X		X	X	
40 42 00	1.4	Shop Drawings						X	X	X
40 42 00	1.4	Product Data		X					X	X
40 61 13	1.4	PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS								
40 61 13	1.4	Shop Drawings						X	X	X
40 61 13	1.4	Product Data		X					X	X
40 61 21	1.4	PROCESS CONTROL SYSTEM TESTING								
40 61 21	1.4	Shop Drawings						X	X	X
40 61 21	1.4	Product Data		X					X	X
40 61 43	1.4	SURGE PROTECTION DEVICES FOR INSTRUMENTATION AND CONTROL EQUIPMENT								
40 61 43	1.4	Shop Drawings						X	X	X
40 61 43	1.4	Product Data		X					X	X
40 61 93	1.4	PROCESS CONTROL SYSTEM INPUT-OUTPUT LIST								

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40 61 93	1.4	Shop Drawings						X	X	X
40 61 93	1.4	Product Data		X					X	X
40 62 05	1.4	COMPUTER SYSTEM HARDWARE AND ANCILLARIES								
40 62 05	1.4	Shop Drawings						X	X	X
40 62 05	1.4	Product Data							X	X
40 63 43	1.4	PROGRAMMABLE LOGIC CONTROLLERS								
40 63 43	1.4	Shop Drawings						X	X	X
40 63 43	1.4	Product Data - PLC		X					X	X
40 66 05	1.4	NETWORK EQUIPMENT								
40 66 05	1.4	Shop Drawings						X	X	X
40 66 05	1.4	Product Data		X					X	X
40 67 00	1.4	CONTROL SYSTEM EQUIPMENT PANELS AND RACKS								
40 67 00	1.4	Shop Drawings						X	X	X
40 67 00	1.4	Product Data		X					X	X
40 67 63	1.4	UNINTERRUPTED POWER SUPPLY								
40 67 63	1.4	Shop Drawings						X	X	X
40 67 63	1.4	Product Data		X					X	X
40 68 63	1.4	CONFIGURATION OF HMI SOFTWARE AND REPORTS								
40 68 63	1.4	Shop Drawings						X	X	X
40 68 63	1.4	Product Data		X					X	X
40 78 00	1.4	PANEL MOUNTED INSTRAMENTS								
40 78 00	1.4	Shop Drawings						X	X	X
40 78 00	1.4	Product Data		X					X	X
41 22 13	1.4	Davit Crane								
41 22 13	1.4	Shop Drawings						X	X	X
41 22 13	1.4	Product Data		X					X	X
41 22 23	1.4	Hoists								
41 22 23	1.4	Shop Drawings						X	X	X

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number:	**GRCA 318719 TWWTP**
Project Title:	**Rehabilitate North Rim Infrastructure TWWTP**

SUBMITTAL			REQUIREMENTS							
			INFORMATIONAL				ACTION			
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND	OTHER
41 22 23	1.4	Product Data		X					X	X
43 23 31.29	1.4	Pumping Equipment - Vertical Inline Centrifugal Pumps								
43 23 31.29	1.4	Shop Drawings						X	X	X
43 23 31.29	1.4	Product Data		X					X	X

SUBMITTAL LIST

Park Acronym/Project Management Information System (PMIS) Number:	**GRCA 318719 TWWTP**
Project Title:	**Rehabilitate North Rim Infrastructure TWWTP**

SUBMITTAL			REQUIREMENTS							
			INFORMATIONAL				ACTION			
SPECIFICATION SECTION	PARAGRAPH NUMBER	DESCRIPTION	CERTIFICATIONS OR LABORATORY TESTS	REPORTS OR CALCULATIONS OR PLAN	MANUFACTURER DATA AND	OTHER	SAMPLES	SHOP DRAWINGS	MANUFACTURER DATA AND	OTHER
46 07 53	1.4	PACKAGE WASTEWATER TREATMENT EQUIPMENT								
46 07 53	1.4	Shop Drawings						X	X	X
46 07 53	1.4	Product Data		X					X	X
46 21 40	1.4	MECHANICALLY CLEANED SCREENS-IN CHANNEL AUGER								
46 21 40	1.4	Shop Drawings						X	X	X
46 21 40	1.4	Product Data		X					X	X

Appendix A

Equipment Types

Construction projects are multi-faceted and involve the use of several different equipment types that can result in various effects on wildlife. The most common impacts result from ground disturbance, vegetation removal, and noise generation.

For this consultation, equipment types are broken down into the following categories: heavy construction, light construction, and cyclic maintenance. These guidelines and definitions are consistent with previous section 7 consultations and analyses of project impacts throughout Grand Canyon National Park.

Heavy Construction

Heavy construction will require use of large equipment for actions such as earthmoving, rock excavation, and construction of facilities. A description of each activity associated with heavy construction is provided below.

Earthmoving

Earthmoving is typical for construction of facilities and roads where large areas of ground disturbance are necessary. Equipment such as large bulldozers, large dump trucks, scrapers, and excavators for transporting several cubic tons of soil and rock are required for such work.

Rock excavation and trenching

This type of activity will be used in installation or repair of utilities or construction of building foundations. The operation of equipment necessary to excavate rock can be very loud (as can the excavation itself) and can result in vibration. Work involving excavation of rock and trenching will typically require use of equipment such as trenchers, hoe-rams, rock saws, hammer hoes, rippers on bulldozers, and large track-hoes with hydraulic hammers.

Construction of facilities

Work involving construction of tall facilities may require use of a large crane over 100 feet high. This has an effect on the surrounding landscape while in use.

Light Construction

Light construction activities require smaller pieces of equipment than those described for heavy construction, and do not generate as much noise.

Examples of light construction includes such activities as road rehabilitation and maintenance, concrete work, utility installation and repair, trail construction, revegetation and grounds maintenance, sign installation, hazardous vegetation removal, and construction of facilities two stories or less. These activities typically require the use of equipment identified as Light Construction (listed below).

Cyclic Maintenance

Cyclic maintenance equipment primarily includes hand-held mechanized tools needed for activities such as typical building repairs and replacements (roof, siding, etc.), painting, grounds work and maintenance, etc.

Construction Category Equipment List

Heavy Construction	• Large bulldozers • Large dump trucks • Scrapers • Excavators • Rock saws • Large track-hoes with hydraulic hammers • Large cranes • Trenchers • Asphalt re-claimers • Loaders
Light Construction	• Backhoes • Small dump trucks • Chainsaws • Jackhammers • Small bulldozers • Bobcats • Large boom truck • Asphalt pavers • Asphalt distributors • Soil compactors • Pionjars • Graders • Cement mixers • Welders and torches • Woodchippers • Stump grinders • Augers • Forklifts • Mechanized mowers
Cyclic Maintenance	• Air compressors • Scissor lifts • Small boom truck • Polaris 4X4s • Chainsaws • Farm tractors • Mechanized hand tools • Snowcat • Snowmobiles • Street sweepers • Pick-up trucks

	• Snowplows • Snow blowers • Mechanized stripers • Concrete saws • Mechanized sewer rods • Mobile generators • Non-mechanized hand tools

Appendix A is extracted from:
Rehabilitate the North Rim and Roaring Springs Utility Systems
Grand Canyon National Park
Biological Assessment
February 2026
National Park Service – U.S. Department of the Interior

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United States Department of the Interior

NATIONAL PARK SERVICE
Grand Canyon National Park
P. O. Box 129
Grand Canyon, Arizona 86023-1238

IN REPLY REFER TO:
A56 (GRCA 8211)

Invasive Plant Free Forage, Materials, Vehicles, and Equipment

Standard Operating Procedure

Purpose: This Standard Operating Procedure (SOP) establishes policies, procedures, and requirements for park staff, volunteers, contractors, concessioners, other agency personnel, partners, and visitors transporting into the park and using livestock forage (including hay, straw, mulch, cubes, feed grain, pellets), materials (including construction, erosion control, site restoration), equipment, and vehicles that could potentially contain invasive plant materials.

Scope: This SOP applies to all Grand Canyon National Park (GRCA) employees, volunteers, contractors, concessioners, other agency personnel, partners, and visitors with livestock. All parties listed are responsible for understanding and adhering to this policy, but ultimate enforcement is the responsibility of GRCA staff.

Procedure: Grand Canyon National Park has established a policy to minimize or prevent the spread of invasive exotic plants into the park through contaminated forage or materials, and from vehicles travelling on the park's non-paved roads.

The park has adopted the following regulations concerning invasive plant free forage and plant containing materials:

> Possessing, storing, or transporting any hay, straw, or mulch that has not been certified as free of noxious invasive plants and seeds by a certified officer through an official state program, is prohibited within the boundaries of Grand Canyon National Park.

Forage:
Only certified invasive plant free forage (hay, straw, mulch) can be used in the park. Official certification from outside of Arizona is acceptable. Baled or loose hay, straw and mulch cannot be taken beyond a trailhead into the

backcountry or into the park's proposed wilderness. Only pelletized feed, compressed hay cubes, and feed grain products can be used in the backcountry. **Grazing of stock is not permitted in any portion of the park.**

Materials:
Plant containing materials such as wattles, erosion matting, and mulch must be made of approved materials that are inherently weed free or certified weed free. Top soil, cinders, aggregate, and other construction material often contain plant material; these materials must be surveyed and approved by Vegetation Program staff to contain no plant species on Arizona's noxious weed list or other highly aggressive invasive plant species. Routine bi-annual surveys of all known pit locations will be complete by Vegetation Program staff; any potential new material sources will be surveyed by Vegetation Program staff, upon request, within a three week time period. Contracts and project specifications will include language to ensure this condition is met.

Exclusions:
Persons with a permit specifically authorizing the otherwise prohibited act.

Unlike many western states which have passed legislation requiring invasive plant free forage, Arizona and Utah have voluntary programs. These programs use the North American Weed Management Association (NAWMA) standards for certification. The North America Weed Free Forage Standards are benchmark standards used across the United States.

Invasive Plant Free Purchasing Policy
This policy was created for the purchase and transport of invasive plant free forage and construction, and site restoration materials into the park:

- Purchasers may include government purchase card holders, concessioner employees, contractors, and private livestock owners visiting the park.
- These parties are responsible for obtaining proof of invasive plant free certification of any plant based materials such as hay, straw, mulch, and grain prior to shipment or delivery to the park.
- If more than one producer is used per year or per project, the purchaser must obtain a certificate from each producer.
- If the materials are not able to be certified at the state or regional level, these materials are prohibited from the park unless they have been approved in consultation with the Vegetation Program Manager.
- Each fiscal, purchasers of plant based materials must provide certificates of invasive plant free certification from each producer utilized.
- Purchasers of top soil, cinders, aggregate, or other construction material must verify that the park's Vegetation Program has surveyed and approved the location prior to purchase.
- Purchasers of erosion control and site restoration materials must verify that they are comprised of inherently weed-seed free materials.

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Invasive Plant Free Contracting Policy

This policy was established to ensure the use of invasive plant free construction and site restoration materials, and to provide public notification of the park's invasive plant free forage and materials policy.

- All project managers, procurement, and contracting staff must ensure that invasive plant free plant based material language is included in the construction and site restoration specifications for all in-park contracts that may use such materials. This includes roadwork, buildings, plant salvage, site restoration, and other contracts which may involve ground disturbance and subsequent erosion control or restoration measures, and any projects that require the import of top soil, cinders, aggregate or any other similar material.
- Wattles and erosion matting should contain materials such as aspen coir or coconut fiber coir that are inherently seed and propagule free and not hay or straw. If bales are required (wattles are preferred), they must be certified invasive plant free straw bales, not hay.
- Mulch material must either be inherently invasive free, such as wood chips or wood straw, or must contain only certified invasive plant free material.
- Hydroseeding and hydromulching will use wood and/or paper fibers.
- These requirements will be clearly stated in the contract specifications.

Vehicle Cleaning Policy

This policy was established to minimize the vehicular and equipment spread of invasive plant materials into the park, and to provide public notification of the park's vehicle cleaning policy. This policy recognizes that it is impractical to expect every business-related vehicle to be washed prior to entering the park; however, the intent is to control the import of invasive materials whenever possible. The emphasis is on those vehicles that travel on non-paved roads while in the park and those that have travelled on non-paved roads prior to entry.

- Prior to entry, contractors and partners must pressure wash all vehicles that could potentially leave paved surfaces in the park.
- Prior to entry, all government vehicles and equipment that have been on non-paved roads outside of the park must be pressure washed. Examples include visiting NPS employees from other park units, visiting or assigned fire crews, leased bulldozers, etc.
- Exceptions to this policy include GRCA river shuttles and GRCA backcountry travel that does not have a vehicle wash station en route; however, these government vehicles should be washed as soon as possible at one of the vehicle wash areas within the park.

Planning and Compliance

Procedures and policies outlined in this document will be referred to and included in park compliance documents in the form of mitigation measures for all applicable projects.

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Definitions

North American Weed Management Association (NAWMA): A network of public and private professional invasive plant managers who are involved in implementing any phase of a county, municipal, district, state, provincial or federal noxious invasive plant law.

North America Weed Free Forage Standards: These standards are those established by NAWMA and adopted by the ACIA and used for inspection of Arizona forage. The North America Weed Free Forage Standards are designed:

- To provide some assurance to all participants that forage certified through this program meets a minimum acceptable standard.
- To provide continuity between the various provinces and states in the program.
- To limit the spread of noxious invasive plants through forage and mulch.

Forage: includes hay, straw, mulch, and feed grain.

Plant containing construction materials: includes hay, straw, mulch, and seeds. Also includes such erosion control and construction materials as wattles, erosion control blankets, mulch used in hydromulching and hydroseeding, straw or hay bales, and natural fiber mats.

Invasive plant free certification: in Arizona this means certified under the state voluntary program to be free from propagative plant parts and free from invasive plant seed from plants set forth on the Arizona designated noxious invasive plant list and the North American designated noxious invasive plant list. Official certifications from other states will be accepted.

Invasive plant free: means free from propagative parts and free from invasive plant seed from plants identified in state, regional, and national lists of invasive plants published by NAWMA. Sources for invasive plant free forage in Arizona and Utah are listed at the end of this document.

Specific Requirements Established by the Park

1. Responsibilities:

A. Vegetation Program
Contact Invasive Plant Biologist or Vegetation Program Manager

1. Work with Backcountry Information Center to review the private stock use policy and handout given to visitors annually.

2. Coordinate training and provide assistance to work units on technical aspects of invasive plant free forage and materials.

3. Coordinate training and guidance to work units regarding the vehicle washing component of this SOP.

4. Monitor and document findings, including producer certificates, concerning implementation of this SOP each fiscal year.

5. Provide all parties mentioned in this SOP a list of Arizona, California, Colorado, Nevada, and Utah Certified Noxious Weed Free Forage and Mulch providers or direct parties to locations where this information can be found.

6. Survey all proposed borrow pit locations outside of park boundaries for invasive plants in May or June and September or October each year and provide a list of approved pits to all division chiefs for dispersal to their employees.

7. Notify borrow pits of the results of the bi-annual surveys and provide standard recommendations.

8. Provide standard mitigation measures to the park's Office of Planning and Compliance for inclusion in park compliance documents and consistently insert these standard mitigations into projects in the Planning and Environmental Compliance (PEPC) database.

9. Provide guidance and training for Resource Advisors.

10. For large-scale projects or as requested by Project Managers, Vegetation Program staff will attend pre-construction meetings to discuss this policy with contractors.

B. Division Chiefs

1. Ensure all aspects of this SOP are communicated and understood by supervisors and employees. At least annually monitor and document findings concerning implementation of this SOP.

2. Provide feedback regarding implementation of this SOP to the Vegetation Program Manager or Science and Resource Management Division Chief as needed.

3. Ensure that the appropriate staff members provide the Vegetation Program's primary contact with updated certificates of inspection from preferred providers upon request.

C. Supervisors

1. Ensure all employees are aware of the contents of this SOP. Answer any questions regarding this SOP or refer employees to the Vegetation Program's primary contact.

2. Ensure all employees are following the guidelines of this SOP.

3. Communicate any difficulties or failure to follow this SOP to the Division Chief and the Vegetation Program Manager.

D. Employees

1. Read this SOP and ask your Supervisor or Vegetation Program Invasive Plant Biologist or Program Manager to clarify any questions.

2. Follow invasive plant free purchasing policy outlined in this SOP.

3. Report any deviation of this SOP by any park employee, contractor, concessioner, or visitor to the Vegetation Program.

4. Project managers, contracting personnel, and government purchase card holders must provide certificates of inspection to the Vegetation Program for each project bringing materials including hay, straw, mulch, or other plant containing materials into the park.

5. Project managers, Contracting Officer's Representatives (COR), and any employee involved in a project that requires the import of top soil, cinders, aggregate, or other construction material must ensure that the pit location has been approved by the park's Vegetation Program prior to purchase.

6. If multiple shipments of these materials are entering the park over the course of the project from multiple sub-contractors, Project managers, contracting personnel, and government purchase card holders are responsible for ensuring that each shipment utilizes only approved materials. These personnel must provide certificates of inspection to the Vegetation Program upon request.

7. Project managers are responsible for ensuring and documenting that contractors and project partners comply with these contract specifications, and must be able to verify the specifications have been met.

8. Contracting personnel and government purchase card holders who purchase large amounts of forage for the trail crew and law enforcement livestock, must ensure that the vendors always use certified forage in their shipments. These personnel must provide certificates of inspection to the Vegetation Program. For example: if the trail crew purchases their forage

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from a feed store in Flagstaff, each shipment may come from a different producer. Therefore a certificate of inspection must be provided with each shipment. These certificates of inspection must be provided to the Vegetation Program.

- If multiple producers are involved with one shipment, then multiple certificates must also be provided.
- It is the responsibility of contracting personnel and government purchase card holders to request the specifics on providers from the vendors.

E. Visitors with livestock

1. Ensure all livestock forage transported into the park is certified invasive plant free.

2. Be prepared to prove this certification either with certified colored string, certification tags, or a written certificate. Visitors should also have certified vendor information on hand for verification.

/s/ Lori J. Makarick
Prepared By
Lori J. Makarick
Vegetation Program

June 1, 2011
Date

/s/
Approved
Palma Wilson
Deputy Superintendent

Date

/s/
Approved
Barclay Trimble
Acting Superintendent

Date

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Certified Vendors of Invasive Plant Free Forage and Mulch

**Vegetation Program staff will update and distribute list annually.*

Arizona
Available from the Arizona Crop Improvement Association website:
http://www.arizonacrop.org/NWFF&M/Grower's%20list.html

Anrac Farms, 7745 N 5th St. Coolidge, AZ 85228. Tel: 480-296-9592. Contact: Scott R. Wilding. Crops Certified: Wheat and Barley Straw.

A.N.S. Inc., 2946 E. Robin Gilbert, AZ 85296. Tel: 480-241-1082. Contact: Brandon Fish. Crop Certified: Wheat Straw.

Desert Ranch Enterprises, 30151 W. Old US 80 Palo Verde, AZ 85343. Tel: 602-680-8320. Contact: Jason Hardison. Crop Certified: Wheat Straw.

Southwest Farm Services, 11926 W. Southern Ave. Tolleson, AZ 85353. Tel: 623-936-4339. Contact: Mike Perez Sr. Crop Certified: Wheat Straw.

Triangle Y, PO Box 2136 Camp Verde, AZ 86322. Tel: 928-699-8628. Contact: Rick Anderson. Crop Certified: Wheat Straw.

Utah
Available from the Utah Department of Agriculture and Food
http://ag.utah.gov/news/publications/documents/Weed-FreeList.pdf

California
Available from the California Department of Food and Agriculture
www.cdfa.ca.gov

Colorado
Available from the Colorado Department of Agriculture
www.colorado.gov/ag/dpi

Nevada
Available from the Nevada Department of Agriculture,
http://agri.nv.gov/nwac/PLANT_WFHProducers.htm

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List of Borrow Pits Outside of Park Boundaries

**Vegetation Program staff will update and distribute list annually*

BABBITT'S RANCH, TIN HOUSE PIT
Contact: 928-607-4606, Les Wilderman
Mailing Address: P.O. Box 815, Williams, AZ 86046

Site Location:
The survey was conducted at the pit location north of Coconino County Road 347. Access the site from Highway 64 approximately 16 miles south of Grand Canyon National Park's South Entrance. Turn west on CCR 347 (unmarked road with a right hand turn lane) and follow it out past the railroad tracks. The Willaha Pit is the second right past the railroad tracks (the first right is directly past the tracks and runs along them). From the Willaha site, continue west on Coconino County Road 347, 2-4 miles after the railroad tracks, take the left fork and the road will follow the large powerline. Cross creek drainage, stay on the heavily travelled road and the pit will be on the right. (Tin House ranch home and other buildings are past pit at the end of the road). The Tin House Pit is about 17-18 Miles past the Willaha Pit.

CEMEX MATERIALS
Contact: 928-606-0055, Darrell Wendel
928-526-5250, Mike Scharfencamp
Mailing Address: 5200 East Railhead, Flagstaff, AZ 86004

Site Locations:

1. Gray Mountain Pit, Mile marker 455 on North 89 between Flagstaff and Cameron
2. McCormick Pit, Sunset Crater Road
3. 58 Dodge Avenue, Flagstaff

~~**COCONINO CINDERS AND MATERIALS**~~
~~Contact: 928-526-9509~~
~~Mailing Address: 7000 East Route 66, Flagstaff, AZ 86004~~
REMOVED FROM LIST – NOT APPROVED FOR USE

DYNA ROCK AND SAND INC.
Contact: 928-289-9349
Mailing Address: 206 W First St., Winslow, AZ 86047

Site Location:
The survey was conducted at two locations in Winslow, AZ. To access the first site, go east on I-40 from Flagstaff to exit 257. Take a left off the highway onto Hwy 87 and continue over the bridge. Turn left into the site, which is visible from the highway and has a large sign and tower that say "Winslow Redi Mix". To access the rock quarry site, turn right out of the main site and follow Hwy 87 over I-40 and continue on Hwy 87

through Winslow following the signs to Payson (there will be a left turn at a stoplight). Once out of town turn left on Hwy 99 and follow to mile marker 29. Turn left and follow road over two cattle guards—the road will then curve to the right. After a couple miles turn into the site on the right side of the road.

~~FLAGSTAFF CONCRETE PRODUCTS~~
~~Contact: 928-773-9139~~
~~Mailing Address: 2150 East Huntington Drive, Flagstaff, AZ 86004~~
REMOVED FROM LIST – NOT APPROVED FOR USE

FLAGSTAFF LANDSCAPE PRODUCTS
Contact: 928-526-0801
Mailing Address: P.O. Box 30326, Flagstaff, AZ 86003

Site Location:
6500 Old Highway 66. Take I-40 east to Page / Country Club exit. Take exit, then turn left at light. At T intersection, turn left onto 89. Take first left onto Old Route 66. Follow road past mall, new mall extension, and waste water treatment plant. About ½ mile past the mall, you will arrive at the location.

JDM SAND & ROCK
**Note – This is the only North Rim pit available as of 2011.*
Contact: 928-643-7113, Steve or Brian
Mailing Address: P.O. Box 113, Fredonia, AZ 86022

Site Locations:
1. Main Site: 1446 North Highway 89A. From Jacob Lake, go all the way through Fredonia heading north. Go past ADOT and Red Hills Manufacturing on the right. This location will be right after all the large oil tanks on the right.
2. Limestone or "RipRap" Pit: Turn south onto FSR 22 at Dennison Mines Building (Paved Road). Turn west at Mile 8.5 (before Cedar Knoll). Follow dirt road approximately 1.0 miles to limestone quarry on left.
3. Cedar Knoll Pit: Like with Limestone Pit, turn south onto FSR 22. Turn west at Mile 11.6 (past utility poles) onto dirt road just past sign: "trucks entering highway". Drive west approximately 4 miles – stay right and follow windy road around knoll to site.

LP'S EXCAVATING CINDER PIT
Contact: 928-635-4107, Jim Cross
Mailing Address: Williams, AZ 86046

Site Location:
Take I-40 to the westernmost Williams exit (Exit 161). Head south of the highway on the frontage road past Denny's to the east about ¼ mile. The site will be on the south (right) side of the road directly before the Williams Cemetery.

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MCNALLEY'S RANCH, WILLAHA PIT
Contact: 928-607-4604, Les Wilderman
Mailing Address: P.O. Box 815, Williams, AZ 86046

Site Location:
Highway 64 16 miles south of park's South Entrance gate. Turn west and go to the Coconino County Road 347 sign. The site is 8.1 miles past the sign. Cross the railroad tracks and cattle guard, then turn right. Take the left fork and drive down to the pit.

MILLER MINE-BLACK CINDER PIT MINE
Contact: 928-526-5700, Earnest Caldwell (millermining@gmail.com)
Mailing Address: 46 Leupp Road, Leupp, AZ 86035

Site Location:
The survey was conducted at the location off Leupp Road. To access the site take I-40 east from Flagstaff and take exit 211 for Winona. Continue northwest on Townsend Winona Road to County Road 419/Leupp Road and turn right (north). Follow Leupp Road until mile marker 441 where the pit access road is on the left. Once on the pit access road you will see a black cinder mine on the hill to the right—this is not the site. Continue down the road and after the first dip then crest in the road there will be a road on the left. Follow this road to the pit which is below the access road.

Q-MAX COMPANY
Contact: 928-635-9255
Mailing Address: P.O. Box 877, Williams, AZ 86046

Site Location:
Highway 64, eight miles south of Valle between mile markers 201 and 202 on the west side of the road. A dedicated turn lane exists for the facility and a large sign is on the access road a few hundred yards in from the highway. Piles are visible from highway.

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SECTION 01 35 05 ENVIRONMENTAL PROTECTION AND SPECIAL CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. This section includes:
   1. Wildlife protection.
   2. Other environmental protection measures.

1.2 DEFINITIONS

A. Contracting Officer: Includes the Government Contracting Officer (CO).

B. Sensitive Resource Areas: Including, but not limited to, archaeological, paleontological sites, threatened and endangered species areas, and special-status plant habitats.

1.3 SUBMITTALS

A. Spill Prevention and Response Plan: After contract award and before the Pre-Construction conference, submit for informational review, a Spill Prevention and Response Plan. The CO will review the proposed Plan. If the plan requires any revisions or corrections, the Contractor shall resubmit the Plan within 10 days. No progress payments will be made until the Plan is accepted.

B. Rehabilitation Plan: Prior to the start of construction, Contractor shall submit a rehabilitation plan for all disturbed areas. The CO will review the proposed Plan. If the plan requires any revisions or corrections, the Contractor shall resubmit the Plan within 10 days. No progress payments will be made until the Plan is accepted.

PART 2 - PRODUCTS

2.1 Spill Prevention and Response Plan

A. The Plan shall be written to comply with Occupational Safety and Health Administration (OSHA), Environmental Protection Agency (EPA), other federal and local requirements, and project requirements.

PART 3 - EXECUTION

3.1 RESOURCE MONITORING AND PROTECTION

A. Resource Monitors for Sensitive Resources: When work is to occur in or near sensitive resource areas, the Contractor shall not proceed with work in those areas unless the required resource monitor(s) are present, unless otherwise authorized by the Contracting Officer. The Contractor is to notify the Contracting Officer at least two weeks in advance of proposed work that will occur in or near sensitive resource areas.

B. Resource Protection: Provide and maintain a minimum 16-foot (5-meter) buffer around all identified sensitive resource areas unless another buffer distance is established by GRCA staff. Fencing, flagging, or taping of site boundaries shall correspond to the approved buffer. The NPS will mark avoidance boundaries in the field by flagging, fencing, or taping for Contractor avoidance.

3.2 UNANTICIPATED DISCOVERY PROTOCOL

A. General Requirement: If previously undocumented sensitive resources are encountered at any time during construction, including but not limited to cultural resources, paleontological resources, biological resources (including nests or roosts), or other protected environmental resources, the Contractor shall immediately halt work in the vicinity of the discovery.

B. Initial Actions
   1. Secure the discovery area to prevent further disturbance.
   2. Do not collect, move, photograph, or otherwise handle materials.
   3. Notify the Contracting Officer (CO) immediately. The CO will contact the appropriate Park resource program manager(s).

C. Direction & Authorization
   1. Follow CO direction for evaluation, protection, and any required coordination (Cultural Resource Program Manager for archeology/human remains; Park Wildlife Program for biological resources).
   2. Work shall not resume in the affected area until authorized by the CO.

D. Cross-References: Implement this protocol in conjunction with:
   1. Section 01 35 13.22 “Archeological Protection” (stop-work for human remains and concealed paleontological resources).
   2. Section 01 35 05 “Wildlife Protection Requirements” and “Vegetation Clearing Timing – Wildlife Driven Avoidance Requirements”

3.3 WILDLIFE PROTECTION REQUIREMENTS

A. Wildlife protections are subject to all applicable federal laws, including Migratory Bird Treaty Act and the Endangered Species Act.

B. Critical species include Humpback Chub, Razorback Sucker, California Condor, Mexican Spotted Owl, Desert Bighorn Sheep, and Special Status Bat Species.

C. All areas to be disturbed shall be within the Limits of Construction (LOC) as noted on the drawings and have boundaries flagged by the Contractor before beginning the activity, and all disturbance and project activities shall be confined to the flagged areas. Disturbance outside flagged areas is prohibited.

D. All project vehicles shall be driven at speeds within posted speed limits on existing roads and shall not exceed 20 mph within project boundaries.

E. Project personnel shall exercise caution when commuting to the project area and obey speed limits to minimize any chance for the inadvertent injury or mortality of species encountered on roads leading to and from the project site.

F. Contractor shall develop a Spill Response Plan based on the Grand Canyon National Park's (Park) Parkwide Spill Response Plan to prevent potential poisoning of wildlife and soil and water contamination.

G. Project sites shall be cleaned up at the end of each day the work is being conducted (e.g., trash disposed of/secured appropriately and scrap materials picked up) to minimize the likelihood of California condors visiting the site. Park wildlife program staff may conduct periodic spot checks to ensure adequate project clean-up measures are being appropriately undertaken.

H. Trash and recycling receptacles and all dumpsters shall be wildlife-proof certified and will be tightly covered to avoid wildlife access.

I. Contractor shall not feed or approach Wildlife.

J. Contractor shall avoid any interaction with condors and immediately contact park wildlife program staff or park dispatch if condors visit a project site. If California condor nesting activity is known within 0.5 miles of a project area, then light and heavy construction equipment (as defined in 01 35 05, Attachment A) in the project area will be restricted during the active nesting season from February 1 to September 30. These dates may be modified based on the most current information, in consultation with the park biologist, the park Section 7 Coordinator, and the U.S. Fish and Wildlife Service.

K. If condors visit a project site, construction project activities shall cease until the condors leave on their own or until techniques, such as hazing, are employed by permitted park personnel that result in the condors leaving the area.

L. If using erosion netting, biodegradable matting with a large-diameter natural fiber shall be used to prevent entrapment of wildlife.

M. Park wildlife biologists will train contractor staff, at the preconstruction meeting, to avoid disturbance to any wildlife species (reptiles, migratory birds, raptors, and bats) found nesting, hibernating, estivating, or otherwise living in, or immediately nearby, work sites.

N. Work involving trenching or digging holes, provisions (generally in the form of ramps, with a slope less than 45°) must be made every 50 feet to allow for the escape of animals that may fall into these recesses, or they must be covered in such a way as to prevent animals (vertebrates) from falling into them.

O. Notify park dispatch and wildlife staff for any physical encounter with bats. If Park wildlife biologists determine that bat specific surveys or roost protection requirements apply, the Contractor shall implement those measures in addition to the requirements of Section 3.5 VEGETATION CLEARING TIMING AND WILDLIFE-DRIVEN AVOIDANCE MEASURES.

P. Care shall 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. Work shall cease if wildlife is encountered in a manner that may result in harm, until Park wildlife biologists provide direction.

Q. Wildlife Department personnel shall be notified/consulted when any wildlife must be disturbed or handled. They will be available to assist with moving/relocating wildlife, when necessary; and/or to make recommendations for relocating any disturbed animals.

R. Vegetation-disturbance limitations implemented for wildlife protection, including seasonal clearing windows, nest-survey requirements, avoidance buffers, and coordination with USFWS, are specified in Section 3.5 VEGETATION CLEARING TIMING AND WILDLIFE-DRIVEN

AVOIDANCE MEASURES. The Contractor shall implement those requirements as wildlife-protection measures for this Project.

3.4 SOUNDSCAPES

A. Reduce equipment noise with best industry practices.

3.5 VEGETATION CLEARING TIMING AND WILDLIFE-DRIVEN AVOIDANCE MEASURES

A. Seasonal Avoidance Requirement
   1. To protect migratory birds, roosting bat species, and other animals using trees and shrubs for forage, nesting, and shelter, the Contractor shall avoid vegetation clearing to the greatest extent possible between April 1 and August 31, the primary bird nesting season. Protection measures for roosting bat species shall be implemented when directed by Park wildlife staff, consistent with the species-specific guidance provided by the National Park Service or USFWS.
   2. Scheduling shall prioritize vegetation removal outside this window unless infeasible due to construction constraints.

B. Requirements When Clearing Cannot Avoid the Nesting Window
   1. If vegetation removal during April 1–August 31 is unavoidable, surveys are required by a qualified biologist. The survey shall be conducted within five (5) days prior to the scheduled vegetation removal.
   2. If the Park is unable to provide a qualified biologist, the Contractor shall retain a qualified biologist. The biologist shall document the survey(s) in a written report and provide the report to the Park for review and acceptance prior to any vegetation removal.

C. Restrictions Based on Survey Findings
   1. If active nests or breeding behavior are detected during surveys, no vegetation removal or other construction activities shall occur within 150 feet of the nest or observed breeding activity.
   2. The 150-foot restriction remains in place until nestlings have fledged, the nest fails, or breeding behaviors are no longer observed.

D. Proceeding Within the 150-Foot Radius
   1. If vegetation removal is to occur while nests are active or breeding behavior is observed, the Contractor must coordinate with USFWS to determine if a Migratory Bird Treaty Act (MBTA) permit or additional avoidance and/or minimization measures are required.
   2. The Contractor shall implement the U.S. Fish & Wildlife Service Nationwide Avoidance & Minimization Measures for Birds. No work may begin until USFWS guidance or permitting (if required) is complete.

E. Responsibility for Delay Costs
   1. The Contractor shall record all nest surveys, buffers, restrictions, and USFWS coordination in the Vegetation Clearing Log and submit updates weekly to the Contracting Officer (CO) and Park Environmental staff.

F. Documentation
   1. The Contractor shall record all nest surveys, buffers, restrictions, and USFWS coordination in the Vegetation Clearing Log and submit updates weekly to the Contracting Officer (CO) and Park Environmental staff.

3.6 VEGETATION AND SOIL MANAGEMENT

A. If erosion-control fencing is used, soil will be piled in front of the fence to avoid creating bare soil and potential for invasive plant species encroachment outside the project area.

B. Trenching and construction equipment transported to the site from outside the park will first be pressure washed to minimize the potential to import invasive plant seed and material to the site.

C. Pruning necessary for the project will adhere to the park's pruning guidelines with the goal of retaining the health and integrity of trees and shrubs treated. Damage to trees or roots in or adjacent to project sites during construction will be avoided as much as possible and, if avoidance is not possible, root pruning guidelines provided by the park's Vegetation Management Program will be followed.

D. Imported fill materials required for the project will be obtained from a park-approved source in adherence to Standard Operating Procedure 8213-007 (01 35 05, Attachment B) Invasive Plant Free Forage and Construction Materials.

1. In areas where ground disturbing activities are planned, all topsoil will be properly salvaged, stored, and redistributed. Topsoil is a term used for A (or A and part of B) horizons or the uppermost layer of soil capable of growing and supporting vegetation. Topsoil contains the essential microorganisms, nutrients, organic matter, and physical characteristics necessary to grow and sustain vegetation. Stripping, stockpiling, and reusing topsoil on construction projects is essential for proper revegetation of disturbed areas. To help guide topsoil management actions, the contractor will access the USDA NRCA Web Soil Survey website (https://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm), delineate project areas, and produce customized soil reports specific to each project area (e.g., North Rim WWTP, Collection System Improvements, Ballfield, Supai Tunnel, Roaring Springs Pumphouse, etc.) where soil disturbance will occur. The USDA Web Soil Survey generated reports will include soil profile descriptions, soil mapping units, characteristics, topsoil depth, soil textures, rock content, soil depth, available water holding capacity, permeability rates, and drainage classes. 120 days before the start of topsoil management actions, the contractor will meet with the Contracting Officer (CO) and GRCA Vegetation Program Manager to discuss the USDA NRCS Web Soil Survey reports and finalize topsoil management actions per project area.
2. The Contractor will remove all topsoil prior to all other soil disturbing operations. The Contractor will remove the topsoil in one pass, will not mix topsoil with subsoil, and will not compact or drive upon topsoil during removal. Topsoil salvage depth by location may vary, but as a general rule a minimum of 6 inches of material shall be conserved in all cases, and additional topsoil may be salvageable in some locations.
3. Live vegetation less than 3 feet in height and limbs less than 1 inch in diameter shall be incorporated as topsoil in the stockpiles. The contractor will properly dispose or bury all topsoil contaminated with invasive non-native plant species as directed by the Contract Officer (CO) and GRCA Vegetation Program Manager.
4. The salvaged topsoil will be stockpiled in windrowed piles along the outer edge of the limits of construction. If possible, the topsoil will be stockpiled in a disturbed area to minimize the impact to adjacent vegetation. If it is impractical to stockpile topsoil adjacent to the disturbed area or objectionable to the Contracting Officer (CO) and GRCA Vegetation Program Manager due to environmental or other concerns within an area, the contractor will remove the topsoil and stockpile at an approved location.
5. Salvaged topsoil will be separated from the sub-soil and stockpiled in windrowed piles no higher than three feet, and no wider than three feet. The contractor will identify removal areas and stockpiles so that topsoil may be replaced in the same locations. If salvaged topsoil must be stored longer than 3 weeks, topsoil stockpiles will be hydroseeded and hyrdo-mulched by the contractor with locally collected seed provided by the GRCA Vegetation Program.

6. Prior to reapplying the topsoil, the contractor will disk or scarify all disturbed areas to a depth of 6” in a direction perpendicular to the natural flow of water. Prior to topsoil placement, if the Contracting Officer (CO) and GRCA Vegetation Program Manager determines that subsoil is excessively compacted by the NPS or contractors’ operations, the contractor will scarify the subsoil to a depth of 24” to de-compact and break the interface between particles.
7. When reapplying topsoil, the contractor will avoid mixing the topsoil with subsoil material. The contractor will spread conserved topsoil to a depth of 4 inches or greater (if additional topsoil is available) over all disturbed soil areas. Topsoil will be spread using the lightest weight equipment applicable. If the Contracting Officer (CO) and GRCA Vegetation Program Manager determine that topsoil is excessively compacted by the NPS or contractors’ operations, the contractor will scarify the topsoil to a depth of 8” to de-compact and break the interface between particles.

E. Water will be applied for dust abatement at the following project sites: North Rim Wastewater Treatment Plant.

3.7 OTHER ENVIRONMENTAL PROTECTION MEASURES

A. The contractor shall be responsible for obtaining and complying with all permits necessary to complete the work based on contractor means and methods. Contractor shall pay all permit fees required and provide all materials, labor, and equipment necessary to comply with permit conditions and provisions at no additional expense to the government. Refer to Section 01 31 00 – Project Management and Coordination.

B. Contractor shall provide all storm water control, erosion control, dust control, air quality control, water quality control, and other pollution control measures necessary to comply with all Federal, State, and municipal laws, codes, rules, regulations, and permits applicable to performance of the work at no additional expense to the government. Contractor shall ensure all construction personnel are aware of all applicable requirements.

C. Contractor shall develop and adhere to a Spill Prevention and Response Plan to ensure that fuel, oil, lubricants, and other hazardous material spills do not occur. Plan will be in accordance with the Grand Canyon National Park's (Park) Parkwide Spill Response Plan. If spills occur, cleanup shall be completed by the contractor at no additional expense to the government.
1. When gasoline, diesel fuel, antifreeze, hydraulic fluid or any other chemical contained within the vehicle is released to the pavement or ground, proper corrective, clean-up, and safety actions specified in the Spill Prevention and Response Plan must be immediately implemented. All vehicles with load rating of 2 tons or greater should carry, at minimum, enough absorbent materials to effectively immobilize the total volume of fluids contained within the vehicle. Repair oil leaks immediately on discovery. Do not use equipment that is leaking. Have oil pans and absorbent material in place prior to beginning repair work. Have the "on scene" capability of catching and absorbing leaks or spillages of petroleum products including antifreeze from breakdowns or repair actions with approved absorbent materials. Keep a supply of acceptable absorbent materials at the job site in the event of spills. Sand or soil are not approved absorbent materials. Use oil pans and absorbent materials to prevent leaks, spills and draining petroleum fluids from falling onto bare ground and paved surfaces during servicing of equipment. Dig up soils contaminated with such fluids, place in appropriate safety containers, and dispose of according to state and/or federal regulations.
2. Equipment found operating on the project that has oil leaks will be shut down and subject to fines.

D. Equipment Washing and Inspections

1. Vehicle and equipment washing is required to preclude entry of seeds, other plant materials (e.g., stems, rhizomes), and soil capable of non-native plant species establishment and spread. The contractor will make arrangements for the Contracting Officer (CO) or GRCA Vegetation Program staff to inspect each vehicle and piece of equipment before entering the Park boundaries. All equipment shall be thoroughly pressure washed and cleaned outside of the Park boundaries before entering. Equipment leaving the park for any reason must be re-washed before returning to the job site.
2. The Contractor shall clean equipment that will be used off surfaced roadways, or approved roadways, prior to the equipment entering the Park Area. It is recommended that cleaning be accomplished by pressure washing, using water only. All equipment surfaces shall be cleaned, with special emphasis given to the undercarriage. This includes, but is not limited to: wheel wells, bumpers, radiator grills, springs, shock absorbers, wire harnesses, skid plates, oil pans, axles, frame ledges, buckets, tracks, belly pans, etc. Cleaning shall also include all dirt and debris inside the cab, or operator area. A Shop-Vac or commercial car wash vacuum system may be used for operator compartments, provided the method used effectively removes all visible debris. Vehicle and equipment cleaning is for the purpose of removing seeds, other plant materials (e.g., stems, rhizomes) and soil accumulations to prevent the potential spread of non-native plants from outside the Park to locations inside the Park. The contractor will make arrangements for the Contracting Officer (CO) or GRCA Vegetation Program staff to inspect each vehicle and piece of equipment before entering the project area. Cleaning shall be performed in a manner that will reasonably remove all visible soil, plant and other foreign material. All equipment that requires washing shall be inspected by government personnel, or contractors/partners assigned to this duty, to ensure compliance.
3. Equipment that requires washing is generally defined as track or rubber-tired machinery intended for use primarily off-road. Examples include backhoes, loaders, earthmovers, graders, rollers, bulldozers, water trucks, etc.; or four wheel drive or passenger vehicles that are driven in off road areas. Equipment may also be stationary, such as a material screening plant, conex storage containers, or a mobile office (mobile offices may be cleaned in the same manner as operator compartments as outlined in 3.3.D.2). The equipment is generally under the direct control of the contractor or sub-contractors, is likely to remain on the construction site for an extended period of time, and may contain adhered soil and seed from other project sites.
4. Equipment/vehicles that do not require washing are defined as those normally used for highway driving only and travel primarily on paved surfaces and well maintained service roads and parking areas. Examples include semi-tractor trailers, dump trucks, concrete trucks, pickup trucks, fuel trucks, service trucks, etc. These delivery and passenger vehicles are generally not under the direct control of the contractor, have no earth-moving function, and do not remain on the project site. These vehicles have a low probability of carrying adhered soil and seed from other projects. However, every vehicle and piece of equipment is subject to rejection from entering the Park if there are obvious signs (covered in mud, plant material adhered to it, etc.) that it could be transporting non-native species into the Park.
5. The Contractor shall make arrangements for the COR to inspect each piece of equipment before entering the project. The COR will maintain records of inspections. Equipment not passing initial inspection must be rewashed outside the Park at no additional expense to the government.
6. Equipment found operating on the project that has not been inspected, will be shut down and subject to fines

E. Upon completion of work, leave area in a clean, natural looking condition as specified in Section 01 57 23 – Temporary Stormwater Pollution Prevention.. Remove all signs of temporary construction and activities incidental to construction of required permanent work.

END OF SECTION 01 35 05

Initial Spill Information Report Form Please fill in as much of the following as possible, using information provided by the caller/reporting official. **Bold fields are of primary importance.**

Date of Report _____ and Time ____:____ AM ____ PM____
Date of Spill/Event _____ and Time ____:____ AM____ PM ____
Name of caller
_____
Telephone number(s) of caller (include area code)
_____
Company Name (if applicable)
_____
Address
_____
Town _____ State _____ Zip Code _____
Name of other informed party _____ Phone Number _____
Type of product alleged spilled
_____
Estimated amount of spill
_____
Is more spillage possible? _____ (Yes or No) Amount? _____
Is the current situation URGENT? _____ (Yes or No) Is HELP needed? _____ (Yes or No)
Nature of call or complaint
_____
Actions taken so far
_____
What resources are at risk? (Check all that apply)
☐Public Safety ☐Surface Drainage
☐Public Water or Well ☐Storm Sewer
☐Private Water or Well ☐Sanitary Sewer
☐Atmosphere ☐Vapors in Building
☐Land or Ground ☐None (complaint only)
☐Open Water
Location of incident
_____
Specific directions to site
_____
_____
_____

SECTION 01 35 10 - TEMPORARY WASTEWATER TREATMENT MANAGEMENT PLAN

PART 1 - GENERAL

1.1 SUMMARY

A. Planning, implementation/construction, and operation of a Temporary Wastewater Treatment System at the North Rim.

B. Contractor is responsible for providing and operating the entire system including replenishment of consumables, spare parts management, and on-time replacement of all parts required to maintain equipment and process operations to meet Arizona Department of Environmental Quality (ADEQ) effluent requirements.

C. Site Conditions:
   1. Approximate TWWTP system location: 36°13'2.70"N, 112° 3'55.93"W.
   2. Approximate site elevation: 8,300 FT-ABOVE SEA LEVEL.
   3. The aviation corridor adjacent to construction activities will be cordoned off with construction fencing to include warning signs on both sides of the access road into the WWTP area. No material or equipment can be stored within the aviation corridor. Limited construction activities may occur within the aviation corridor as needed to complete the work if no other reasonable means of construction are available; this work will be requested 72 hours in advance to CO/COR and on-site CMR for coordination with NPS aviation operations. All fencing and erosion control within proximity of aviation corridor impacted by rotor wash will be secured to prevent blowing hazards to construction and aviation operations. All personnel will receive aviation safety brief upon first arriving to the site to include the restricted activities of the aviation corridor and general safety protocols of the aviation zone.

1.2 RELATED SECTIONS

A. Section 01 33 23 – Submittal Procedures

B. Section 01 35 05 – Environmental Protection and Special Controls

C. Section 01 35 15 – Discharge Emergency Response Plan

1.3 SUBMITTALS

A. Submit under provisions of Section 01 33 23.

B. Temporary Wastewater Treatment Management Plan (TWTMP): Submit detailed implementation plan per the requirements in this specification. This plan will include but not be limited to:
   1. Communication/Documentation Plan for coordination with NPS and engineering staff, construction document handling (submittals, RFI, etc.), overall project management, etc.
   2. Operations Plan for how the TWWTP will be handed over to third-party operations staff. The plan will include but not be limited to:
      a. Strategy for competitively hiring third-party operators

b. Details for how third-party operators will be trained by TWWTP manufacturer
c. Details for how third-party operators will be supported by the TWWTP manufacturer throughout the life of the TWWTP.
d. Details for how the TWWTP will be started and shut down seasonally.
e. Details for how the Contractor will coordinate with NPS staff to haul and dispose of TWWTP screenings and solids and ensure regulatory compliance. Biosolids Management Plan (BMP) Required §1(D) and §3.2(H) reference ADEQ requirements and disposal tickets to be provided to demonstrate proper disposal. 30 days prior to commissioning, identifying the disposal practice pathway (Part 503 Subpart B, C, or D), receiving facility permit information, pollutant characterization sampling plan, VAR method, and recordkeeping protocol per §503.17.

3. Submittal of TWTMP shall be a minimum of 30 days prior to work planned.

1.4 QUALIFICATION

A. The Contractor responsible for developing the TWTMP and suppling/installing the TWWTP is required to have a minimum of three years of experience in the supply of wastewater management of treatment and collection systems.

B. The Contractor responsible for operating the TWWTP shall have an operator with a Grade 3 Wastewater Operator License for operating a wastewater treatment plant permitted for 0.15 MGD in the State of Arizona.

1.5 TEMPORARY WASTEWATER TREATMENT MANAGEMENT PLAN

A. The Contractor shall submit to the Contracting Officer a TWTMP for installation and operation of the TWWTP. The plan shall be submitted a minimum of thirty (30) working days prior to installation. The TWTMP shall indicate the sequence of installation operations, and will establish all other operations to maintain wastewater treatment service during the construction period. The TWTMP shall be reviewed and approved by the Contracting Officer at least five (5) working days before any action can be taken. No deviation from the approved TWTMP will be allowed without prior written approval.

B. The TWTMP shall include a Discharge Emergency Response Plan indicating the procedures, personnel, equipment, and activities that will be implemented in the event of a discharge, spill or overflow to the environment. The Contractor shall be responsible for implementation of the Discharge Emergency Response Plan in accordance with Section 01 35 15.

C. The Contractor shall submit with the TWTMP all maintenance procedures and their intended frequency both during the operating season and during the off-season/winterization period.

D. The Contractor shall observe and comply with all Federal, State, and local laws, ordinances, codes, orders, and regulations which in any manner affect the conduct of the work, specifically as they relate to discharges, spills, or overflows to the environment. The Contractor shall be fully responsible for preventing permit violations, discharges, spills or overflows; containing discharges, spills or overflows; recovery and legal disposal of discharges, spills or overflows; any fines, penalties, claims and liability arising from negligent or willful discharge, spill or overflow, and violation of any law, ordinance, code, order, or regulation as a result of the discharge, spill or overflow. The Contractor shall be responsible for payment of any fines or penalties assessed against the Contracting Officer for such discharges, spills, or overflows,

including any attorney fees and costs associated with defending any action against the Contracting Officer resulting from such discharges, spills or overflows.

E. The Contractor shall not damage existing public and private improvements, interrupt existing services and/or facility operations which may cause a discharge, spill or overflow. Any utility and/or improvement which is damaged by the Contractor shall immediately be repaired at the expense of the Contractor.

F. The Contractor will be charged for all costs associated with Park staff members' efforts if they are dispatched to the system failure.

G. The Contractor is prohibited from discharging any groundwater, stormwater or hazardous waste encountered during the construction project to the sanitary sewer system without prior written approval of the Contracting Officer.

H. As part of TWTMP, contractor to provide a roles and responsibilities matrix that includes the NPS.

PART 2 - PRODUCTS

1. Not Used

PART 3 - EXECUTION

3.1 OPERATION OF TEMPORARY WASTEWATER TREATMENT PLANT

A. Contractor is responsible for operating the TWWTP to include effluent discharge, screenings and biosolids disposal. Effluent must meet the minimum ADEQ effluent requirements. Park staff will take daily samples to confirm the system is operating per the discharge permit.

B. Operator shall meet all license requirements established by ADEQ to operate a wastewater treatment plant permitted for 0.15 MGD, Grade 3 Arizona Wastewater Operator License.

C. The Contractor shall inspect and maintain the TWWTP daily.

D. Contractor shall perform daily effluent monitoring and meet permitted effluent limits.

E. The Contractor shall submit as part of the TWTMP, the monitoring procedure and frequencies for the TWWTP. The Contractor shall dedicate a minimum of one person to the system whose sole function/responsibility is to continuously monitor the operation of the pumps and the water level in the tanks to detect any possible failure that may cause a wastewater discharge, spill or overflow to the environment, or failures to the existing diversion system or utility connections, etc . A minimum of one qualified person shall be available for operation of the TWWTP at all times (24 hours a day 7 days a week) to monitor the system while treatment operations are active (operator has to be present at the TWWTP 8 hours per day 5 days per week).

3.2 COMMUNICATION/DOCUMENTATION

A. The Contractor shall maintain a daily log of all inspection, maintenance and repair records, and provide weekly copies to the Contracting Officer.

B. The Contractor shall immediately report to the Contracting Officer any spill, major process upset, major equipment failure, or any other event in which may cause a reportable event to the ADEQ and/or cause a violation of the ADEQ permit.

3.3 TEMPORARY TREATMENT SYSTEM FAILURE

A. In the event of a spill or overflow, or permit violation, immediately implement the Discharge Emergency Response Plan (See Section 01 35 15).

END OF SECTION 01 35 10

SECTION 01 35 13.22 – ARCHEOLOGICAL PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

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

1.2 DEFINITIONS

A. 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.

B. Archeologically Sensitive Areas: Areas having potential to contain significant (National Register eligible) archeological resources. If archaeological resources cannot be avoided, park archaeologists will develop an appropriate mitigation strategy in consultation with the State Historic Preservation Office and as appropriate with the park's associated Tribes.

C. Non-sensitive Areas: Areas with little potential of containing significant (National Register eligible) archeological resources.

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

E. 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.

F. National Historic Preservation Act and Statute: The National Historic Preservation Act (NHPA) of 1966 is a federal law that protects the United States' historic and archaeological sites with the goal to preserve cultural heritage, protect sites from federal development, and encourage preservation.

1.3 SUBMITTALS

A. Daily Work Schedule: Submit a Daily work Schedule detailing construction work in archeologically sensitive areas. Submit to Contracting Officer (CO) 30 days before start of ground disturbing site work.

1.4 QUALITY ASSURANCE

A. At least one week before on-site work begins, and prior to submittal of the Daily Work Schedule, the Contractor shall meet with Contracting Officer and Archeological Monitor to discuss Daily Work Schedule, equipment, and special methods used in archeologically sensitive areas.

B. Contractor shall ensure approved Daily Work Schedule is followed throughout construction. If schedule changes occur, the Contractor will provide an update to the approved submittal and coordinate schedule changes with the CO and NPS Archeological Monitor a minimum of 48 hours in advance of work.

PART 2 - PRODUCTS

2.1 DAILY WORK SCHEDULE

A. Daily Work Schedule is required for work occurring within archeologically sensitive areas. Include all work that is to occur within the area 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 at each archeologically sensitive area.

PART 3 - EXECUTION

3.1 ARCHEOLOGICAL PROTECTION

A. Provide and maintain a minimum 16-foot (5-meter) buffer around all identified archeological sites unless another buffer distance is established by GRCA Cultural Resources staff. Fencing, flagging, or taping of site boundaries shall correspond to the approved buffer. The NPS will mark avoidance boundaries in the field by flagging, fencing, or taping for Contractor avoidance.

B. Archeological Monitor will observe all ground-disturbing site work, including construction of temporary facilities, at known archeologically sensitive areas, 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, perimeter staking, and GPS as a reference point to record locations of findings.

C. The Secretary of the Interior's Standards for the Treatment of Historic Properties with Guidelines for the Treatment of Cultural Landscapes and Director's Order 28: Cultural Resources Management will be followed for this project.

D. If previously unknown cultural (archeological) resources are encountered during construction, the Contractor shall immediately stop all work in the immediate vicinity of the discovery prior to any further disturbance and notify the Cultural Resource Program Manager, followed by notification to the COR. Work shall not resume in the affected area until the Cultural Resource Program Manager has had sufficient time to investigate, document, and evaluate the discovery, determine

appropriate treatment measures, complete any required consultation, and approve resumption of work.

E. Contractor personnel, subcontractor personnel, and all other persons not qualified and expressly authorized by the Cultural Resource Program Manager shall be prohibited from entering or disturbing any archeological site and from collecting, handling, moving, or removing artifacts or other cultural materials. Prohibited materials include, but are not limited to, historic bottles, cans, projectile point, and other artifact types.

F. If human remains are encountered at any time, all work in the immediate vicinity of the discovery shall cease immediately, prior to any further disturbance. The Contractor shall immediately notify the Cultural Resource Program Manager. If an archeologist is not present, the Contractor shall report the location and nature of the discovery to the Cultural Resource Program Manager. Access to the discovery area shall be limited to personnel authorized by the Cultural Resource Program Manager, and all other construction personnel shall leave the area. Human remains shall be treated with respect and dignity at all times. No photographs, video, drawings, sketches, or other visual documentation. Discussion of the discovery except as necessary to notify appropriate staff and implement required procedures, shall be limited. Work shall not resume in the affected area until the Cultural Resource Program Manager authorizes resumption of work.

G. Activities will be conducted in a way that will not damage or move inventoried paleontological resources. If concealed paleontological resources are encountered during project activities, all necessary steps will be taken to protect them.

H. Although there is no surface evidence of paleontological resources, if concealed paleontological resources are encountered during project activities, all necessary steps will be taken to protect them, and an appropriate mitigation strategy will be developed.

I. Buildings and Structures: Preserve and protect all historic buildings and structures within the project area. The Contractor shall prepare a protection plan for any Work that may affect historic buildings or structures. The protection plan shall be reviewed by the GRCA Historical Architect, the GRCA Cultural Resource Program Manager, and other appropriate staff before such Work begins.

3.2 BARRICADES

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

3.3 ARCHEOLOGICAL INVESTIGATION BY NON-NPS PERSONNEL

A. Archeologic investigations by non-NPS or unqualified personnel (NPS or non-NPS) is prohibited. All access to investigate, document, access, archeological resources must be approved by the Cultural Resource Program Manager.

3.4 OBSERVATION

A. An Archeological Monitor shall be present during all ground-disturbing activities unless monitoring is determined to be unnecessary by the Cultural Resource Program Manager. The Archeological Monitor, in coordination with the Contractor’s field crew, shall establish a safe means of observing active ground-disturbing work while maintaining adequate visibility of the area being disturbed.

3.5 DISCOVERY OF RESOURCES

A. If Archeological Monitor discovers resources, immediate relocation of work to a non-sensitive area may be required to allow the Monitor time to identify, consult, and document resources and, if necessary, develop, and implement, an appropriate mitigation plan. Contractor shall relocate work to non-sensitive areas where monitoring is not normally sensitive required.

B. If resources are discovered while Archeological Monitor is absent, stop work immediately and report the discovery to the Contracting Officer.

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 01 35 13.22

SECTION 01 35 15 - DISCHARGE EMERGENCY RESPONSE PLAN

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Development of a Discharge Emergency Response Plan, to be implemented in the event of a discharge, spill or overflow to the environment, or a diversion system failure, including loss of a plug.

1.2 RELATED SECTIONS

A. Section 01 33 23 – Submittal Procedures.

B. Section 01 35 10 – Wastewater Flow Management Plan.

1.3 SUBMITTALS

A. Submit under provisions of Section 01 33 23.

B. Emergency Response: Detailed implementation plan.

1.4 DISCHARGE EMERGENCY RESPONSE PLAN (DERP) DEVELOPMENT

A. The Contractor shall develop and submit to the Contracting Officer at least thirty (30) working days prior to the start of construction at a site requiring flow management, a written Discharge Emergency Response Plan (DERP) in a form similar to the attached sample at the end of this section. The level of detail contained in the sample plan shall be considered the minimum requirements. The DERP shall be developed to respond to any construction related discharge, spill or overflow to the environment or an event that could lead to a discharge, spill or overflow to the environment, or an outage of the temporary wastewater treatment system. The Contractor's DERP shall not rely on the Park's personnel for emergency response, but they may be dispatched, at the Contracting Officer's discretion, to provide additional assistance. The Contractor is prohibited from discharging any groundwater, stormwater, or hazardous waste encountered during the construction project to the sanitary sewer system without prior written approval of the Contracting Officer.

B. The DERP shall include at minimum, the following:

1. Development of an emergency notification procedure that complies with state and federal requirements including but not limited to, CWA §311 (NRC notification, 1-800-424-8802), A.R.S. §49-201, and A.A.C. R18-8-268. The Contractor shall designate primary and secondary representatives, their respective phone numbers, and mobile phone numbers. Contracting Officer contacts shall also be listed.

2. Identification of personnel and equipment/tools that will be utilized in the event of a discharge, spill or overflow to the environment. Include an emergency response team with arrangements for backup personnel and equipment. The emergency response team shall be able to dispatch to the site 24 hours a day 7 days a week including weekends

and holidays to respond immediately to any discharge, spill or overflow to the environment related to the Project work.

3. Identification of storm inlets, manholes and waterways in the immediate project area.

4. Step-by-step procedures to contain, control, and minimize discharges, spills or overflows to the environment.

5. Cleanup procedures.

6. Typical plug search and retrieval procedures.

C. At the pre-construction meeting, the Contractor will be provided with a list of Contracting Officer representatives to contact in case of a discharge, spill, or overflow to the environment. These contacts shall be added to the DERP.

D. Contractor cannot begin work on temporary wastewater treatment or bypass pumping until the Contracting Officer has approved the DERP in writing. An approved copy of the DERP shall be available on the job site at all times.

E. It shall be the Contractor's responsibility to assure that all employees, including subcontractors, know and obey all emergency procedures included in the DERP.

1.5 DISCHARGE EVENT

A. In the event of a discharge, spill, or overflow to the environment, or an event that could lead to a discharge, spill, or overflow to the environment, the Contractor shall:

1. Immediately implement the DERP without direction from the Contracting Officer, to control and contain the discharge, spill, or overflow to the environment.

2. Contact Contracting Officer and representatives immediately. Contact ADEQ with two hours of spill 602-771-2330. Information to provide shall include at minimum, the following:

   a. location of discharge, spill, or overflow to the environment;
   b. estimated volume;
   c. time discharge, spill, or overflow began;
   d. duration if already terminated, or expected duration if in progress;
   e. cause (if known), if not known provide only the known facts
   f. control measures implemented;
   g. type of remedial and/or clean up measures taken;
   h. description of affected or potentially affected sensitive areas such as waterways, channels, catch basins and entrances to existing underground storm drains;
   i. Evidence of any environmental and/or human health impacts.

3. Based on this information, the Contracting Officer will determine if the discharge, spill or overflow is contained.

4. If the discharge, spill or overflow is deemed reportable, the Contractor shall draft a follow up report to regulatory agencies and submit to the Contracting Officer for review. The draft shall be submitted within 3 working days and the final report submitted by certified mail within 5 working days of the incident.

B. The Contractor shall, within two (2) working days of the discharge, spill or overflow, or other event prompting implementation of the DERP, submit to the Contracting Officer a written Discharge Incident Report (Figure 1).

C. The Contracting Officer will evaluate the suggested procedural changes to avoid further discharges, spills, overflows or emergencies and will instruct the Contractor to revise the DERP and Wastewater Flow Management Plan (WFMP) if applicable to incorporate these changes. The Contracting Officer may institute further corrective actions, as deemed necessary. The Contractor shall not resume work at a site requiring flow management until the revised DERP and WFMP if applicable has been approved.

D. The Contractor shall observe and comply with all Federal, State, and local laws, ordinances, codes, orders, and regulations which in any manner affect the conduct of the work, specifically as they relate to discharges, spills, or overflows to the environment. The Contractor shall be fully responsible for preventing discharges, spills, or overflows to the environment, containing the discharges, spills or overflows, recovery and legal disposal of discharges, spills or overflows, any fines, penalties, claims and liability arising from negligent or willful discharge, spill or overflow, and violation of any law, ordinance, code, order, or regulation as a result of the discharge, spill or overflow. The Contractor shall be responsible for payment of any fines or penalties assessed against the Contracting Officer for any such discharge, spill or overflow, including any attorney fees and costs associated with defending any action against Contracting Officer resulting from such discharge, spill or overflow.

E. The Contractor shall not damage existing public and private improvements, interrupt existing services and/or facility operations which may cause a discharge, spill or overflow to the environment. Any utility and/or improvement which is damaged by the Contractor shall immediately be repaired at the expense of the Contractor.

F. Once the discharge, spill or overflow has been contained and the situation causing the event has been stabilized, the Contractor shall restore the affected areas to original condition, as soon as possible.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 01 35 15

(SAMPLE DERP)

PROJECT NAME

GRCA 318719 – REHABILITATE NORTH RIM INFRASTRUCTURE

DISCHARGE EMERGENCY RESPONSE PLAN

EMERGENCY NOTIFICATION PROCEDURES:

In the event of a wastewater discharge, spill or overflow to the environment, partial or complete line blockage, construction debris entering the sewer stream, or another emergency, the following parties shall be notified immediately, and the Emergency Response Plan initiated. Calls will be placed in the numerical order shown below. If unable to reach a person, a voice message will be left and the next person will be called. This process will be repeated until contact is made with someone from Contractor, Contracting Officer and the Contracting Officer.

Contractor Contacts:

1.	Call Office	303-999-9999	(24 hr. phone)
2.	xxxxx	303-999-9999	(Home)
		303-999-9999	(Cell)
3.	xxxxx	303-999-9999	(Home)
		303-999-9999	(Cell)
4.	xxxxx	303-999-9999	(Home)
		303-999-9999	(Cell)

Contracting Officer Contacts:

1.	xxxxx	303-286-9999	(Office)
		303-999-9999	(Home)
2.	xxxxx	303-999-9999	(Office)
		303-999-9999	(Cell)
3.	After hours	303-999-9999	(24-hour Emergency Line)

EQUIPMENT AVAILABLE:

All equipment, but not limited to the equipment listed below, necessary to contain or mitigate a sewage spill shall be on site within one hour of when the spill occurs.

- **Vac Con Combo Jet Truck (2700 gal. Capacity)**. This truck can be used to clear a blockage as well as provide 2,700 gallons of storage capacity.

- **12" Pump w/ 550' of discharge hose**. This pump and hose will be on standby and can be delivered and set up quickly to help in the event of primary and redundant pump failures.

- Repair clamps for HDPE pipe.

- Heat welding equipment for HDPE pipe.

- Small backhoe to move earth and help contain spill.

CONTAINMENT/MITIGATION

In the event of a wastewater discharge, spill or overflow, Contractor will immediately implement the Emergency Response Plan. The first priority will be to prevent any wastewater from entering any waterways, streams and storm sewers. Dikes or berms will be constructed as needed. The next priority will be to prevent any wastewater from reaching and contaminating groundwater. Mitigation and cleanup will begin once the situation has been brought under control. Any free standing wastewater on the ground will be pumped and the soil will be removed until uncontaminated dry soil is reached. Photos will be taken to document mitigation. Photos will also be taken to document any property damage.

A completed Wastewater Discharge Incident Report will be submitted to the DPM as soon as possible or within a maximum of 48 hours of the start of any wastewater discharge, spill or overflow.

1. NOTIFICATION REQUIREMENTS

Contractor is solely responsible for any liability for violations of any State or federal environmental law or regulation, and hereby indemnifies the Contracting Officer from any such liability associated with a wastewater discharge, spill or overflow as a result of their work on the Contracting Officer's facilities. In the event of a discharge, spill or overflow of pollutants - including raw wastewater - that has the potential to affect public health or the environment, the following parties shall be notified:

1.	xxxxx	303-999-99999	(Office)
		303-999-9999	(Home)
2.	xxxxx	303-999-9999	(Office)
		303-999-9999	(Cell)
3.	xxxxx	303-999-9999	(24-hour Emergency Line)

B. PREPARED BY:

XXX Construction Co.: _____

Signature Date

FIGURE 1

DISCHARGE
INCIDENT REPORT

Project Title:

Report Date:

Incident Date:

Discharge Location:

Time & Duration of Discharge:

Estimated Pollutant Volume:

Notification to Owner/Engineer
Who/When Notified:

Description of the Incident:

Cause (if known):

Control Measures Implemented:

Remedial and/or Cleanup Measures Taken:

Recommended Procedural Changes:

REPORTED BY: [Contractor Representative]

_____
Signature

Date

RECEIVED BY: [Owner Representative]

_____
Signature

Date

[Engineer Representative]

_____
Signature

Date

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 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.

1.3 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 representatives for preparation and maintenance of the APP.
   a. Designate Lead Site Safety Supervisor
   b. Designate Innercanyon Site Safety Supervisor in support of the Lead Site Safety Supervisor
   c. Lead and Innercanyon Site Safety Supervisors shall have received Wilderness Safety Training and Wilderness First Aid Training.

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.

1.4 ACCIDENT REPORTING

A. Reportable Accidents: 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.

1. Notify Contracting Officer immediately in the event of a reportable accident.
2. 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.

B. Near Miss: Contractor to report all near-miss incidents (including minor incidents).
1. An employee who witnesses a near miss incident must complete the Near Miss Reporting form and submit to a Manager or Human Resources. The reporting system will not result in disciplinary action of the reporter and, if desired by the person reporting, may be anonymous;
2. All near miss incidents will be reviewed by company management to identify the root cause and the weaknesses in the system contributing to the incident. The reporting individual may be asked to participate in the incident investigation; and
3. Investigation results will be used to improve safety systems, hazard control, risk reduction, and to educate employees. All of these represent opportunities for training, feedback on performance, and a commitment to continuous improvement.

1.5 RESOURCES – N/A

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.
5. Planning for possible emergency situations, as detailed in Article 1.2. Such planning shall take nature of construction, site conditions, and degree of exposure of persons and property into consideration.
6. Heat stress management plan.
7. Aviation Coordination Plan

a. Includes communication plan: at minimum contractor and CMR will contact the South Rim Helibase to coordinate daily flight operations no later than 830am each day for aviation activity that may impact the North Rim Helibase.
b. Contractor will inspect construction fencing, erosion control, and any miscellaneous construction materials prior to any planned aviation operations at the North Rim Helibase.
c. Construction and safety barrier fencing with 500ft of the aviation corridor will be heavy gauge metal fencing secured to the ground to provide stability of the fencing from rotor wash aviation operations; heavy helicopters utilize the North Rim Helibase, i.e. chinook or equivalent, fencing to be structural sound and fastened to the ground and/or with ballast to not be impacted by heavy helicopter rotor wash.

8. 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.

2.2 FIRST AID FACILITIES

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

B. Contractor first aid facilities shall be established in locked facilities at North Rim WWTP.

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 National Fire Protection Association 2024 International Fire Code, Chapter 33.

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 01 35 23

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SECTION 01 35 73 - DELEGATED DESIGN PROCEDURES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. General provisions for delegated design services.
2. Coordination of delegated designs with other Work.
3. Qualifications requirements for delegated design professionals.
4. Limitations on Contracting Officer's review of delegated design Submittals.
5. Responsibilities of delegated design professionals.

B. Scope:

1. Where delegated design is specifically Contractor's responsibility in accordance with the Contract Documents, Contractor shall provide labor, services, other effort, and pay all costs necessary and required to perform delegated design services for Work that will be part of the completed Project as a functioning whole.
2. Perform delegated design Work in accordance with the Contract Documents, delegated design Action Submittals approved by Contracting Officers Representative, and Shop Drawings, product data Submittals, and Samples approved by the associated delegated design professional.
3. Contractor's correction period, general warranty and guarantee, and obligations for safety and protection apply to delegated design Work to the same extent such provisions apply to all other Work under the Contract.
4. Specifications requiring delegated design services include, but are not necessarily limited to, the following:

    a. Section 03 15 19 - Anchorage to Concrete.
    b. Section 09 22 16 – Non-Structural Metal Framing.
    c. Section 26 41 13 – Lightning Protection System.
    d. Section 40 05 07 – Pipe Support Systems.

5. Not Delegated Design: The following are not delegated design and are not covered by this Section:

    a. Contractor's use of design professionals for: (1) temporary construction or temporary facilities not part of the completed Project as a functioning whole, or (2) Contractor's means, methods, procedures, techniques, and sequences of construction and safety and protection measures incident thereto.
    b. Certain final designs that, in accordance with commonly accepted practice, are typically prepared by unlicensed, unregistered individuals, including for manufactured or fabricated systems, components or assemblies, not acting under the supervisory control of the design professional in responsible charge, but who commonly possess appropriate certification from a relevant industry organization, together with appropriate training and experience.

C. Related Requirements:

1. Sections of Divisions 02-46 where delegated design Work is required.

1.2 REFERENCES

A. Terminology:

1. Terminology indicated below are not defined terms and are not indicated with initial capital letters but, when used in this Section and Specifications of Division 02-46 where delegated design Work is required, have the meaning indicated below:
   a. "Delegated design" means preparing the final design of part of the completed, permanent Work by one or more delegated design professionals, in accordance with the Contract Documents. The terms "delegated design", "delegated design services", "delegation of design responsibility", and similar or derivative terms have the same meaning.
   b. "Delegated design professional" means the licensed and registered engineer, architect, geologist, or other design professional retained by or employed by Contractor, Subcontractor, or Supplier to perform delegated design services for delegated design Work and possessing appropriate experience and qualifications for such delegated design services.
   c. "Delegated design Work" means delegated design services, associated construction, and related Work.
   d. "Instruments of service", relative to delegated designs, means delegated design professional's: (1) certifications (including delegated design professional's certification of compliance, as required in this Section, and other certifications required of delegated design professional), (2) reports (where required), (3) design drawings, (4) design specifications, (5) other documents specifically indicated as delegated design professional's "instruments of service" in the Contract Documents, and (6) documents modifying a delegated design (after Contracting Officer's Representative approval of the original delegated design Submittals). "Instruments of service" are to be sealed, signed, and dated by delegated design professional and expressly required as Submittals. Shop Drawings sealed and signed by delegated design professional are delegated design professional's "instruments of service".

1.3 GENERAL PROVISIONS CONCERNING DELEGATED DESIGN SERVICES

A. Delegated Designs - General:

1. This Section augments the requirements of the General Conditions, as may be amended by the Supplementary Conditions, and other provisions of the Contract Documents regarding Contractor's responsibilities for delegated design Work.
2. Delegated design professionals or their employer shall furnish professional liability insurance. Provisions on professional liability insurance are set forth in the Division 1 Specifications.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Coordination - General:
   a. Contractor shall coordinate the services of delegated design professionals with all other elements of the Work.
   b. Contractor has full responsibility for scheduling delegated designs and all related Work.

c. Allow sufficient time in Progress Schedule for performance of delegated design services, including requests for interpretation or clarification between delegated design professional and Contractor and between Contractor and Contracting Officer.

2. Coordination of Delegated Design Work's Connections to Other Work:

a. Where delegated design Work connects to other Work designed by Contracting Officer's Representative, existing construction, or both, the delegated design Work shall be consistent with the other Work and existing construction to which delegated design Work connects, and adjacent construction.

b. Submit details, loading, anchorage, and other coordinating information necessary for the delegated design Work to properly interface with Work designed by Contracting Officer's Representative.

c. Changes in the Work, whether designed by Contracting Officer's Representative, designed by delegated design professional, or existing construction, necessary as a result of the delegated design are ineligible for increase in Contract Price or Contract Times, unless: (1) otherwise agreed by Contracting Officer, or (2) expressly indicated otherwise elsewhere in the Contract Documents for the associated delegated design Work.

d. Changes requiring extra compensation, time, or both arising from delegated design aspects needed for convenience of Contractor, Subcontractor, or Supplier, are not grounds for increase in Contract Price or Contract Times.

3. Coordination of Submittals, Fabrication, Production, and Shipment:

a. Do not release for raw materials procurement, fabrication, production, and shipment to the Site materials, equipment, or systems designed by delegated design professional until the associated delegated design professional has reviewed and approved all associated Shop Drawings, product data, Samples, and (relative to shipment) source quality control Submittals, and such Submittals have been delivered to and accepted by the Contracting Officer.

1) For delegated design systems that required reactions to be submitted to the Contracting Officer. These submittals shall be submitted and approved first before approval is given for the delegated design submittal.

b. Allow sufficient time in the Progress Schedule for required Submittals and required actions by delegated design professionals and Contracting Officer's Representative.

1.5 QUALITY ASSURANCE

A. Qualifications:

1. Delegated Design Professionals:

a. Each delegated design professional shall possess not less than the minimum qualifications set forth in this provision. Where the Specifications for the associated delegated design Work establish more-stringent qualifications requirements, comply with the more-stringent requirements.

b. Each delegated design professional shall comply with all of the following:

1) Legally qualified, as both an individual and as a business entity, to practice the associated design discipline(s) in the jurisdiction where the Site is located, including possessing current, valid license and registration for the design discipline(s) for which the delegated design professional will render its services on the Project.

2) Possess not less than five years of experience in the subject design discipline(s).

3) Served as design professional in responsible charge on not less than five other designs similar in scope and complexity to the Work for which delegated design professional is retained on the Project; construction of such prior projects shall be complete by the start of the Project's construction.

c. Summary of Qualifications: Submit to Contracting Officer summary of delegated design professional's experience and qualifications, including:
   1) Evidence of coverage under appropriate professional liability insurance in accordance with the Contract Documents.
   2) Evidence of delegated design professional's ability to legally conduct business as a design professional in the same jurisdiction as the Site, as a business entity.
   3) Copy of delegated design professional's current, valid personal design professional license and registration for the same jurisdiction as the Site. Such documents shall indicate the individual's name, license or registration number, and dates for which the license or registration is valid.
   4) Other information reasonably requested by Contracting Officer.

1.6 GENERAL PROVISIONS FOR DELEGATED DESIGN SUBMITTALS

A. Under the Division 02-46 Specifications section(s) where delegated design Work is required, furnish to Contracting Officer Submittals such as:

1. Action Submittals:

   a. Delegated design professional's instruments of service Submittals.

2. Informational Submittals:

   a. When delivered to Contracting Officer, the following must bear delegated design professional's Submittal approval stamp:
      1) Shop Drawings, product data Submittals, Samples, testing plans.
      2) Results of source quality control and field quality control activities.
   b. Delegated design professional's calculations.
   c. Reports of delegated design professional's visits to the Site, bearing delegated design professional's dated signature.
   d. Other Informational Submittals required for the subject delegated design Work.

B. Limitations of Contracting Officer's Review of Delegated Design Submittals:

1. Delegated Design Professional's Instruments of Service Submittals:

   a. Contracting Officer's review of delegated design instruments of service Submittals is for the limited purposes indicated herein.
   b. The following disclaimer applies to Contracting Officer's responses to delegated design professional's instruments of service Submittals:
      1) Contracting Officer's review and approval of delegated design instruments of service is only for the limited purpose of verifying that performance and design criteria given in the Contract were used in the delegated design, and checking for compliance with the Contracting Officer's Representative design concept expressed in the Contract Documents.
      2) Contractor is solely responsible for complying with: the Contract Documents, Subcontractor and Supplier instructions consistent with the Contract Documents, Owner's directions, and Laws and Regulations.

3) Contractor is solely responsible for obtaining, correlating, confirming, and correcting dimensions at the Site; quantities; information and choices pertaining to fabrication processes; means, methods, sequences, procedures, and techniques of construction; safety precautions and programs incident thereto; and for coordinating the Work of all trades.
4) The Contractor Officer is not responsible for the effects of resubmittals or tracking progress of resubmittals.

2. Delegated Design Informational Submittals:

a. Other provisions of the Contract Documents notwithstanding, Contracting Officer's review of delegated design Informational Submittals is limited to only:
1) Verifying the Submittal was furnished as required; and
2) Submittal generally appears complete (except for calculations); and
3) Submittal bears delegated design professional's approval stamp; or, for calculations prepared by or for delegated design professional, that such calculations bear delegated design professional's seal, signature, and date; or, for delegated design professional's reports of visits to the Site, that such report is legible, and bears delegated design professional's signature with date.

b. Contracting Officer receives such Submittals, including delegated design professional's calculations, on behalf of Owner, for Owner's records.

c. Contracting Officer and others involved in the Project have the right to rely on delegated design professional's approval stamp as meaning that the delegated design professional has performed and appropriate review of the Submittal and determined it to be complete, in accordance with delegated design professional's instruments of service approved by Contracting Officer's Representative, in accordance with delegated design professional's design intent, and in accordance with the Contract Documents.

3. Contracting Officer Representative's Other Comments on Delegated Design Submittals:

a. Despite the limitations of Contracting Officer's review of Submittals for delegated design Work, should Contracting Officer become aware of, or reasonably suspect existence of, potential of associated delegated design Work to adversely affect health, safety, or welfare of persons, or pose reasonable potential for damage to the Work, work of other contractors, or adjacent property, Contracting Officer's will advise Contractor in writing of general nature of Contracting Officer's concern.

b. Such advisory by Contracting Officer, if issued, is rendered in good faith and does not in any way constitute:
1) Contracting Officer's review of all aspects of the delegated design.
2) Any sharing by Contracting Officer of any of delegated design professional's responsibilities or professional liability.
3) Any responsibility imposed, in any way, on Contracting Officer for any aspect of the delegated design professional's services or design, beyond the limited purposes of Contracting Officer's review as set forth in the Contract Documents.

c. Contractor and its Subcontractors and Suppliers, including delegated design professionals, shall immediately investigate Contracting Officer's concern indicated in such advisory and remedy as necessary and required.

d. Neither Contracting Officer nor Owner, nor their respective consultants and subcontractors, is obligated to review any Submittal for delegated design Work beyond the limited review required by the Contract Documents. No such advisory, if issued, entitles Contractor, Subcontractor, or Supplier, including delegated design professionals, to rely on such advisory or to

assume that any further such reviews or written or oral advisories are forthcoming.

1.7 RESPONSIBILITIES OF DELEGATED DESIGN PROFESSIONALS

A. Standard of Care:

1. Unless a higher standard of care is established by the Division 02-46 Specifications section where the associated delegated design Work is required, the delegated design services shall comply with the following standard of care:
    a. Except as provided in the paragraph immediately above this, the standard of care for all delegated design professional services and related services performed or furnished by delegated design professionals for the Project will be the care and skill ordinarily used by members of the subject profession practicing under similar circumstances at the same time and in the same locality.

B. Responsibilities of delegated design professionals employed on the Work include, but are not necessarily limited to, the following, unless specifically indicated otherwise in the associated elements of the Contract Documents where the delegated design is required:

1. Ethical Conduct and Professionalism: Comply with Laws and Regulations and applicable standards and guidelines relevant design professional organizations for ethical conduct and professional practice.
2. Comply with Laws and Regulations and relevant design standards applicable to the subject delegated design Work.
3. Performance and Design Criteria Indicated in the Contract Documents and Other Information:
    a. Review performance and design criteria, indicated in the Contract Documents, that the delegated design Work must satisfy.
    b. Prepare written requests for interpretations or clarifications of performance or design criteria.
    c. Review existing information about the Site that constitutes Technical Data (if any, applicable to the subject delegated design Work), as indicated in the Supplementary Conditions.
4. Site Information and Investigations: With Contractor, obtaining all other necessary dimensions, field information, and other information necessary for preparing delegated design Submittals.
5. Design and Other Professional Services: Personally perform and prepare, or actively exercise direct, personal, supervisory control over others performing or preparing:
    a. Necessary design professional evaluations of conditions, materials, and equipment.
    b. Prepare the instruments of service Submittals and calculations Submittal for the subject delegated design Work, where required by the associated Division 02-46 Specifications and other, associated Contract Documents.
    c. Assist Contractor with applying for and obtaining permits and approvals (not previously obtained by Owner or those for whom Owner is responsible) necessary for the delegated design Work.
    d. Review and approve or take other appropriate action on Shop Drawings (unless such Shop Drawings are sealed and signed by delegated design professional), product data, Samples, and testing plans, and other Submittals associated with the delegated design Work.
    e. Prepare modifications of the delegated design instruments of service as necessary.
6. Sealing and Signing:

a. Seal, sign, and indicate date of sealing and signing, on all of the following when such Submittals are required by the Division 02-46 Specifications where the delegated design Work is required:
   1) Instruments of service Submittals, including certification of compliance required.
   2) Calculations.
   3) Modifications to the delegated design.
   4) Other documents required to be sealed and signed by Laws or Regulations or the Contract Documents.

b. Sealing and signing documents in accordance with Laws and Regulations and the Contract Documents, prior to submittal (through Contractor) to Contracting Officer, and for submittal to authorities having jurisdiction to obtain necessary permits and approvals.

7. Certification of Compliance by Delegated Design Professional:

   a. Schedule:
      1) Submit certification of compliance after Contracting Officer's acceptance of delegated design professional's qualifications statement.
      2) Obtain Contracting Officer's approval of certificate of compliance Submittal prior to furnishing other Submittals for delegated design Work under the same Specifications section, unless otherwise allowed by Engineer.

   b. Through Contractor, submit to Contracting Officer, delegated design professional's written certification indicating:
      1) General Information: (1) Project name and designation, (2) Contractor name and Contract designation, (3) Subcontractor or Supplier name (when applicable), (4) full name of delegated design professional's business entity under which the delegated design services were performed, (5) full name and license number of the individual sealing and signing the subject delegated design Work, (6) specific elements of delegated design Work to which the certification applies, and (7) delegated design professional's seal, signature, and date of signature.

   c. Explicit certification that the subject delegated design complies with:
      1) All applicable performance and design criteria indicated in the Contract Documents. Expressly indicate on certification of compliance the specific performance and design criteria used in the delegated design, and reaction forces of the delegated design imparted to other Work and existing construction. Reaction forces imparted from the delegated design elements to the Contracting Officer Representative's designed system shall include the following:
         a) Reaction forces imparted from the delegated design elements to the Contracting Officer Representative's designed system shall be presented as follows:
            (1) Unfactored loads per category (dead, live, wind, seismic, etc.).
            (2) Load combinations presented in Load Factor Resistance Design (LRFD) format from each element transmitting load.
         b) All Laws and Regulations.
         c) Applicable design standards commonly applicable to such types of construction. Expressly indicate such design standards on the certification of compliance.
         d) The applicable standard of care. Expressly indicate the applicable standard of care.

8. Approvals of Other Delegated Design Submittals:

   a. Review and taking appropriate action on Submittals for delegated designs:

b. Such reviews and approvals or other appropriate action shall be to ascertain compliance with:
   1) Delegated design professional's design intent.
   2) Delegated design professional's instruments of service and calculations.
   3) Associated requirements of the Contract Documents.

c. Delegated design professional's review stamp or facsimile thereof, review action or disposition concerning the associated Submittal for the delegated design, date of review, and name of person performing the review shall be clearly legible on the associated Submittals (except for delegated design professional's own instruments of service Submittals, calculations, and reports of delegated design professional's visits to the Site). Prominently display delegated design professional's Submittal review stamp or facsimile thereof on: (1) each sheet of Shop Drawings, (2) each major section of product data Submittals, (3) each Sample, (4) each testing plan, and (5) each other Submittal associated with the delegated design for which such review stamp is required.

d. Do not apply delegated design professional's Submittal review stamp and comments, if any, over other text, tables, or graphics.

e. Where review stamp or facsimile thereof is required, submit to Contracting Officer only those Submittals for delegated design Work that bear delegated design professional's explicit approval of the Submittal.

9. Respond promptly to requests for interpretation or clarification on delegated design professional's instruments of service and other Submittals for the delegated design Work.

10. Progress and Quality of Construction of Delegated Design Work:

    a. Where appropriate for the subject delegated design Work, periodically visit the Site at appropriate intervals to observe the progress and quality of the subject delegated design Work.

    b. Where delegated design professional does not visit the Site during construction, keep informed of the progress and quality of the subject delegated design Work via discussions with Contractor, Subcontractor, and Suppliers, via photographic documentation, and other means acceptable to delegated design professional.

    c. Advise Contractor in writing when the subject delegated design Work is not in accordance with the delegated design professional's instruments of service (approved by Contracting Officer) and related Submittals approved by delegated design professional.

    d. Furnish to entity that retained delegated design professional copy of delegated design professional's written report of each visit to the Site.

11. Modifications to Design:

    a. Design appropriate modifications to the delegated design Work, including preparing new or revised certifications, reports, design drawings, sketches, design specifications, and calculations, as appropriate.

    b. Such instruments of service and calculations shall be submitted to Contracting Officer through Contractor to same extent original instruments of service Submittals and calculations, if any, where required by the Contract Documents for the subject delegated design Work.

12. Other services, as mutually agreed upon by delegated design professional and its client, or as required elsewhere in the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 01 35 73

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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. "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.

B. "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.

C. "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.

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. "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.

F. "Replace" - 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:

1. 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.
2. Replacement with New Materials: Includes replacement with new material of like kind (custom fabricated of manufactured). Duplication of appearance using like material.

3. 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.

G. "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.

H. "Remove and Reinstall" - To detach items from existing construction, repair and prepare for reuse, and reinstall where indicated.

I. "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.

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).
   a. Following contact award, the NPS will provide documentation to support the preparation of the HPTP based on consultation with the State Historic Preservation Office (SHPO) for the Contractor's use.
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 to 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: In accordance with Section 01 32 33 "Photographic Documentation," show existing conditions of adjoining construction and site improvements including finish surfaces that might be misconstrued as damage caused by historic treatment operations. Submit before work begins.

1.4 QUALITY ASSURANCE

A. Historic Preservation Treatment Specialist Qualifications: Experienced firm with required certifications and training able to demonstrate through past performance they are qualified to perform this work.

1.5 STORAGE AND PROTECTION OF HISTORIC MATERIALS

A. Removed and Salvaged Historic Materials:

1. Clean salvaged historic items.
2. Pack or crate items after cleaning. Identify contents of containers.
3. Store items in secure area until delivery to Contracting Officer.
4. Transport items to storage area indicated on Drawings.
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 new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use as designed.

C. Existing Historic Materials to Remain: Protect construction indicated to remain against damage and soiling during historic treatment. When permitted by Contracting Officer, items may be removed to suitable, protected storage location during historic treatment and reinstalled in their original locations after historic treatment 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 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 Fahrenheit.
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 Fahrenheit unless approved means are provided for maintaining 45 degrees Fahrenheit temperature of air and materials during, and for 48 hours subsequent to, cleaning.

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 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 sequence of work
3. Disassembly and reassembly techniques and steps
4. Equipment and tools required
5. Supplies and materials with manufacturer or supplier identified including specific clean up/storage procedure including frequency and documentation of such.
6. Skilled trades and crafts required
7. Anticipated testing and analysis of fabric
8. Additional investigations for extents or magnitude of treatments needed
9. Protective measures
10. Seasonal limitations on work
11. Alternative means if primary treatment method is unfeasible
12. 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.

C. 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 Contracting Officer prior to installation.

D. 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.

E. Existing Drains: Prior to start of work or cleaning operations, test drains and other water removal systems to ensure drains and systems function properly. Notify Contracting Officer immediately of stopped or blocked drains or systems. Do not begin Work of this Section until drains are in working order.

1. Provide method to prevent solids including stone or mortar residue from entering drains or drain lines. Clean out drains and drain lines blocked or filled 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.

3.3 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

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 consolidate 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.

END OF SECTION 01 35 91

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 Divisions 2 through 49 Sections for specific test and inspection requirements.

1.2 DEFINITIONS

A. 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.

B. 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.

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

F. Field Quality Control Testing: Tests and inspections performed on-site for installation of work and for completed work.

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

H. 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.

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 "Quality Assurance" Article 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.

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 four hours of noted deficiency.
4. Upload to CM Software

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 one calendar day after inspection was performed.

F. Off-Site 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 shall be assigned no 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 E 329; 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 attached STSI. 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 3 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: 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:

1. Access to Work.
2. Incidental labor and facilities necessary to facilitate tests and inspections.
3. Adequate quantities of representative samples of materials that require testing and inspecting. Assist agency in obtaining samples.
4. Facilities for storage and field curing of test samples.
5. Delivery of samples to testing agencies.
6. Preliminary design mix proposed for material mixes that require control by testing agency.
7. 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, off-site 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 OFF-SITE CONTROL

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

3.2 ON-SITE 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 on site.
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.

E. Additional Preparatory and Initial Phases: 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, on-site 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.

C. Quality Control Daily Reports shall accurately portray all work and materials. The materials shall match the materials as approved from the Construction Documents (CD) requirements. Combustible/flammable materials shall be documented as well.

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.

END OF SECTION 01 40 00

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STATEMENT OF STRUCTURAL TESTS AND SPECIAL INSPECTIONS

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

Park: Grand Canyon National Park (GRCA)

Project Management Information System (PMIS) Number: GRCA 318719

Project Name: Rehabilitate North Rim Utility Infrastructure

Project Area: North Rim District – Temporary Wastewater Treatment Plant - TWWTP

Structural Engineering Firm: HDR Engineering, Inc

This Statement of Structural Tests and Special Inspections is being submitted as required by Chapter 17 of the **2024 International Building Code** (IBC-24). 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: Juan Coronado PE
(Type or print name)

Signature: _____ Date: 06/10/2026

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

PART 1 - SEISMIC AND WIND REQUIREMENTS

1.1 SEISMIC REQUIREMENTS, IBC-24 SECTION 1704.3.2

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

Not applicable for the temporary treatment system package.

1.2 WIND REQUIREMENTS, IBC-24 SECTION 1704.3.3

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

Not applicable for the temporary treatment system package.

PART 2 - 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-24.
    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**.

PART 3 - 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

3.1 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

3.2 AMERICAN SOCIETY OF NON-DESTRUCTIVE TESTING (ASNT) CERTIFICATION

Non-Destructive Testing Technician – Level II or III

3.3 AMERICAN WELDING SOCIETY (AWS) CERTIFICATION

AWS-CWI Certified Welding Inspector

3.4 EXTERIOR DESIGN INSTITUTE (EDI) CERTIFICATION

EDI-EIFS Certified EIFS inspector

3.5 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

3.6 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

3.7 OTHER

_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____
_____ _____

PART 1 - 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-24 Section 1705.2; American Institute of Steel Construction: AISC 360-22 Chapter N, AISC 341-22 Chapter J)				
	Prior to Welding (AISC 360-22 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		X		
	b. Dimensions (alignment, root opening, root face, bevel)		X		
	c. Cleanliness (condition of steel surfaces)		X		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	d. Tacking (tack weld quality and location)		X		
	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 360-22 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	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	f. Interpass temperature maintained (minimum/maximum)			X	
	g. Proper position (F, V, H, OH)			X	
	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 360-22 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		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	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		
	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 360-22 Section N5 and AISC 341-22 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 341-22 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		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	3. Lamellar tearing		X		
	4. Beam cope and access hole		X		
	5. Reduced beam section repair		X		
	6. Weld tab removal		X		
	Prior to Bolting (AISC 360-22 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 360-22 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	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	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	
	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 360-22 Table N5.6-2)				
	Document acceptance or rejection of bolted connections.		X		
	Other Inspection Tasks (AISC 360-22 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-24 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-24 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 341-22 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 341-22 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 341-22 Table J9.2)				
	1. Achievement of minimum specified concrete compressive			X	
	Cold-formed Steel Trusses Spanning 60-feet or Greater (IBC-24 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-24 Section 1705.3)				
X	1. Inspect reinforcing steel, including prestressing tendons, and placement.	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**		X	**Prior to every concrete placement.**
X	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.	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**		X	**Prior to every concrete placement.**
X	4. Inspection of anchors post-installed in hardened concrete members.	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**			
	a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained tension load		X		
X	b. Mechanical anchors and adhesive anchors not defined in 4 a	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**		X	**During installation of at**

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
					least 40% of installed anchors.
X	5. Verify use of approved design mix.	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**		X	**Prior to concrete placement.**
X	6. Prior to placement fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	**ACI-CCSI/ACI-FTT; NICET-CT; ICC-RCS**	X		
X	7. Inspect concrete and shotcrete placement for proper application techniques.	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**	X		
X	8. Inspect for maintenance of specified curing temperature and techniques.	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**		X	**After each concrete placement.**
	9. Inspection of prestressed concrete:				
	a. Application of prestressing forces		X		
	b. Grouting of bonded prestressing tendons in the seismic-force-resisting system.		X		
X	10. Erection of precast structural members	**PE/SE; EIT; ACI-CCSI/ACI-FTT; NICET-CT**		X	**During preacast erection.**
	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		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	12. Inspect installation tolerances of precast concrete diaphragm connections for compliance with ACI 550.5 (American Concrete Institute).			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.			X	
	14. Inspection formwork for shape, location and dimensions of the concrete member being formed.			X	
	Masonry Construction (IBC-24 Section 1705.4)				
	1. Inspect masonry construction in accordance with IBC-24 Section 1705.4 and TMS 602-22 (The Masonry Society)/ACI 530.1-13 Article 1.6.				
	Level 1 Quality Assurance				
	Tests: None.				
	Inspection: Verify compliance with the approved submittal and project specifications.			X	
	Level 2 Quality Assurance				
	Tests:				
	1. Verify slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with TMS 602-22 Specification Article 1.5B.1.b.3 for self-consolidating grout.		X		
	2. Verify f'm and f'aac in accordance with TMS 602-22 Specification Article 1.4B prior to construction, except where specifically exempted.		X		
	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	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	c. Grade and size of prestressing tendons and anchorages.			X	
	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. Periodic inspection is required after the first 5000 square feet of AAC masonry.)		X	X	
	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		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	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	
	Level 3 Quality Assurance				
	Tests:				
	1. Verify f'm and f'aac in accordance with TMS 602-22/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 602-22/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		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	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		
	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-24 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	

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	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	
	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-24 Section 1705.6)				
X	1. Verify materials below shallow foundations are adequate to achieve the required bearing capacity.	**PE/GE; EIT; NICET-GET; NICET-ST; ICC-SSI**		X	**Prior to placement of foundation rebar and after installation of underground utility.**
X	2. Verify excavations are extended to proper depth and have reached proper material.	**PE/GE; EIT; NICET-GET; NICET-ST; ICC-SSI**		X	**After excavation is complete.**
X	3. Perform classification and testing of compacted fill materials.	**PE/GE; EIT;**		X	**Prior to placement of**

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
		NICET-GET; NICET-ST; ICC-SSI			**foundation rebar and after installation of underground utility or process piping.**
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.	**PE/GE; EIT; NICET-GET; NICET-ST; ICC-SSI**	X		
X	5. Prior to placement of compacted fill, inspect subgrade and verify that site has been prepared properly.	**PE/GE; EIT; NICET-GET; NICET-ST; ICC-SSI**		X	**Prior to placement of foundation rebar and after installation of underground utility or process piping.**
	Driven Deep Foundation Elements (IBC-24 Section 1705.7)				
	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		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	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-24 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		
	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-24 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		

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	e. Verify final installation torque.		X		
	f. Other data as required by the project specifications.		X		
	Fabricated Items (IBC-24 Section 1705.11)				
X	1. Inspect fabricated items in accordance with Section 1704.2.5.	**PE/SE; EIT; ICC-SSBSI;**	X		**For each prefabricated component to be installed on the site.**
	Wind Resistance (IBC-24 Section 1705.12)				
	1. Provide inspections when required by Section 1705.12.		X		
	Seismic Resistance (IBC-24 Section 1705.13)				
	1. Provide inspections when required by Section 1705.13.				
	Testing and Qualification for Seismic Resistance (IBC-24 Section 1705.14)				
	1. Test and qualify seismic resistance in accordance with IBC-24 Section 1705.14 and the project specifications.				
	Sprayed Fire-Resistant Materials (IBC-24 Section 1705.15)				
	1. Inspect sprayed fire-resistant materials in accordance with IBC-24 Section 1705.15 and the project specifications.				
	Mastic and Intumescent Fire-Resistant Coatings (IBC-24 Section 1705.16)				

Required?	Structural Test or Special Inspection	Required Qualifications	Continuous	Periodic	Frequency of Periodic Test or Inspection
	1. Perform inspections in accordance with AWCI 12-B (Association of the Wall and Ceiling Industry) and IBC-24 Section 1705.16.			X	
	Exterior Insulation and Finish Systems (EIFS) (IBC-24 Section 1705.17)				
	1. Perform inspections in accordance with project specifications and IBC-24 Section 1705.17.			X	
	Fire-Resistant Penetrations and Joints (IBC-24 Section 1705.18)				
	1. Perform inspections in accordance with project specifications and IBC-24 Section 1705.18.			X	
	Smoke Control (IBC-24 Section 1705.19)				
	1. Perform testing in accordance with project specifications and IBC-24 Section 1705.19.				
	Sealing of Mass Timber (IBC-24 Section 1705.20)				
	1. Perform testing in accordance with project specifications and IBC-24 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.

1.4 ABBREVIATIONS AND ACRONYMS

A. Industry Organizations: Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the entities found in 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 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*

B. 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)**

C. American Society for Testing and Materials International (ASTM):
- **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**
- **C1240 Standard Specification for Silica Fume Used in Cementitious Mixtures**
- **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**
- **C1319 Standard Specification for Concrete Grid Paving Units**
- **C1338 Standard Test Method for Determining Fungi Resistance of Insulation Materials and Facings**
- **C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates**
- **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**
- **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**
- **C33 Standard Specification for Concrete Aggregates**
- **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**
- **C67 Standard Test Methods for Sampling and Testing Brick and Structural Clay Tile**
- **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**
- **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**
- **D198 Standard Test Methods of Static Tests of Lumber in Structural Sizes**
- **D2103 Standard Specification for Polyethylene Film and Sheeting**
- **D217 Standard Test Methods for Cone Penetration of Lubricating Grease**
- **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**
- **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))**
- **D7186 Standard Practice for Quality Assurance Observation of Roof Construction and Repair**
- **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**
- **E241 Standard Guide for Limiting Water-Induced Damage to Buildings**
- **E2432 Standard Guide for General Principles of Sustainability Relative 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**
- **E90 Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements**
- **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**
- **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**

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 42 00

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SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for temporary utilities, support facilities, 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.

1. Up to a maximum 10,000 gallons per day from April 15 through October 15 without metering and without payment of use charges.
2. Potable Water from existing water system is available for use up to a maximum 5,000 gallons per day and 250,000 gallons total from October 16 through April 14.
3. Provide connections, certified backflow devices (with annual inspection and certification provided), meter and extensions of services as required for construction operations without any additional permit costs. Contractor shall record daily water use and submit to CO.

C. Electric Power Service: Electric power from existing system is available for use without metering and without payment of use charges. Provide connections and extensions of services as required for construction operations without any additional permit costs.

1.4 QUALITY ASSURANCE

A. Electric Service: Comply with National Electrical Contractors Association (NECA), National Electrical Manufacturers Association (NEMA), and Underwriter Laboratories (UL) standards and regulations for temporary electric service. Install service to comply with National Fire Protection Association (NFPA) 70.

B. Environmental Protection: Provide environmental protection as required by agency(ies) with jurisdiction and as indicated in Contract Documents. Coordinate with requirements of the following:

1. Regulatory Requirements
2. Indoor Air Quality (IAQ) Management
3. Noise and Acoustics Management
4. Environmental Management
5. Construction Waste Management

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 TEMPORARY 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 Asphalt Paving specification.

C. Chain-Link Fencing: Minimum 2 inch, 0.148 inch thick, galvanized steel, chain-link fabric fencing; minimum 6 feet high with galvanized steel pipe posts; minimum 2-3/8 inch OD (outside diameter) line posts and 2-7/8 inch OD corner and pull posts, with 1-5/8 inch OD top rails.

D. Safety Barrier Fence: Must be able to secure work areas from large wildlife such as elk. Provide chain link fencing or equivalent for safety barrier fencing within 500ft of the aviation corridor. Reference Specification 01 35 23 Safety Requirements for additional fencing requirements as it relates to the aviation corridor operations.

E. Barrier Tape: Yellow tape Imprinted with "CAUTION: CONSTRUCTION AREA," manufactured by Reef Industries, Inc., Houston, Texas, or approved equal.

F. Lumber and Plywood: Comply with requirements in Division 06 Section "Rough Carpentry."

2.2 TEMPORARY FACILITIES

A. Field Offices, General: Prefabricated or mobile units with serviceable finishes, temperature controls, and foundations adequate for normal loading.
   1. Locations at WWTP

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 720 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. Facilities shall be tied down as needed to protect from high winds.

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. Provide one (1) Contracting Officers Field Offices

1. Submit Field Office Plan that includes at a minimum a site plan with the proposed location each office within the limits of construction and temporary utilities connections/routing and floor plan dimensioned of the specific units to be supplied.

2. Outlets: Minimum of two, quad outlets with surge protection.
3. Refrigerator: Under counter, 3.2-cubic-foot volume with 0.8-cubic-foot freezer with dedicated power receptacle.
4. Fire Extinguisher: UL listed and FM (Fire Pump Motors) approved, minimum rating of 2-A:10-B:C, dry chemical.
5. First-Aid Kit: General office/light industrial kit which includes antiseptic wipes, bandages, disposable gloves, tape, instant cold pack, dressing pads, eye pads, and scissors.
6. 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 2-drawer and one 4-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.
7. Manufactured computer work station, capable of containing CPU (central processing unit), monitor, keyboard, printer; work station chair.
8. Additional tables necessary for copier.
9. Two 5-gallon trash cans and one 30-gallon trash can with lid.
10. Ceiling mounted general lighting fixtures.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate the 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.

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 the NPS collection system as directed by NPS.

C. Water for construction.

1. Available from the North Rim tank farm, and designated fire hydrants from May 15-October 15. Install piping and connections as required in the vicinity of the water source-must be within the limits of construction as indicated on the drawings. Facilities must be cleaned and maintained in a condition acceptable to NPS. At Substantial Completion, restore these facilities to condition existing before initial use.
2. Contractor shall furnish non-potable water from a source outside park boundary at all other times.

D. 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.

E. Heating: Provide temporary heating 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 system will not be allowed without written authorization from Contracting Officer. When the permanent heating system is approved for use as temporary heating, pay costs until final acceptance. Permanent heating 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. 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 shall start on date of Final Acceptance.

F. 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.

G. Existing Electric Power Service: Use of existing electric power service will be permitted, as long as equipment is maintained in a condition acceptable to NPS.

1. When temporary connections are removed, restore existing utility services to original condition.

H. Temporary Electric Power Service: Provide electric power service and distribution system of sufficient size, capacity, and power characteristics required for construction operations.

1. Install electric power service underground and within the limits of construction, 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. Lighting should be limited to what is necessary to safely perform work. Lights shall be angled down and include shielding.
3. Lights shall be turned off when work site is inactive.

J. Telephone Service: No telephone service is available on site for Contractor's use.

3.3 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. Contracting Officers Field Office:

1. Provide Heat, lights, power, temporary water pressure and sewage holding tanks.
2. Provide office, furnishings, and utility connections no later than 7 days prior to start of field activities. Exact location will be determined by Contracting Officer.
3. Maintain equipment, furnishings, and structures. Provide equipment replacement elements as needed. Provide weekly cleaning services and trash disposal. Maintain and service water and sewer holding tanks as required.

C. Temporary Roads and Paved Areas: Construct and maintain temporary roads and paved areas adequate for construction operations. Temporary roads shall only be constructed as shown on the drawings.

1. Coordinate elevations of temporary roads and paved areas with permanent roads and paved areas.

2. Vehicle traffic is often impassable on State Route 67 from Jacobs Lake to the North Rim Lodge and on other North Rim roadways from December 15- Mar 15. The contractor shall maintain access at all times if working at the North Rim during this period. Snow removal of State Highway 67 and North Rim roads will not be provided by NPS or the ADOT. Refer to specification 01 73 00.
3. Prepare subgrade and install subbase and base for temporary roads and paved areas according to Division 31 Section "Earth Moving."
4. Recondition base after temporary use, including removing contaminated material, regrading, proof-rolling, compacting, and testing.
5. Remove temporary roads and revegetate to existing conditions at completion. 90 days before the start of revegetation actions the contractor will meet with the Contracting Officer (CO) and GRCA Vegetation Program Manager to discuss planned actions.

D. Traffic Controls: Erect and maintain barricades, lights, danger signals, and warning signs in accordance with Manual on Uniform Traffic Control Devices (MUTCD), Part IV, latest edition.

1. Protect existing site improvements to remain including curbs, pavement, and utilities.
2. Maintain access for fire-fighting equipment and access to fire hydrants.
3. Illuminate barricades and obstructions at night; keep safety lights burning from sunset to sunrise.
4. Adequately barricade and post open cuts in or adjacent to thoroughfares.
5. Protect pedestrian traffic by guardrails or fences.
6. 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 ramps at changes of elevation.
7. Cover pipes, hoses, and power lines crossing sidewalks and walkways with troughs using beveled edge boards.
8. Install Barrier Tape where directed by Contracting Officer. Keep a minimum of two rolls on site.

E. Dewatering Facilities and Drains: Comply with requirements of NPS. 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.

F. Project Identification and Temporary Signs: Provide Project identification and other signs as indicated on Drawings. Fence, barricade, or otherwise block off the immediate work area to prevent unauthorized entry.

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 notification of construction activities and detour signs at road closures and along detour routes.
4. Erect and maintain sufficient notification of construction activities and detour signs at trailheads, along trails and along detour routes.

G. Waste Disposal Facilities: Provide waste-collection containers in sizes adequate to handle waste from construction operations. Comply with requirements of NPS.

H. Existing Stair Usage: Use of existing stairs will be permitted, as long as stairs are cleaned and maintained in a condition acceptable to Contracting Officer. At Substantial Completion, restore stairs to condition existing before initial use.

I. Temporary Use of Permanent Stairs: Cover finished, permanent stairs with protective covering of plywood or similar material so finishes will be undamaged at time of acceptance.

3.4 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 Prior to Mobilization: Contractor shall ensure prior to moving on to entering the park boundary equipment, is free of soil, seeds, vegetative matter, or other debris that could contain or hold seeds. Ensure equipment has been pressure washed and is free of soil, seeds, vegetative matter, or other debris that could contain or holds seeds or other plant material (e.g., stems, rhizomes). The contractor will make arrangements for the Contracting Officer (CO) or GRCA Vegetation Program staff to inspect each vehicle and piece of equipment before entering the project area. Equipment shall be considered free of soil, seeds, and other debris when visual inspection does not disclose such material. Disassembly of equipment components or specialized inspection tools are not required.

C. Cleaning of Equipment On-site: Contractor shall take care in washing tools and equipment to contain washdown, and properly clean and dispose of materials and fluids. Washdown should not be introduced to the environment.

D. Temporary Erosion and Sedimentation Control: Refer to Section 01 57 23 "Temporary Storm Water Pollution Prevention".

E. Tree and Plant Protection: Refer to Section 01 11 00 "Summary of Work".

F. 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.

G. Site Enclosure Fence: Before construction operations begin, furnish and install chain link fencing to prevent people and animals from easily entering site except by entrance gates.

1. Extent of Fence: As required to enclose entire Project site or portion determined sufficient 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.

H. 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.

I. Barricades, Warning Signs, and Lights: Comply with requirements of Manual on Uniform Traffic Control Devices (MUTCD), part IV, 2003 edition for erecting structurally adequate barricades, including warning signs and lighting.

J. 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.

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. 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.
2. Tobacco Use, Smoking, and Vaping: Smoking within buildings or temporary storage sheds is prohibited.
3. Supervise welding operations, combustion-type temporary heating units, and similar sources of fire ignition according to requirements of NPS. Check with Park; many require "burn permits" for welding.
4. 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.
5. Provide temporary standpipes and hoses for fire protection. Hang hoses with warning sign stating hoses are for fire-protection purposes only and are not to be removed. Match hose size with outlet size and equip with suitable nozzles.
6. Hazard Control: Take necessary precautions to prevent fire during construction. Do not store flammable or combustible liquids in 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.
7. 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.

8. 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.

9. Vehicles and Equipment: Provide one extinguisher on each vehicle or piece of equipment.
10. Service and Refueling Areas: Locate areas a minimum of 50 feet from buildings. Shut down equipment before refueling.

3.5 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 01 50 00

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SECTION 01 57 19.12 – NOISE AND ACOUSTICS MANAGEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Special requirements for noise and acoustics management during 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 7 A.M. to 9 P.M.

C. Nighttime: All non-daytime hours.

D. Receiving noise area: Any real property where people live or work and where noise is heard, excluding the project or source area.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 NOISE MANAGEMENT

A. Noise Control: Perform 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. Repetitive and/or intermittent, high-level noise (impact noise): Permitted only during Daytime.

1. Do not exceed the following A-weighted decibel (dBA) limitations at 100 feet:

Sound Level in dBA	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 100 feet:

EARTHMOVING	dBA	MATERIALS HANDLING	dBA
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		

C. Ambient Noise:

1. Maximum allowable noise levels (dBA) for receiving noise area at nearest occupied structure shall be as follows:

a. Visitor and Residential receiving area
Daytime: 65 dBA
Nighttime: 45 dBA

b. Administrative/Operations area
Daytime: 67 dBA
Nighttime: 65 dBA

c. In the event the existing local ambient noise level exceeds the maximum allowable receiving noise level, the allowable receiving noise level maximum for construction operations shall be adjusted as follows:

d. Residential receiving area: Maximum 3 additional dBA above the local ambient as measured at property line.

e. Commercial/Industrial receiving area: Maximum 5 additional dBA above the local ambient as measured at the property line.

3.2 FIELD QUALITY CONTROL

A. Assess potential effects of construction noise on adjacent NPS operations, concessionaire, and visitors in accordance with ASTM E1686 and as follows:

1. Ambient noise measurement: Measure at nearest occupied structure at a height of at least four (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 01 57 19.12

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 one (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, either 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 one (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. Inspection Schedule: Submit schedule for inspection and monitoring of storm water pollution prevention measures.

D. 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 project boundaries and outside limits of work performed under this Contract in their existing condition or restore to an equivalent or improved condition as approved by Contracting Officer.

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 Agency(ies) with Jurisdiction.

C. Notice of Termination (NOT): After Substantial Completion of Work, file a Notice of Termination (NOT) with the Agency(ies) with Jurisdiction.

D. Contracting Officer Notification: Contractor shall notify Contracting Officer in writing and by telephone of these events:

1. Erosion and sediment control meeting/briefing.
2. Following installation of required sediment control structures.
3. Prior to removal of or modification to sediment control structures.
4. 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. Furnish, install, maintain, and operate necessary control measures and other equipment necessary to prevent erosion as described in approved UPPP.

L. 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 STORM WATER POLLUTION CONTROL MEASURES

A. Temporary control measures shall be removed with permission of Contracting Officer within 20 working days after final acceptance of project, and/or once grading is complete and slopes have stabilized.

END OF SECTION 01 57 23

SECTION 01 61 03 - EQUIPMENT - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements of this Specification Section apply to all equipment provided on the Project including those found in other Divisions even if not specifically referenced in individual "Equipment" Articles of those Specification Sections.

B. Related Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 81 10 - Wind and Seismic Design Criteria.
   4. Section 03 15 19 - Anchorage to Concrete.
   5. Section 03 31 30 - Concrete, Materials and Proportioning.
   6. Section 05 50 00 - Metal Fabrications.
   7. Section 07 92 00 - Joint Sealants.
   8. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Gear Manufacturers Association (AGMA).
   3. ASTM International (ASTM):
      a. E1934, Standard Guide for Examining Electrical and Mechanical Equipment with Infrared Thermography.
      b. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
   4. Hydraulic Institute (HI):
      a. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
   5. International Electrotechnical Commission (IEC).
   6. Institute of Electrical and Electronics Engineers, Inc. (IEEE).
   7. International Organization for Standardization (ISO):
      a. 1940, Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State - Part 1: Specification and Verification of Balance Tolerances.
      b. 21940-11, Mechanical Vibration - Rotor Balancing - Part 11: Procedures and Tolerances for Rotors with Rigid Behavior.
   8. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Enclosures for Industrial Control and System.
      c. MG 1, Motors and Generators.
   9. International Electrical Testing Association (NETA):
      a. ATS, Acceptance Testing Specification for Electrical Power Distribution Equipment and Systems.
   10. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
   11. National Institute for Certification in Engineering Technologies (NICET).
   12. National Institute of Standards and Technology (NIST).
   13. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.
   14. Underwriters Laboratories, Inc. (UL).

a. 508, Standard for Safety Industrial Control Equipment.
b. 508A, Standard for Safety Industrial Control Panels.
c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

15. Vibration Institute.

B. All testing required by this specification section to be provided and paid for by Contractor.

C. Natural frequency analysis firm:
1. An independent firm, whose sole or principal part of its business is the calculation of and analysis of natural frequencies of rotating equipment.
2. Minimum of 10 years experience.
3. Employs a registered professional engineer who has experience in finite element analysis, rotordynamic analysis and experimental modal analysis.
a. Minimum five years combined field testing and data analysis experience.
b. Qualified Vibration Category III certification from the Vibration Institute.

D. Vibration Testing Program:
1. Testing firm:
a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
a. Minimum of three years field experience covering all phases of field vibration testing and data gathering.
b. Qualified Vibration Category II certification from the Vibration Institute.
3. Analysis personnel:
a. Minimum five years combined field testing and data analysis experience.
b. Qualified Vibration Category III certification from the Vibration Institute.

E. Infrared Thermography Testing Program:
1. Testing firm:
a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
a. Minimum of one year field experience covering all phases of field thermography testing and data gathering.
b. Supervisor certified by NETA or NICET.
3. Analysis personnel:
a. Minimum three years combined field testing and data analysis experience.
b. Supervisor certified by NETA or NICET.

F. Electrical Equipment and Connections Testing Program:
1. Testing firm:
a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration , and adjusting of systems.
b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
2. Field personnel:
a. Minimum of one year field experience covering all phases of electrical equipment inspection, testing, and calibration.
b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
c. Supervisor certified by NETA or NICET.

3. Analysis personnel:
    a. Minimum three years combined field testing and data analysis experience.
    b. Supervisor certified by NETA or NICET.

G. Miscellaneous:
1. A single manufacturer of a "product" shall be selected and utilized uniformly throughout Project even if:
    a. More than one manufacturer is listed for a given "product" in Specifications.
    b. No manufacturer is listed.
2. Equipment, electrical assemblies, related electrical wiring, instrumentation, controls, and system components shall fully comply with specific NEC requirements related to area classification and to NEMA 250 and NEMA ICS 6 designations shown on Electrical Power Drawings and defined in the Electrical specifications.
3. Variable speed equipment applications: The driven equipment manufacturer shall have single source responsibility for coordination of the equipment and VFD system and verify their compatibility.

1.3 DEFINITIONS

A. Product: Manufactured materials and equipment.

B. Major Equipment Supports - Supports for Equipment:
1. Located on or suspended from elevated slabs with supported equipment weighing 2000 LBS or greater, or;
2. Located on or suspended from roofs with supported equipment weighing 500 LBS or greater, or;
3. Located on slab-on-grade or earth with supported equipment weighing 5000 LBS or more.

C. Equipment:
1. One or more assemblies capable of performing a complete function.
2. Mechanical, electrical, instrumentation or other devices requiring an electrical, pneumatic, electronic or hydraulic connection.
3. Not limited to items specifically referenced in "Equipment" articles within individual Specifications.

D. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

E. Baseplate or Equipment Base Plate or Machine Base:
1. Are fabricated frames of structural shapes and plates with enough strength and sturdiness to serve as the surface to which other equipment is attached to and supported by. Baseplates can be directly mounted and grouted to concrete equipment support bases or machined and bolted to a sole plate.

F. Sole Plate:
1. A thick steel machined plate that is attached to and grouted to a concrete equipment support base.
2. Base plates are bolted to a sole plate when a sole plate is specified and/or provided.

1.4 SUBMITTALS

A. Shop Drawings:
1. General for all equipment:
    a. See Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
    b. Data sheets that include manufacturer's name and complete product model number.
        1) Clearly identify all optional accessories that are included.

c. Acknowledgement that products submitted comply with the requirements of the standards referenced.
d. Manufacturer's delivery, storage, handling, and installation instructions.
e. Equipment identification utilizing numbering system and name utilized in Drawings.
f. Equipment installation details:
    1) Location of anchorage.
    2) Type, size, and materials of construction of anchorage.
    3) Anchorage setting templates.
    4) Manufacturer's installation instructions.
g. Equipment area classification rating.
h. Shipping and operating weight.
i. Equipment physical characteristics:
    1) Dimensions (both horizontal and vertical).
    2) Materials of construction and construction details.
j. Equipment factory primer and paint data.
k. Manufacturer's recommended spare parts list.
l. Equipment lining and coatings.
m. Equipment utility requirements include air, natural gas, electricity, and water.
n. Ladders and platforms provided with equipment:
    1) Certification that all components comply fully with OSHA requirements.
    2) Full details of construction/fabrication.
    3) Scaled plan and sections showing relationship to equipment.

2. Mechanical and process equipment:
    a. Operating characteristics:
        1) Technical information including applicable performance curves showing specified equipment capacity, rangeability, and efficiencies.
        2) Brake horsepower requirements.
        3) Copies of equipment data plates.
    b. Piping and duct connection size, type and location.
    c. Equipment bearing life certification.
    d. Equipment foundation data:
        1) Equipment center of gravity.
        2) Criteria for designing vibration, special or unbalanced forces resulting from equipment operation.
3. Electric motor:
    a. Motor manufacturer and model number.
    b. Complete motor nameplate data.
    c. Weight.
    d. NEMA design type.
    e. Enclosure type.
    f. Frame size.
    g. Winding insulation class and temperature rise.
    h. Starts per hour.
    i. Performance data:
        1) Motor speed-torque curve superimposed over driven machine speed-torque curve during start-up acceleration and at rated terminal voltage a minimum permissible or specified terminal voltage for all motors over 50 HP.
        2) Time-current plots with acceleration versus current and thermal damage curves at the operating and ambient temperatures and at rated terminal voltage and minimum permissible or specified terminal voltage for all motors over 50 HP.
        3) Guaranteed minimum efficiencies at 100 PCT, 75 PCT, and 50 PCT of full load.
        4) Guaranteed minimum power factor at 100 PCT, 75 PCT, and 50 PCT of full load.
        5) Locked rotor and full load current at rated terminal voltage and minimum permissible or specified terminal voltage.

6) Starting, full load, and breakdown torque at rated terminal voltage and minimum permissible or specified terminal voltage.

j. Bearing data and lubrication system.

k. Natural frequency calculations for:
   1) Completed assembly including but not limited to the equipment base, rotating piece of equipment, and the rotating piece of equipment driver.
   2) Individual piece of rotating equipment.
   3) Equipment driver and connected gear reducer, if applicable.

l. Thermal protection system including recommended alarm and trip settings for winding and bearing RTD's.

m. Fabrication and/or layout drawings:
   1) Dimensioned outlined drawing.
   2) Connection diagrams including accessories (strip heaters, thermal protection, etc.).

n. Certifications:
   1) When utilized with a reduced voltage starter, certify that motor and driven equipment are compatible.
   2) When utilized with a variable frequency controller, certify motor is inverter duty and the controller and motor are compatible.
      a) Include minimum speed at which the motor may be operated for the driven machinery.

o. Electrical gear:
   1) Unless specified in a narrow-scope Specification Section, provide the following:
      a) Equipment ratings: Voltage, continuous current, kVA, watts, short circuit with stand, etc., as applicable.
   2) Control panels:
      a) Panel construction.
      b) Point-to-point ladder diagrams.
      c) Scaled panel face and subpanel layout.
      d) Technical product data on panel components.
      e) Panel and subpanel dimensions and weights.
      f) Panel access openings.
      g) Nameplate schedule.
      h) Panel anchorage.
      i) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.

4. Systems schematics and data:
   a. Provide system schematics where required in system specifications.
      1) Acknowledge all system components being supplied as part of the system.
      2) Utilize equipment, instrument and valving tag numbers defined in the Contract Documents for all components.
      3) Provide technical data for each system component showing compliance with the Contract Document requirements.
      4) For piping components, identify all utility connections, vents and drains which will be included as part of the system.
5. For factory painted equipment, provide paint submittals in accordance with Section 10 50 00, 46 07 53, and drawing A101.
6. Qualifications for:
   a. Natural frequency analysis firm and personnel.
   b. Vibration testing firm and personnel.
   c. Infrared thermography testing firm and personnel.
   d. Electrical equipment and connections testing firm and personnel.
7. Equipment Monitoring and Testing plans, in accordance with PART 3 of this Specification Section:
   a. Natural frequency analysis and calculations.
   b. Vibration testing.

c. Thermography testing.
d. Electrical equipment and connection testing.

B. Factory Test Reports:
1. Natural frequency bump test reports where required for rotating equipment.
a. Minimum characteristics of impact hammer.
1) Frequency Range 1 kHz.
2) Range (5v output) 5,000 LBF (22,200 N).
3) Hammer Sensitivity (7pprox.) 1 mV/lbf (0.23 mV/N).
4) Resonant Frequency 12 kHz
2. Motor, equipment and final assembled equipment including motor.
a. Determine natural frequency of assembled motor prior to shipping to OEM or job site.
1) Individual motor fastened to an “infinitely rigid” mass at the same bolt circle as the final assembled equipment.
b. Determine natural frequency of the pump.
1) Pump fastened to an “infinitely rigid” mass at the same bolt circle as the final assembled equipment.
c. Determine natural frequency of the pump/motor assembly.
1) Pump/motor assembly fastened to an “infinitely rigid” mass at the same bolt circle as the final field assembled equipment.
d. For this use, the "infinitely rigid" mass shall be at least 10 times the weight of the equipment being tested.
3. Submit natural frequency report(s) for approval prior to shipment.
4. Equipment performance tests.
a. As listed in individual equipment specifications.

C. Informational Submittals:
1. Notification, at least one week in advance, that testing will be conducted at factory.
2. Certification from equipment manufacturer that all manufacturer-supplied control panels that interface in any way with other controls or panels have been submitted to and coordinated with the supplier/installer of those interfacing systems.
3. Submit sample Manufacturer's Field Service Report (MFSR). Report shall use manufacturer’s standard report or use the form in the Exhibits and have at least the following information:
a. Certification that equipment has been installed properly, has been initially started up, has been calibrated and/or adjusted as required, and is ready for operation.
b. Certification for major equipment supports that equipment foundation design loads shown on the Drawings or specified have been compared to actual loads exhibited by equipment provided for this Project and that said design loadings are equal to or greater than the loads produced by the equipment provided.
c. Motor test reports.
d. Field noise testing reports if such testing is specified.
e. Preliminary field quality control testing format to be used as a basis for final field quality control reporting.
f. Provide three bound final written reports documenting natural frequency testing, vibration monitoring and testing for specified equipment.
1) Include the acceptance criteria of all equipment tested.
2) Provide individual tabbed sections for information associated with each piece of tested equipment.
g. Certification prior to Project closeout that electrical panel drawings for manufacturer-supplied control panels truly represent panel wiring including any field-made modifications.
h. Testing and monitoring reports in accordance with PART 3 of this Specification Section.
i. Certification that driven equipment and VFD are compatible.

4. Submit completed Manufacturer's Field Service Report (MFSR) for each piece of equipment supplied.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Motors:
      a. Baldor.
      b. General Electric.
      c. Hyundai Heavy Industries.
      d. Marathon Electric.
      e. Rockwell - Reliance.
      f. Siemens.
      g. TECO-Westinghouse.
      h. Toshiba U.S.
      i. U.S. Motors, Nidec Motor Corporation.
      j. WEG.
   2. Mechanical variable speed drives:
      a. Reeves.
      b. U.S. Motors (VariDrive).

B. Submit request for substitution in accordance with Section 01 33 23.

2.2 MANUFACTURED UNITS

A. Electric Motors:
   1. Where used in conjunction with adjustable speed AC or DC drives, provide motors that are fully compatible with the speed controllers.
   2. Design for frequent starting duty equivalent to duty service required by driven equipment.
   3. Design for full voltage starting.
   4. Design bearing life based upon actual operating load conditions imposed by driven equipment.
   5. Size for altitude of Project.
   6. Furnish with stainless steel nameplates which include all data required by NEC Article 430.
   7. Use of manufacturer's standard motor will be permitted on integrally constructed motor driven equipment specified by model number in which a redesign of the complete unit would be required in order to provide a motor with features specified.
   8. AC electric motors less than 1/3 HP:
      a. Single phase, 60 Hz, designed for the supply voltage shown on the Drawings.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
      c. Built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element with stainless steel enclosure.
   9. AC electric motors 1/3 to 1 HP:
      a. Single or 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
         1) For single phase motors, provide built-in manual reset thermal protector or integrally mounted manual motor starter with thermal overload element.
   10. AC electric motors 1-1/2 to 10 HP:
      a. 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.
      b. Permanently lubricated sealed bearings conforming to ABMA standards.
      c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
   11. AC electric motors greater than 10 HP:
      a. 3 PH, 60 Hz, designed for the supply voltage shown on the Drawings.

b. Oil or grease lubricated antifriction bearings conforming to ABMA standards.
    1) Design bearing life for 90 PCT survival rating at 50,000 HRS of operation for motors up to and including 100 HP.
    2) For motors greater than 100 HP, design bearing life for 90 PCT survival rating at 100,000 HRS of operation.
c. For vertical motors provide 15 year, average-life thrust bearings conforming to ABMA standards.
d. Thermal protection:
    1) For all motors controlled from a variable frequency drive and for all other motors 50 HP and above, provide integral thermostatic type ("klixon") thermal detectors with normally closed contacts that will open on overtemperature.
        a) Two thermal sensing devices per phase in each phase hot-spot location.
    2) For Raw Water Booster Pump motors at the Roaring Springs Pumphouse provide resistance type temperature detectors (RTD).
        a) 100-ohm platinum type
        b) Eight RTDs total per motor: two for each motor winding, one for drive-end bearing and one for non-drive-end bearing.
e. Vibration Detector / Accelerometer:
    1) For Raw Water Booster Pump motors at the Roaring Springs Pumphouse only, provide three accelerometers, mounted on a bracket 90DEG apart to monitor vibration along the X Y and Z motor axes.
        a) Metrix model 162VTS-200-256-00.
        b) 1.60 in/sec, peak.
        c) 3/8-24UNF x 3/8" mounting.
        d) Non-hazardous locations.
        e) 4-20mA output signals, 2-pin terminal block, loop powered.
        f) Motor manufacturer shall fabricate/install the mounting bracket.

12. Severe duty motors to have the following minimum features:
    a. All cast iron construction.
    b. Gasketed conduit box.
    c. Epoxy finish for corrosion protection.
    d. Hydroscopic varnish on windings for corrosion protection.
    e. Drain plug and breather.

B. NEMA Design Squirrel Cage Induction Motors:
    1. Provide motors designed and applied in compliance with NEMA and IEEE for the specific duty imposed by the driven equipment.
    2. Motors to meet NEMA MG 1 (NEMA Premium) efficiencies.
    3. Do not provide motors having a locked rotor kVA per HP exceeding the NEMA standard for the assigned NEMA code letter.
    4. For use on variable frequency type adjustable speed drives, provide:
        a. Induction motors that are in compliance with NEMA MG 1, Part 31.
        b. Nameplate identification meeting NEMA MG 1 Part 31 requirements.
        c. Insulated drive end bearing on all motors.
        d. Insulated non-drive end bearings, at a minimum, on all motors with horizontal shaft 10 HP and larger.
        e. An insulated bearing carrier on the non-drive end for vertical shaft motors 100 HP and larger.
        f. Shaft grounding ring on all motors:
            1) Factory installed, maintenance free, circumferential, bearing protection ring with conductive microfiber shaft contacting material.
            2) Electro Static Technology AEGIS SGR Bearing Protection Ring or approved equal.
        g. Have the following minimum turndown ratio without the use of additional cooling, such as a blower, to provide continuous supply of cooling air over the motor.
            1) Variable torque: 10:1.

2) Constant torque: 6:1.

5. Design motor insulation in accordance with NEMA standards for Class F insulation with Class B temperature rise above a 40 DEGC ambient.
6. Design motors for continuous duty.
7. Size motors having a 1.0 service factor so that nameplate HP is a minimum of 15 PCT greater than the maximum HP requirements of the driven equipment over its entire operating range.
   a. As an alternative, furnish motors with a 1.15 service factor and size so that nameplate HP is at least equal to the maximum HP requirements of the driven equipment over its entire operating range.
8. Motor enclosure and winding insulation application:
   a. The following shall apply unless modified by specific Specification Sections:

MOTOR LOCATION	MOTOR ENCLOSURE / WINDING INSULATION
Unclassified Indoor Areas	TEFC, Standard Insulation
Wet indoor Areas	TEFC, Encapsulated Windings
Wet outdoor Areas	TEFC Encapsulated Windings, WP-II (for vertical motors)

NOTE: Provide TENV motors in the smaller horsepower ratings where TEFC is not available.

9. Provide oversize conduit box complete with clamp type grounding terminals inside the conduit box.
10. Balance motors to ISO G2.5 level.
    a. Submit prior to shipping to OEM or job site.

2.3 COMPONENTS

A. Gear Drives and Drive Components:
   1. Size drive equipment capable of supporting full load including losses in speed reducers and power transmission.
   2. Provide nominal input horsepower rating of each gear or speed reducer at least equal to nameplate horsepower of drive motor.
   3. Design drive units for 24 HR continuous service, constructed so oil leakage around shafts is precluded.
   4. Utilize gears, gear lubrication systems, gear drives, speed reducers, speed increasers and flexible couplings meeting applicable standards of AGMA.
   5. Gear reducers:
      a. Provide gear reducer totally enclosed and oil lubricated.
      b. Utilize antifriction bearings throughout.
      c. Provide worm gear reducers having a service factor of at least 1.20.
      d. Furnish other helical, spiral bevel, and combination bevel-helical gear reducers with a service factor of at least 1.50.

2.4 ACCESSORIES

A. Guards:
   1. Provide each piece of equipment having exposed moving parts with full length, easily removable guards, meeting OSHA requirements.
   2. Interior applications:
      a. Construct from expanded galvanized steel rolled to conform to shaft or coupling surface.
      b. Utilize non-flattened type 16 GA galvanized steel with nominal 1/2 IN spacing.
      c. Connect to equipment frame with hot-dip galvanized bolts and wing nuts.
   3. Exterior applications:
      a. Construct from 16 GA stainless steel or aluminum.
      b. Construct to preclude entrance of rain, snow, or moisture.

c. Roll to conform to shaft or coupling surface.
d. Connect to equipment frame with stainless steel bolts and wing nuts.

B. Anchorage:
1. Cast-in-place anchorage:
a. Provide ASTM F593, Type 316 stainless steel anchorage for all equipment.
b. Configuration and number of anchor bolts shall be per manufacturer's recommendations.
c. Provide two nuts for each bolt.
2. Drilled anchorage:
a. Adhesive anchors per Section 03 15 19.
b. Epoxy grout per Section 03 31 30.
c. Threaded rods same as cast-in-place.

C. Data Plate:
1. Attach a stainless steel data plate to each piece of rotary or reciprocating equipment.
2. Permanently stamp information on data plate including manufacturer's name, equipment operating parameters, serial number and speed.

D. Gages:
1. Provide at the following locations:
a. Inlet and outlet of all reciprocating, centrifugal and positive displacement mechanical and process equipment.
b. At locations identified on Drawings.
2. Utilize tapping sleeves for mounting per Section 40 05 00.

E. Lifting Eye Bolts or Lugs:
1. Provide on all equipment 50 LBS or greater.
2. Provide on other equipment or products as specified in the narrow-scope Specification Sections.

F. Platforms and Ladders:
1. Design and fabricate in accordance with OSHA Standards.
2. Fabricate components from galvanized steel.
3. Provide platform surface: Non-skid grating, unless specified in narrow-scope Specification Sections.

2.5 FABRICATION

A. Design, fabricate, and assemble equipment in accordance with modern engineering and shop practices.

B. Manufacture individual parts to standard sizes and gages so that repair parts, furnished at any time, can be installed in field.

C. Furnish like parts of duplicate units to be interchangeable.

D. Ensure that equipment has not been in service at any time prior to delivery, except as required by tests.

E. Furnish equipment which requires periodic internal inspection or adjustment with access panels which will not require disassembly of guards, dismantling of piping or equipment or similar major efforts.
1. Quick opening but sound, securable access ports or windows shall be provided for inspection of chains, belts, or similar items.

F. Provide common, lipped base plate mounting for equipment and equipment motor where said mounting is a manufacturer's standard option.
1. Provide drain connection for 3/4 IN PVC tubing.

G. Machine the mounting feet of rotating equipment.

H. Fabricate equipment which will be subject to Corrosive Environment in such a way as to avoid back to back placement of surfaces that cannot be properly prepared and painted.
   1. When such back to back fabrication cannot be avoided, provide continuous welds to seal such surfaces from contact with corrosive environment.
   2. Where continuous welds are not practical, after painting seal the back to back surfaces from the environment in accordance with Section 07 92 00.

I. Natural frequency/critical Speed:
   1. All rotating parts accurately machined and in as near perfect rotational balance as practicable.
   2. Excessive vibration is sufficient cause for equipment rejection.
   3. Ratio of all rotative speeds to natural frequency/critical speed of a unit or components: Greater than 1.2.

J. Control Panels Engineered and Provided with the Equipment by the Manufacturer:
   1. Manufacturer's standard design for components and control logic unless specific requirements are specified in the specific equipment Specification Section.
   2. NEMA or IEC rated components are acceptable, whichever is used in the manufacturer's standard engineered design, unless specific requirements are required in the specific equipment Specification Section.
   3. Affix entire assembly with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to delivery.
      a. Control panels without an affixed UL 508A or UL 698A label shall be rejected.
   4. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
      a. Determine the SCCR rating by one of the following methods:
         1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
         2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
         3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
      b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
      c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

K. Equipment Base:
   1. Adequate grout and vent openings to allow grout to flow under entire base.

2.6 SHOP OR FACTORY PAINT FINISHES

A. Electrical Equipment:
   1. Provide factory-applied paint coating system(s) for all electrical equipment components

2.7 SOURCE QUALITY CONTROL

A. Motor Tests:
   1. Test motors in accordance with NEMA and IEEE standards.
   2. Provide routine test for all motors.
   3. The Contracting Officer (CO) reserves the right to select and have tested, either routine or complete, any motor included in the project.
      a. The CO will pay all costs, including shipping and handling, for all motors successfully passing the tests.
      b. Contractor shall pay all costs, including shipping and handling, for all motors failing the tests.
      c. If two successive motors of the same manufacturer fail testing, the CO has the right to reject all motors from that manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment as shown on Drawings and in accordance with manufacturer's directions.

B. Utilize templates for anchorage placement for slab-mounted equipment.

C. For equipment having drainage requirements such as seal water, provide 3/4 IN PVC or clear plastic tubing from equipment base to nearest floor or equipment drain.
   1. Route clear of major traffic areas and as approved by Contracting Officer.

D. Do not construct foundations until major equipment supports are approved.

E. Extend all non-accessible grease fittings using stainless steel tubing to a location which allows easy access of fittings from closest operating floor level.

F. Equipment Base:
   1. Construct level in both directions.
   2. Take particular care at anchor bolt locations so these areas are flat and level.

G. Machine Bases / Sole Plates:
   1. Grease or tape anchorages and jack screws to inhibit grout from adhering to bolts and other anchors.
      a. Jack screws number and size by equipment manufacturer.
         1) Jack Screw
            a) 304 Stainless Steel minimum.
            b) 0.5 inches diameter minimum.
         2) Jack Screw Pad
            a) 2 inch diameter minimum
            b) Anchored in place with a structural epoxy adhesive.
   2. Install machine base of rotating equipment on equipment base.
   3. Level in both directions using jack screws, with a machinist level, according to machined surfaces on base.
      a. Base shall be level within vertical tolerance of the lesser of (a) 0.005 inch per foot with no more than 0.0005 inches difference between any two points, or (b) equipment manufacturer’s written instructions.
   4. Level machine base on equipment base and align couplings between driver and driven equipment.

H. Rotating Equipment Couplings:
   1. Align in the annular and parallel positions.
      a. For equipment rotating at 1200 RPM or less, align both annular and parallel within 0.001 IN tolerance for couplings 4 IN size and smaller.
      b. Couplings larger than 4 IN size: Increase tolerance 0.0005 IN per inches of coupling diameter, i.e., allow 6 IN coupling 0.002 IN tolerance, and allow a 10 IN coupling 0.004 IN tolerance.
      c. For equipment rotating at speeds greater than 1200 RPM allow both annular and parallel positions within a tolerance rate of 0.00025 IN per inch coupling diameter.
   2. If equipment is delivered as a mounted unit from factory, verify factory alignment on site after installation and realigned if necessary.
   3. Check surfaces for runout before attempting to trim or align units.

I. Grouting:
   1. Level onto equipment base with jack screws in accordance with the Contract Documents, provide a dam or formwork around base to contain grout between equipment base and equipment support pad.
   2. Preparation:
      a. Extend dam or formwork to cover leveling shims and blocks.
      b. Anchor sleeves:

1) Required for equipment (Pumps, Mixers, Blowers) greater than 50 HP
2) If anchor sleeves were used, fill voids in anchor sleeves with foam or room temperature vulcanizing (RTV) silicone to keep grout from filling sleeves.

c. Do not use nuts below the machine base to level the unit.
d. Saturate top of roughened concrete surface with water before grouting.

3. Grout Installation:
   a. Install grout until entire space under machine base is completely filled to underside of base.
      1) Voids are unacceptable.
   b. Puddle grout by working a stiff wire through the grout and vent holes, to ensure grout is installed properly and to release air entrained in grout or base cavity.
4. After Grout Installation:
   a. When grout is sufficiently hardened, remove dam or formwork and finish exposed grout surface to fine, smooth surface.
   b. Completely cover exposed grout surfaces with wet burlap and keep covering sufficiently wet to prevent too-rapid evaporation of water from grout.
   c. Check for voids by tapping along the top deck of the mounting plate. A solid thud indicates grout-filled areas while a drum-like hollow sound indicates a void requiring filling.
      1) Void areas are to be filled by drilling 1/8 INCH NPT holes in opposite corners of each void area. Grout to be pumped into one void with a grout gun until grout emerges from the other vent hole.
   d. When grout is fully hardened (after not less than seven days), remove jack screws, and tighten nuts on anchor bolts and similar anchors to required torque.
   e. Inspect and verify levelness of machine base and, if not in accordance with requirements, remedy by removing base and reinstalling in accordance with the Contract Documents.
   f. Inspect driver-driven equipment for proper alignment. When not in accordance with requirements, remedy so that the Work is not defective.

3.2 INSTALLATION CHECKS

A. For all equipment specifically required in detailed specifications, secure services of experienced, competent, and authorized representative(s) of equipment manufacturer to visit site of work and inspect, check, adjust and approve equipment installation.
   1. In each case, representative(s) shall be present during placement and start-up of equipment and as often as necessary to resolve any operational issues which may arise.

B. Secure from equipment manufacturer's representative(s) a written report and deliver to CO immediately prior to leaving jobsite . Report shall certify that equipment:
   1. Has been properly installed and lubricated.
   2. Is in accurate alignment.
   3. Is free from any undue stress imposed by connecting piping or anchor bolts.
   4. Has been operated under full load conditions and that it operated satisfactorily.

C. No separate payment shall be made for installation checks.
   1. All or any time expended during installation check does not qualify as Operation and Maintenance training or instruction time when specified.

3.3 WIRING CONNECTIONS AND TERMINATION

A. Clean wires before installing lugs and connectors.

B. Coat connection with oxidation eliminating compound for aluminum wire.

C. Terminate motor circuit conductors with copper lugs bolted to motor leads.

D. Tape stripped ends of conductors and associated connectors with electrical tape.
   1. Wrapping thickness shall be 150 PCT of the conductor insulation thickness.

E. Connections to carry full ampacity of conductors without temperature rise.

F. Terminate spare conductors with electrical tape.

3.4 FIELD QUALITY CONTROL

A. General:
   1. Furnish equipment manufacturer's field quality control services and testing as specified in the individual equipment Specification Sections.
   2. Perform and report on all tests required by the equipment manufacturer's Operation and Maintenance Manual.
   3. Provide testing of electrical equipment and connections in accordance with the Electrical specifications.
   4. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
      a. Contract Drawings and Specifications.
      b. Related construction change documentation.
      c. Approved Shop Drawings.
      d. Approved Operation and Maintenance Manuals.
      e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plans:
   1. Approved in accordance with Shop Drawing submittal schedule.
   2. Included as a minimum:
      a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
      b. List and description of testing and analysis equipment to be utilized.
      c. List of all equipment to be testing, including:
         1) Name and tag numbers identified in the Contract Documents.
         2) Manufacturer's serial numbers.
         3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:
   1. Minimum calibration frequency:
      a. Field analog instruments: Not more than 6 months.
      b. Field digital instruments: Not more than 12 months.
      c. Laboratory instruments: Not more than 12 months.
      d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.
   2. Carry current calibration status and labels on all testing instruments.
   3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:
   1. Provide reports with tabbed sections for each piece of equipment tested.
   2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
      a. Include legible copies of all forms used to record field test information.
   3. Prior to start of testing, submit one copy of preliminary report format for Contracting Officer review and comment.
      a. Include data gathering and sample test report forms that will be utilized.
   4. In the final report, include as a minimum, the following information for all equipment tested:
      a. Equipment identification, including:
         1) Name and tag numbers identified in the Contract Documents.
         2) Manufacturer's serial numbers.
         3) Other pertinent manufacturer identification,
      b. Date and time of each test.
      c. Ambient conditions including temperature, humidity, and precipitation.

d. Visual inspection report.
e. Description of test and referenced standards, if any, followed while conducting tests.
f. Results of initial and all retesting.
g. Acceptance criteria.
h. "As found" and "as left" conditions.
i. Corrective action, if required, taken to meet acceptance.
j. Verification of corrective action signed by the Contractor, equipment supplier, and CO or CO's authorized representative.
k. Instrument calibration dates of all instruments used in testing.

5. Provide three (3) bound final reports prior to Project final completion.

E. Electrical Equipment and Connections Testing Program:
1. Perform testing on Electrical equipment and connections in accordance with the Electrical specification requirements.
2. Testing of motors:
a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors 50 HP or above.
b. Ensure motor has been lubricated.
c. Bump motor to check for correct rotation.
3. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

F. Other Testing:
1. Perform tests and inspections not specifically listed but required to assure equipment is safe to energize and operate.
2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.

G. Infrared Thermography Testing Program:
1. Perform infrared thermography testing for equipment specified in other Divisions during the Equipment Demonstration Period.
a. Perform on all rotating and reciprocating equipment having drivers 25 HP or greater.
b. Perform on electrical equipment and connections: See Section 26 08 13.
2. Additional requirements for infrared thermography monitoring and testing equipment:
a. Temperature range: -10 to 350 DEGC.
b. Accuracy: ±2 PCT or 2 DEGC, whichever is greater.
c. Repeatability: ±1 PCT or 1 DEGC, whichever is greater.
d. Temperature indication resolution: 0.1 DEGC.
e. Minimum focus distance: 0.3 meters.
f. Output in color palettes: JPEG, BMP, or other digital format compatible with Windows.
3. Perform inspection per ASTM E1934.
a. Operate VFD driven equipment at 100 PCT speed during thermographic inspection.
4. Acceptability of electrical connections and components based on temperature comparison between components and ambient air temperatures not greater than 10 DEGC per ASTM E1934.
5. Acceptability of motors and equipment bearings based on temperature rise not greater than 5 DEGC above the equipment and/or bearing manufacturers published criteria.
6. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds acceptability standards.

H. Equipment Vibration Monitoring and Testing Program:
1. Provide vibration testing on all rotating and reciprocating equipment having driver 50 HP and greater.

2. Utilize a Contracting Officer approved testing agency to perform vibration monitoring.
3. Additional requirements for vibration monitoring and testing equipment at 25 DegC:
    a. Requirements for analyzer.
        1) Frequency range: 10 Hz to 20 kHz
        2) Frequency Accuracy: 0.02 percent.
        3) Non-integrated spectral amplitude accuracy: 5 percent, 3 Hz to 65kHz.
        4) Single integrated spectral amplitude accuracy: 5 percent 10 Hz to 20kHz.
        5) Supports measurements of acceleration, velocity, displacement, envelope demodulation for bearing defect detection.
        6) Capable of two-place computer balancing.
    b. Requirements for vibration sensor at 25 DegC:
        1) Sensitivity: ±5 percent = 100 mV/g.
        2) Acceleration range: ±50 g.
        3) Amplitude nonlinearity: ±1 percent.
        4) Frequency response: ±10 Hz to 7 kHz (±3 dB).
4. Acceptability of pumping equipment to be based on current ANSI/HI criteria:
    a. ANSI/HI 9.6.4-2009 for all pumps.
5. Repair or replace equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceeds standards.
6. Permanently attach vibration test and monitoring mounting pads to the equipment at locations
7. recommended by the equipment manufacturer or as recommended by the vibration testing agency.
8. Utilize mounting pads suitable for permanent installation and for incorporation into a predictive maintenance program.
9. For variable speed equipment provide vibration testing at 1 Hz increments of VFD speed throughout entire operating range (1 hz to 60 hz).
10. Diagnosis to include, but is not limited to the following:
    a. Unbalance.
    b. Misalignment.
    c. Bent shaft.
    d. Journal bearing related problems.
    e. Rolling contract bearing problems.
    f. Mechanical looseness.
    g. Resonance.
    h. Foundation flexibility.
    i. Electrically induced problems.
    j. Pump problems.
    k. Fan problems.
    l. Coupling problems.
    m. Drive belt problems.
    n. Gear problems.
    o. Electric motor induced vibration from VFD or VFD carrier frequency.
    p. Natural frequency of the installed equipment.
11. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency, ISO 1940 Balance Quality Grade 6.3 as a minimum.
12. Tolerances for pumping equipment shall be per HI published standards.
13. Immediately notify Contracting Officer if equipment is shown to be out of range of the specified tolerance until the equipment meets the specified normal operation range required in the machinery fault guide analysis.
14. Document testing with written report.
    a. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.
    b. Natural frequency of installed equipment utilizing an impact hammer.

3.5 ABBREVIATION TABLE

A. As indicated in the Drawings.

END OF SECTION 01 61 03

EXHIBIT A

MANUFACTURER FIELD SERVICE REPORT

This field service report is generic in nature. An electronic copy of this form will be furnished upon request from the CO. This report is to reflect that all requirements of the Operations and Maintenance Manual and the individual equipment specification requirements have been performed for the installation and operation and also to provide a baseline for amperage draw for each phase, vibration readings, rotation, alignment and all other applicable tests required to insure that the equipment has been installed properly. A MFSR will be required for each individual piece of equipment requiring a MFSR.

Definitions of Reports:

Initial service report: Required for construction preparations. Equipment delivered to site is in good condition and conforms to specification requirements. Anchor bolts, hardware and ancillary items (piping, flanges, conduits, fuel/power supply) are compatible with equipment.

Interim service report: Required for equipment installation onto base or foundation. Piping connections, electrical and control connections or structural attachment are complete. For equipment stored on site over four weeks, interim service report will document that manufacturer's long-term storage procedures have been incorporated and equipment has not been damaged, nor coatings deteriorated.

Final service report is to be completed when equipment can be started, electrical amperage and voltage draw measured, cold and hot alignments performed, vibration testing and monitoring performed and the equipment is found to be in compliance with Manufacturer's operating parameters and the requirements of the individual equipment specifications.

PROJECT: _____

Report Status:

Initial Service Report completed and submitted on _____

Interim Service Report completed and submitted on _____

Final Service Report completed and submitted on _____

Commencement of Warranty _____

I Description

A. Equipment Name and Identification: _____

_____

B. Serial Number: _____

C. Specification Section Number: _____

D. Manufacturer: _____

E. Representative: _____

F. Type of Service: Initial _____ Interim _____ Final _____

II General Review

A. The above referenced equipment/material/supplies have been inspected, checked, and adjusted. Yes _____ No _____

Summary: _____

_____

B. The above referenced equipment/material/supplies were placed upon properly prepared or suitable substrate. N/A _____ Yes _____ No _____

Summary: _____

_____

C. The above referenced equipment/material/supplies are free from any undue stress imposed by any connected piping, anchor bolts or any other load. N/A _____ Yes _____ No _____

Summary: _____

_____

D. The above referenced equipment/material/supplies have operated under design conditions. N/A _____ Yes _____ No _____

Summary: _____

_____

E. The above referenced equipment/material/supplies have been installed in accordance with the manufacturer's recommendations and the Procurement Documents, require no corrective work, and are hereby approved. Yes _____ No _____

Summary: _____

_____

F. The above referenced equipment/material/supplies are acceptable to the manufacturer as installed providing the following corrective action(s) are performed:

1. _____
2. _____
3. _____
4. _____
5. _____

III Inspection Checklist

Item	Acceptable (Yes/No)	Readings/Comments
Bearings (1)		
Belts (tension reading)		
Lubrication Levels		
Vibration (1) (2) (MILS/SEC)		
Infrared Thermography (1) (2)		
Starting AMPS		
Full Load AMPS		
Volts		
Rotation		
Jacket Temperature (DEGF)		
Seal Water Flow Rate (GPH or GPM)		
Seal Water Pressure (PSI)		
O-rings/Packing		
Alignment (1)		
Anchor Bolts		
Grout		

Item	Acceptable (Yes/No)	Readings/Comments
Substrate Approval		
Sound level (4 FT from unit) (1) (dB)		
Other		

(1) Inspection or testing reports must be attached.
(2) Provide vibration testing and monitoring procedures for Contracting Officer's review and approval prior to testing.

IV O&M Manuals

A. The O&M manual as presented contains all information required for proper operation, maintenance, and instruction of this system. N/A _____ Yes _____ No _____

Summary: _____

_____

V Preventive Maintenance

A. The preventive maintenance summary outlined in the O&M manual is acceptable for operation of the system throughout the warranty period. N/A _____ Yes _____ No _____

Summary: _____

_____

VI Operator Training/Classroom Instruction

A. Training and instruction have been performed in accordance with the requirements of the Procurement Documents. N/A _____ Yes _____ No _____

B. Final Training/Classroom Instruction Completed on: _____

Summary: _____

_____

VII Remarks

_____

_____

_____

VIII Certification

I hereby certify, that I, _____, am a duly authorized representative of the manufacturer, that I am empowered by the manufacturer to inspect, approve, and operate his equipment, and that I am authorized to make recommendations required to assure that the equipment furnished by the manufacturer is complete and operational, except as modified herein. I also certify that all information contained herein is true and accurate.

By: _____
(Authorized Representative)

For: _____

Date: _____

IX Acknowledgments

By: _____

For: _____
(Contractor)

Date: _____

By: _____

For: _____
(Contracting Officer)

Date: _____

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. 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 or 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. Products salvaged or recycled from other projects are not considered new products.
3. Comparable Product: 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.

B. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of additional manufacturers named in the specification.

C. Definitions pertaining to sustainable development: As defined in ASTM E2114.

D. 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.

E. Chain-of-Custody: Process whereby a product or material is maintained under physical possession or control during its entire life cycle.

F. 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.

G. Stewardship: Responsible use and management of resources in support of sustainability.

H. 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 ten-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. Record Submittals as specified in – Sustainable Design Close-Out Documentation, submit:

1. Affirmative Procurement Reporting Form. Submit on form in Appendix A of this Section, or similar form as approved by Contracting Officer (CO).
2. Submit environmental data in accordance with Table 1 of ASTM E2129 for these products:

a. Masonry
b. Finish Carpentry
c. Plastic Fabrications
d. Building Insulation
e. Roofing
f. Joint Sealers
g. Wood & Plastic Doors
h. Windows
i. Skylights
j. Glazed Curtain Wall
k. Gypsum Board
l. Tile
m. Acoustical Ceilings
n. Resilient Flooring
o. Carpet
p. Wall Coverings
q. Paints & Coatings
r. Toilet Compartments
s. Loading Dock Equipment
t. Office Equipment
u. Furnishings & Accessories
v. Renewable Energy Equipment
w. Elevators
x. Plumbing fixtures and equipment.
y. HVAC equipment
z. Lighting equipment

3. Material Safety Data Sheets (MSDS): For each product required by OSHA to have a MSDS, submit an MSDS. MSDS shall be prepared within the previous five 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.
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.

4. Chain of Custody: Submit chain-of-custody documentation for sustainable forestry for these products:

a. Rough Carpentry
b. Finish Carpentry
c. Wood Doors
d. Windows
e. Wood Flooring
f. Furnishings & Accessories

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.

C. Provide minimum 45 percent post-consumer recycled content and minimum 100 percent recovered fiber content of industrial paperboard in accordance with EPA’s Comprehensive Procurement Guidelines and ASTM D5663.

D. Provide minimum 10 percent post-consumer recycled content and minimum 10 percent recovered fiber content of carrier board in accordance with EPA’s Comprehensive Procurement Guidelines and ASTM D5663.

E. Provide minimum 5 percent post-consumer recycled content and minimum 5 percent recovered fiber content of brown papers (e.g., wrapping papers and bags) in accordance with EPA’s Comprehensive Procurement Guidelines and ASTM D5663.

1.7 ENVIRONMENTALLY PREFERABLE PRODUCTS

A. Provide environmentally preferable products to greatest extent possible.

1. To greatest extent possible, 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% (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 Specifications, prepare written document using appropriate form properly executed.
3. Refer to Divisions 2 through 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 Specifications establish "salient characteristics" of products.

B. Product Selection Procedures:

1. Product: Where Specifications name single product and manufacturer, provide named product that complies with requirements or approved equal.
2. Manufacturer/Source: Where Specifications name single manufacturer or source, provide product by named manufacturer or source that complies with requirements or approved equal.
3. Products: Where 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 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 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 "Comparable Products" Article for consideration of an unnamed product.
6. Available Manufacturers: Where 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 "Comparable Products" Article for consideration of an unnamed product.
7. Product Options: Where Specifications indicate sizes, profiles, and dimensional requirements on Drawings are based on a specific product or system, provide specified product, system, or approved equal.
8. Basis-of-Design Product: Where Specifications name product and include a list of manufacturers, provide specified product or a comparable product by one of the other named manufacturers, or approved equal. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics based on the product named.
9. Visual Matching Specification: Where 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.

    a. If no product available within specified category matches and complies with other specified requirements, comply with provisions in Part 2 "Product Substitutions" Article for proposal of product.

10. Visual Selection Specification: Where 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 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 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 COMPARABLE PRODUCTS

A. Conditions: Contracting Officer will consider Contractor's request for comparable product 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:

1. 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.
2. Detailed comparison of significant qualities of proposed product with those named in Specifications. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements indicated.
3. Evidence proposed product provides specified warranty.
4. List of similar installations for completed projects with project names and addresses and names and addresses of architects and owners, if requested.
5. 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.

END OF SECTION 01 67 00

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						

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

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SECTION 01 71 21 – SPECIALTY ENGINEERING REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish engineering design, drawings, and calculations for Specialty Engineering Requirements, as indicated, in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 DEFINITIONS

A. Structural Engineer of Record (SER):

1. Structural engineer legally eligible to seal structural Contract Documents for project.
2. Seal acknowledges SER performed or supervised analysis, design, and document preparation for building structure and has knowledge of requirements for structural system.
3. The SER is responsible for the design of the primary structural system.

B. Specialty Structural Engineer (SSE):

1. Registered Engineer other than Structural Engineer of Record (SER), licensed to practice structural engineering in state in which project is located.
2. Undertakes engineering calculations, design and drawing preparation of components, systems, or installation methods and equipment for specific temporary portions of Work or special items of permanent Work required to be furnished by Contractor.
3. Provide designs and details for items of permanent Work declared to be minor or non-structural.
4. Employee or officer of Contractor or fabricator, employee or officer of an entity providing components to a fabricator, or an independent consultant.
5. The Contractor is responsible for any structural engineering tasks that are required for construction related services.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SYSTEM DESIGN

A. Contract Documents show conceptually detailed components describing aesthetic intent and provides a performance-type prescription for the design, fabrication, and installation.

B. Contractor is responsible for the engineering and design of components and materials as well as fabrication and installation.

C. Develop conditions not shown in Contract Documents to same level of aesthetics in compliance with performance and aesthetic criteria specified and indicated for detailed areas.

D. Provide engineering design with drawings and calculations sealed by registered Engineer, licensed to practice structural engineering where the project is located.

E. Comply with requirements of Contract Documents, codes, regulations, standards, and guidelines including:

1. Nationally published amendments.
2. Local Amendments.
3. Structural criteria provided.
4. Additional requirements indicated in specification sections.

F. Reference Standards:

1. Refer to technical specification sections for listed standards.

G. Minor deviations in dimensions and profiles may be considered provided design concept is unchanged or intended performance is not compromised as judged by the Architect.

H. Where SSE exercises professional judgment and takes exception to specified criteria or reference standards, disclose exception in writing.

3.2 DOCUMENTATION

A. Include the following items common to project:

1. Project Identification:
    a. Project name.
    b. Project location.
    c. Identifying project numbers.
    d. North arrow.
    e. Scale.
2. Governing Codes:
    a. Building code and edition.
    b. Referenced codes and standards.
    c. Design method used for the design.
3. Service Loads.
4. Strength loads or factors.
5. Design Load:
    a. Dead loads.
    b. Live loads.
    c. Snow loads.
    d. Wind loads.
    e. Seismic loads.
6. Material Properties:
    a. Design properties.
    b. ASTM designations.
7. Computer Submittals:
    a. Documentation of computer programs including the program name and version should be included with any submittal of computer calculations. In the case of custom software or spreadsheet developed in house it may be necessary to provide hand calculation of representative elements to verify the use of the program.

B. Include maximum design loads at connection points to primary structure.

1. Indicate values consistent with method used for design including service loads or strength loads with factors.
2. Design system to apply loads to the structure through the centerlines of the supporting element.
3. Assume building supports are free to rotate. Torsional or flexural fixed supports shall not be used unless approved by the SER.
4. When fixed or eccentric supports are used, provide additional framing as deemed necessary by the SER at no additional cost.

C. Include member sizes, required reinforcing, connection details and material specifications.

D. Include statements where the SSE has exercised professional judgment and takes exception to the specified criteria or referenced standard. Final authority and responsibility for decisions concerning structural design criteria shall belong to the SER. When exceptions are stated as qualifications to the contractor's proposal, the SER shall be notified and respond prior to award.

E. SSE shall review and approve the shop drawings and special erection drawings prepared by a fabricator or supplier and attest to that review with a signed shop drawing stamp, or other means, prior to submittal of the drawings to the SER. When standardized erection drawings are used, there is no need to provide a shop drawing approval stamp.

END OF SECTION 01 71 21

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SECTION 01 73 20 - OPENINGS AND PENETRATIONS IN CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Methods of installing and sealing openings and penetrations in construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 05 50 00 - Miscellaneous Metals.
   4. Section 07 84 00 - Firestopping.
   5. Section 07 92 00 - Joint Sealants.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      c. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      d. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
      e. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
      f. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
      g. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      h. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
      i. A995, Castings, Austenitic-Ferritic (Duplex) Stainless Steel, for Pressure-Containing Parts.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 501, Class 1 Locations.
      b. 90A, Standard for Installation of Air Conditioning and Ventilating Systems.
      c. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA).

1.3 DEFINITIONS

A. Corrosive Areas: For the purpose of this specification section, the following areas are defined as corrosive:
   1. None.

B. Hazardous Areas: Areas shown in the Contract Documents as having Class I or Class II area classifications.

C. Washdown Areas: Areas having floor drains or hose bibbs.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. For each structure provide dimensioned or scaled (minimum 1/8 IN = 1 FT) plan view drawings containing the following information:

a. Vertical and horizontal location of all required openings and penetrations.
b. Size of all openings and penetrations.
c. Opening type.
d. Seal type.

3. Manufacturer's installation instructions for standard manufactured products.

1.5 SITE CONDITIONS

A. Reference the project Geotechnical Report for groundwater levels.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe Sleeves:
1. Steel, Hot-dipped galvanized after fabrication.
2. Penetrations 24 IN DIA or less: ASTM A53, Schedule 40.
3. Penetrations larger than 24 IN DIA: ASTM A36, Minimum 1/4 IN thickness.
4. Provide weep ring where wall thickness permits.
5. Where wall thickness does not permit a weep ring, use SikaSwell product.

B. Backing Rod and Sealant: See Specification Section 07 92 00.

C. Modular Mechanical Seals:
1. Acceptable manufacturers:
a. Link-Seal.
2. 316 stainless steel bolts, nuts and washers.

D. Integrally Cast Wall Pipes:
1. Match material of buried piping.
2. Grade equal to connecting piping system.
3. Provide weep ring where wall thickness permits.
4. Where wall thickness does not permit a weep ring, use SikaSwell product.

E. Firestopping Material: See Specification Section 07 84 00.

F. Sheet Metal Sleeves:
1. Galvanized steel: ASTM A653, G90.
2. Minimum 12 GA.

G. Commercial Wall Castings:
1. Ductile iron, ASTM A536.
2. Grade equal to connecting piping system.

PART 3 - EXECUTION

3.1 FABRICATION

A. Fabricate pipe sleeves in accordance with Specification Section 05 50 00.

B. Provide waterstop plate/anchor flange for piping, ducts, castings and sleeves cast-in-place in concrete.
1. For fabricated units, weld plate to sleeve, pipe, or ductwork.
2. For commercial castings, cast water stop/anchor with wall pipe.
3. Plate is to be same thickness as sleeve, pipe, casting or ductwork.
4. For fabricated units, diameter of plate or flange to be 4 IN larger than outside diameter of sleeve, pipe or ductwork.
5. For commercial castings, waterstop/anchor size to be manufacturer standard.
6. Provide continuous around entire circumference of sleeve, pipe, or ductwork.

3.2 INSTALLATION AND APPLICATION

A. Firestopping materials used in fire-resistance rated construction shall be in full compliance with Specification Section 07 84 00.

B. Seal openings and penetrations in non-fire-resistance-rated construction in accordance with Specification Section 07 92 00.

C. Obtain prior approval from Contracting Officer (CO) or Contracting Officer's Representative (COR) when any opening larger than 100 SQIN must be made in existing or newly completed construction.

D. Perform HVAC penetrations in accordance with NFPA 90A.

E. Perform electrical penetrations in accordance with NFPA 70, Article 501.

F. When mechanical or electrical work cannot be installed as structure is being erected, provide and arrange for building-in of boxes, sleeves, insets, fixtures or devices necessary to permit installation later.
   1. Lay out chases, holes or other openings which must be provided in masonry, concrete or other work.

G. Where pipes, conduits or ducts pass through floors in washdown areas, install sleeves with top 3 IN above finish floors.
   1. In non-washdown areas, install sleeves with ends flush with finished surfaces.

H. Size sleeves, blockouts and cutouts which will receive sealant seal such that free area to receive sealant is minimized and seal integrity may be obtained.

I. For insulated piping and ducts, size sleeves, blockouts and cutouts large enough to accommodate full thickness of insulation.

J. Where pipes, conduits or ducts pass through grating, provide banding at the entire perimeter of the opening.
   1. Metal grating: See Specification Section 05 50 00.

K. Where pipes, conduits or ducts are removed where passing through grating:
   1. Metal grating:
      a. Provide banding at perimeter and cover opening with 1/4 IN plate of the same material of the grating.
      b. See Specification Section 05 50 00.
   2. FRP grating:
      a. Provide full depth cover meeting same loading requirement as existing material or replace grating section.

L. Do not cut into or core drill any beams, joists, or columns.

M. Do not install sleeves in beams, joists, or columns.

N. Do not install recesses in beams, joists, columns, or slabs.

O. Field Cutting and Coring:
   1. Saw or core drill with non-impact type equipment.
   2. Mark opening and drill small 3/4 IN or less holes through structure following opening outline.
   3. Sawcut opening outline on both surfaces.
      a. Knock out within sawcuts using impact type equipment.
      b. Do not chip or spall face of surface to remain intact.
      c. Do not allow any overcut with saw kerf.
   4. Existing floor slabs, ceiling slabs, walls, and other cast-in-place concrete may contain embedded conduit (PVC or metal) along with rebar. Contractor is responsible to locate any existing conduit and rebar (through X-ray, radar, or other method) prior to core drilling or saw cutting.

a. Conduit shall not be cut. Repair of any damage to embedded conduit as a result of penetration installation shall be the responsibility of the Contractor.
b. Penetrations shall be located to avoid cutting rebar, for penetration sizes 6 inch or less in diameter.
c. Obtain approval from the engineer prior to cutting structural steel.

P. Where alterations are necessary or where new and old work join, restore adjacent surfaces to their condition existing prior to start of work.

Q. Where area is blocked out to receive sheet metal sleeve at later date:
1. If blockout size is sufficient to allow placement, utilize dowels for interface of initially placed concrete and sleeve encasement concrete which is placed later.
a. Size blockout based on sleeve size required plus 4 to 6 IN each side of sleeve for concrete encasement.
b. Provide #4 dowels at 12 IN spacing along each side of blockout with minimum of two dowels required per side.
2. If blockout size is not sufficient to allow placement of dowels, provide keyway along all sides of blockout.
a. Size blockout based on sleeve size required plus 2 to 4 IN each side of sleeve for concrete encasement.

R. For interior wall applications where backer rod and sealant are specified, provide backer rod and sealant at each side of wall.

S. Refer to Drawings for location of fire-rated walls, floors, and ceilings.
1. Utilize firestopping materials and procedures specified in Specification Section 07 84 00 IN conjunction with scheduled opening type to produce the required fire rating.

T. Use full depth expanding foam sealant for seal applications where single or multiple pipes, conduits, etc., pass through a single sleeve.

U. Do not make duct or conduit penetrations below high water levels when entering or leaving tankage, wet wells, or other water holding structures.

V. Modular Mechanical Seals:
1. Utilize one seal for concrete thickness less than 8 IN and two seals for concrete, 8 IN thick or greater.
2. Utilize two seals for piping 8 IN diameter and larger if concrete thickness permits.
3. Install seals such that bolt heads are located on the most accessible side of the penetration.

W. Backer Rod and Sealant:
1. Install in accordance with Specification Section 07 92 00.
2. Provide backer rod and sealant for modular mechanical seal applications.
a. Apply on top side of slab penetrations and on interior, dry side wall penetrations.

3.3 SCHEDULES

A. General Schedule of Penetrations through Floors, Roofs, Foundation Base Slabs, Foundation Walls, Foundation Footings, Partitions and Walls for Ductwork, Piping, and Conduit:
1. Provide the following opening and penetration types:
a. Type A - Block out 2 IN larger than outside dimensions of duct, pipe, or conduits.
b. Type B - Saw cut or line-drill opening. Place new concrete with integrally cast sheet metal or pipe sleeve.
c. Type C - Fabricated sheet metal sleeve or pipe sleeve cast-in-place. Provide pipe sleeve with water ring for wet and/or washdown areas.
d. Type D - Commercial type casting or fabrication.
e. Type E - Saw cut or line-drill opening. Place new concrete with integrally cast pipe, duct or conduit spools.
f. Type F - Integrally cast pipe, duct or conduit.

g. Type G - Saw cut or line-drill and remove area 1 IN larger than outside dimensions of duct, pipe or conduit.
h. Type H - Core drill.
i. Type I - Block out area. At later date, place new concrete with integrally cast sheet metal or pipe sleeve.
j. Type J - Grating Banding for any field cut openings.

2. Provide seals of material and method described as follows.
   a. Category 1 - Modular Mechanical Seal.
   b. Category 2 - Roof curb and flashing according to SMACNA specifications unless otherwise noted on Drawings.
   c. Category 3 - 12 GA sheet metal drip sleeve set in bed of silicon sealant with backing rod and sealant used in sleeve annulus.
   d. Category 4 - Backer rod and sealant.
   e. Category 5 - Full depth compressible sealant with escutcheons on both sides of opening.
   f. Category 6 - Full depth compressible sealant and flanges on both sides of opening. Flanges constructed of same material as duct, fastened to duct and minimum 1/2 IN larger than opening.
   g. Category 7 - Full depth compressible sealant and finish sealant or full depth expanding foam sealant depending on application.
   h. Category 8 - Banding for all grating openings and banding and cover plate of similar materials for abandoned openings.
3. Furnish openings and sealing materials through new floors, roofs, grating, partitions and walls in accordance with Schedule A, Openings and Penetrations for New Construction.
4. Furnish openings and sealing materials through existing floors, grating, roofs, partitions and walls in accordance with Schedule B, Openings and Penetrations for Existing Construction.

SCHEDULE A. OPENINGS AND PENETRATIONS SCHEDULE FOR NEW CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors on grade above water table	C F I	4 Not Req 4	C F I (1)	7 Not Req 7	C F I (1)	4 Not Req 7
Through slab on grade below water table	F	Not Req	F	Not Req	F	Not Req
Through floors in washdown areas	C I	4 4	C H (2) I (1)	4 3 4	F H (2) I (1)	Not Req 3 7
Through exterior wall below grade above water table	C F I	7 Not Req 7	C D F I (1)	1 Not Req Not Req 1	F I (1)	Not Req 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	C F I	7 Not Req 7	C D F H (2)	1 Not Req Not Req 1	C F H (2) I (1)	7 Not Req 7 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	F	Not Req	F	Not Req	F	Not Req
Through exterior wall above grade	A B C	6 6 6	A B D H (2)	5 5 Not Req 5	C H (2)	5 4
Roof penetrations	A	2	A	2	A	2
Through interior walls and slabs not covered by the above applications	A C	4 4	A C	4 4	A C F	4 4 Not Req
Grating openings and penetrations	J	8	J	8	J	8

SCHEDULE B. OPENINGS AND PENETRATIONS SCHEDULE FOR EXISTING CONSTRUCTION

APPLICATIONS	DUCTS		PIPING		CONDUIT	
	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY	OPENING TYPE	SEAL CATEGORY
Through floors on grade above water table	B	7	B	7	B	7
Through slab on grade below water table	E	Not Req	E	Not Req	E	Not Req
Through floors in washdown areas	G	3	G H (2)	3 3	G H (2)	3 3
Through exterior wall below grade above water table	B	7	B (1) B (3) H (2)	7 1 7	B (1) (3) H (2)	7 7
Through wall from tankage or wet well (above high water level) to dry well or dry area	B E	7 Not Req	B E H (2)	1 Not Req 1	B (1) (3) E H (2)	7 Not Req 7
Through wall from tankage or wet well (below high water level) to dry well or dry area	E	Not Req	E	Not Req	E	Not Req
Through exterior wall above grade	G	6	G (1) (3) H (2)	5 5	G (1) (3) H (2)	5 7
Roof penetrations	G	2	G (1) (3) H (2)	2	G	2
Through interior walls and slabs not covered by the above applications	G	4	G (1) (3) H (2)	4 4	G (1) (3) H (2)	4 4
Grating openings and penetrations	J	8	J	8	J	8

(1) Multiple piping 3 IN and smaller or multiple conduits.
(2) Single pipe 3 IN and smaller or single conduit.
(3) Single pipe or conduit larger than 3 IN.

END OF SECTION 01 73 20

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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: Submit Plan describing procedures at least 10 days before cutting and patching will be performed, requesting approval to proceed. Include:

1. Extent: Describe cutting and patching, show how performed, and indicate why they cannot be avoided.
2. 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.
3. Products: List products to be used and firms or entities that will perform Work.
4. Dates: Indicate when cutting and patching will be performed.
5. 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.
6. 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.
7. 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 prevent 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: 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 01 73 29

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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 land surveyor certifying location and elevation of 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 Surveys: Submit two copies signed by land surveyor.

D. Quantity Surveys: Submit 2 copies showing quantities of work performed and actual construction completed in place.

E. Contractor Construction Camp Development Plan: Identify camps, as referenced in Section 01 73 60, to be used within 30 days of the Notice to Proceed. Submit a narrative plan for each camp 60 days prior to occupancy outlining functions and facilities included at each camp.

F. Utility Management Plan: Submit and maintain a narrative plan with supporting drawings for coordination with the NPS in maintaining water utility services, wastewater utility services, and power utility services.

1.3 QUALITY ASSURANCE

A. Land Surveyor Qualifications: Professional legally qualified to practice in jurisdiction where Project is located 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; and underground electrical services.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
3. Contractor shall hire a third party subsurface utility engineering (SUE) entity to coordinate utility locates of existing utilities and perform potholing of all proposed crossing of existing utilities.
    a. Call Arizona 811 and obtain utility locates from owning utilities.
    b. Locate NPS owned utilities on behalf of NPS.
    c. Submit a potholing plan that includes a map of the proposed locations of potholing at each utility crossing to Contracting Officer.
    d. Immediately backfill all utilities with cinders to the appropriate compaction.
    e. Submit a potholing report that includes pothole locations by project coordinates, depths below grade, and photos of exposed utilities.
    f. Contractor shall not proceed with new utility excavation until potholing report is approved by the Contracting Officer.

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, inspections, etc.

1. Electrical: Entrance Contact: Contact Garkane Energy to coordinate electrical service requirements. Service Contact: Contact NPS Contracting Officer to coordinate electrical requirements inside the Park boundary.

2. Water Service Contact: Contact NPS Contracting Officer to coordinate Water service requirements.

3. Wastewater Service Contact: Contact NPS Contracting Officer to coordinate Wastewater service requirements.

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 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 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 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 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. Utility As-Constructed Surveys: Survey and record final locations of all new utilities and ancillary systems including, but not limited to:
1. Raw and finished waterlines, valve locations, and drain valve discharge points.
2. WTP yard piping, valve boxes, etc.
3. Power/Electrical lines, pull boxes, switching cabinets, transformers, etc.
4. Fiber conduits and pullboxes.

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 Fahrenheit.
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 01 73 40

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SECTION 01 73 60 – CONSTRUCTION CAMPS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes requirements for construction camps for Contractor personnel located within the Grand Canyon National Park at the North Rim District.

1.2 DEFINITIONS

A. Construction Camp: Temporary facilities to house Contractor personnel during construction.
   1. The intended use may include camping units, trailer complex for living purposes, food prep stations, common areas, utilities and trash removal provisions, personnel vehicle parking, and possible construction administration trailers.
   2. Construction camps are not intended for equipment and material staging and should not consist of construction equipment and tool storage, material stockpiling, construction equipment parking, and similar.

1.3 QUALITY ASSURANCE

A. Professional Outfitter: Demonstrated experience in providing similar operations within the Grand Canyon or other remote work sites associated with Construction, research, or similar activities.

1.4 SUBMITTALS

A. North Rim Contractor Construction Camp Development Plan
   1. Within 30 days of the Notice to Proceed, identify construction camps designated in this specification to be used by Contractor and associated schedules/timing.
   2. Within 90 days prior to occupancy, submit a plan and drawing of the proposed Contractor's Site facilities within the limits of construction detailing:
      a. Location and sizes of self-contained camping units
      b. Any adjoining land uses and structures including residences, restrooms, campsites, trails, etc.
      c. Vehicle access plan
      d. Overflow parking areas
      e. Location of material storage areas
      f. Location of water service connections, if proposed
      g. Location of restroom services, if proposed.
      h. Location of electrical service connections, if proposed
      i. Location of electrical generator, if proposed
      j. Location of waste storage and disposal services, if proposed.
      k. Method and destination of waste disposal

1.5 PROJECT CONDITIONS

A. Establishment of construction camps will be permitted at:
   1. WWTP Camp is located adjacent to WWTP (outside the helipad area).

PART 2 - PRODUCTS

2.1 CONTRACTOR CONSTRUCTION CAMPS

A. Locations: Camps shall be provided only at the locations identified in Paragraph 1.5 above and as shown on the drawings.

B. WWTP Camp

1. The camp consists of 7 designated camping units that can be utilized by up to 21 persons at any time.
2. A maximum of 40 FT RV or trailer will be allowed at this camp.
3. Water, electric, and sewer connections are available at this site.
4. All units must be self-contained and no tent camping is allowed.
5. No parking, equipment, or personnel is allowable in the designated helicopter landing zone as shown on drawings
6. Contractor shall install temporary fence to prevent personnel or debris from entering helicopter landing zone during use.
7. All trash and equipment must be contained and secured at all times due to wildlife concerns and helicopter flight operations in the vicinity.
8. Generator use will be allowed at a maximum of 70 dBA at SR67. Noise attenuation for generators is required.
9. Contractor shall abide by the same rules and regulations posted at the North Rim campground, unless otherwise approved.
10. Due to the storage of jet fuel at the adjacent helipad, no smoking is allowed at this site.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Camp locations are limited to the areas described in this specification and shown on the Drawings.

B. Locate camps to limit site disturbance and as directed by the Contracting Officer.

C. Provide each camp ready for construction staff use prior to commencing construction activities in the area serviced by the camp. Do not remove until facilities are no longer needed. Do not mobilize a camp multiple times in the same location.

3.2 OPERATION, TERMINATION, AND REMOVAL

A. Keep camps neat and clean

B. Maintain and clean toilet facilities at least weekly.

C. Dispose of other camp waste at least weekly.

D. NPS may conduct food service inspections by a Public Health Consultant (PHC) at food preparation areas at construction camps. Contractor shall allow access and comply with directives issued by the PHC.

E. Temporary electric and water service termination and removal:
   1. Remove each temporary facility when need for its service has ended, or no later than Substantial Completion.
   2. Complete permanent construction that may have been delayed because of interference with temporary facility.
   3. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.

F. Return site to previous condition at completion of work.

G. Materials and facilities that constitute temporary facilities are property of Contractor.

END OF SECTION 01 73 60

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. Demolition Waste: Building and site improvement materials resulting from demolition or selective demolition operations.

C. 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.

D. 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.

E. Disposal: Removal off-site of demolition and construction waste and subsequent sale, recycling, reuse, or deposit in landfill or incinerator acceptable to authorities having jurisdiction.

F. 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.

G. Garbage: Refuse and scraps resulting from preparation, cooking, dispensing, and consumption of food.

H. 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.

I. Recycle: Recovery of demolition or construction waste for subsequent processing in preparation for reuse.

J. Salvage: Recovery of demolition or construction waste and subsequent sale or reuse in another facility.

K. 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.

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. Material Transport: Due to the project location remoteness and required use of aircraft for material transport, the Contractor shall minimize the transport of unnecessary product packaging and other non-project materials to the site.

C. Salvage /Recycle Requirements: 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:

1. Land clearing debris (chipped debris can be used on site for mulch or erosion control)
2. Clean dimensional wood, palettes
3. Plywood, OSB (oriented strand board), and particle board
4. Concrete (can be ground and used for fill on site)
5. Asphaltic concrete (can be ground and used for fill on site)
6. Cardboard, paper, packaging, newsprint
7. Metals (from banding, stud trim, piping, rebar, roofing, other trim, steel, iron, galvanized sheet steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze)
8. Gypsum drywall - unpainted
9. Non-hazardous paint and paint cans
10. Beverage containers: Aluminum, glass, and plastic containers
11. Insulation
12. Ceiling grid and tiles
13. Ductwork
14. Wiring
15. Other mixed construction and demolition waste as appropriate.

D. 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.

E. 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.

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 3 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 1 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

1. 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: 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:

1. Review and discuss waste management plan including responsibilities of Waste Management Coordinator.
2. Review requirements for documenting quantities of each type of waste and its disposition.
3. Review and finalize procedures for materials separation and verify availability of containers and bins needed to avoid delays.
4. Review procedures for periodic waste collection and transportation to recycling and disposal facilities.
5. Review procedures for reduction of single-use plastic products on site.
6. 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, site-clearing 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: 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:

1. Landfill tip fees per ton.
2. If diverted, tip fee savings from landfill diversion.
3. Costs of recycling, salvage, or reuse.
4. Revenue from recycling, salvage, or reuse.
5. 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 three days of submittal return.
2. Distribute waste management plan to entities when they begin work on-site. 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 off-site 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 designated by Government.
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 on-site workers.

B. Recycling Incentives: Revenues, savings, rebates, tax credits, and other incentives received for recycling waste materials shall accrue to Contractor.

C. 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 on-site 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.

B. Concrete: Remove reinforcement and other metals from concrete and sort with other metals.

1. Pulverize concrete to maximum 4 inch 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: Roll large pieces tightly after removing debris, trash, adhesive, and tack strips.

1. Store clean, dry carpet 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 on-site, 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 on-site.

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 on-site.
2. Remove and transport debris in manner preventing spillage on adjacent surfaces and areas.

B. Burning: Do not burn waste materials.

C. Disposal: Transport waste materials off Government property and legally dispose of them.

END OF SECTION 01 74 19

SECTION 01 75 10 - CHECKOUT AND START-UP PROCEDURES FOR WASTEWATER TREATMENT FACILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Administrative and procedural requirements for checkout and startup of equipment, systems, and facilities for the North Rim Temporary Wastewater Treatment Plant.

B. Scope:
   1. Contractor shall initially check out, start up, and place wastewater-treatment related equipment and systems installed under the Contract into successful operation without discharging to the distribution system, in accordance with the material and equipment manufacturers' written instructions, Suppliers' recommendations at the Site, and the Contract Documents.
   2. Provide the following:
      a. All labor, tools, materials, and equipment required to complete equipment and system checkout and startup.
      b. Chemicals, lubricants, and other required operating fluids necessary for checkout, startup, and initial operation of the Work.
      c. Filters and other temporary or consumable items necessary for checkout, startup, and initial operation of the Work.
      d. Fuel, electricity, water, and other temporary utilities and temporary facilities necessary for checkout and startup of equipment and systems, unless otherwise specified.
      e. Manufacturer's field services.
   3. The General Conditions, as may be modified by the Supplementary Conditions, and Section 01 77 00 - Closeout Requirements, address requirements for documenting Substantial Completion.

C. Related Sections include but are not necessarily limited to:
   1. Section 01 78 23 – Operation and Maintenance Data
   2. Section 01 61 03 – Equipment - Basic Requirements.
   3. Section 01 77 00 – Closeout Requirements.
   4. Section 01 79 00 – Demonstration and Training.
   5. Section 40 61 13 – Process Control Systems - General Requirements

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Do not start up equipment or system(s) for continuous operation until all components of that equipment item or system, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
   2. Contractor shall be responsible for providing sufficient personnel for startup activities. Government may provide operations staff to observe startup activities and participate in process decisions, but they should not be relied upon to actively participate.
   3. Suppliers of specific equipment or systems shall be present during checkout, startup, and initial operation of, unless otherwise acceptable to the CO or otherwise required by the Contract Documents.
   4. Do not start up equipment and system(s), without submitting acceptable preliminary operations and maintenance manuals for equipment in accordance with the Contract Documents.

B. Checkout and Startup Planning Meeting:

1. Contractor, with appropriate Subcontractors and Suppliers, shall attend and participate in a meeting with CO to discuss planning, scheduling, and coordination of checkout and startup activities.
2. Upon mutual concurrence of CO and Contractor, meeting may be concurrent with the Training Scheduling Conference required in Section 01 79 00 – Demonstration and Training.
3. Meeting shall be held not less than 45 days prior to first scheduled training session for the equipment and system(s) to be checked out and started-up.
4. Attend meeting prepared to knowledgably and effectively discuss:
    a. Status of the Work and schedule-to-complete for requirements prerequisite to checkout and startup.
    b. Schedule for and status of training required for each equipment item and system.
    c. Schedule for checkout, startup, and field quality control activities for the subject Work.
    d. Status and quantities of required consumables, lubricants, and utility services necessary for checkout and startup.
5. Meeting will be chaired by the Contracting Officer Representative (COR). The COR will prepare and distribute a record of topics discussed and decisions made during the meeting.
    a. If meeting is concurrent with the Training Scheduling Conference required under Section 01 79 00 - Demonstration and Training, Contractor shall chair and prepare minutes of the training scheduling planning portion of the meeting and furnish its draft minutes to COR to incorporate into the overall minutes.
6. Comply with decisions made at the meeting and the Contract Documents.

C. Sequencing:
1. Comply with Section 01 11 00 - Summary of Work, regarding phasing of the Work and allowable shutdowns.

D. Scheduling:
1. Progress Schedule:
    a. Clearly indicate in the Progress Schedule planned and actual dates for checkout, startup, and field quality control activities, including all demonstration testing activities addressed in this Specifications section and elsewhere in the Contract Documents. Separately indicate checkout, startup, and field quality control activities for each equipment item and system.
    b. Perform startup and field quality control activities on the associated, scheduled dates, unless otherwise acceptable to the CO.
2. Restrictions for Scheduling:
    a. Checkout of materials, equipment, and systems by Contractor that do not involve or require Government personnel may be performed at any time during normal working hours. Where required by the Contract Documents or requested by CO, perform checkout in the presence of CO or their designated representative.
    b. Startup, including initial operation of materials, equipment, and systems, shall not be initiated on: Monday, Friday, Saturday, Sunday, Government holidays, the day immediately prior to a holiday, or the day immediately following a holiday, unless otherwise acceptable to the CO.
    c. Unless otherwise indicated in the Contract Documents or acceptable to the CO, perform all startup during normal working hours of the day shift.
    d. To the extent practicable, where extended-duration startup or field quality control activities are required by the Contract, avoid having such activities extend into evening, night, weekend, or holiday hours.
    e. The CO reserves the right to require a minimum seven days' notice of rescheduled startup when Contractor cannot perform the associated activities as scheduled.
3. Operation and Maintenance Data:
    a. Comply with Section 01 78 23 - Operation and Maintenance Data.
    b. A preliminary copy of all operation and maintenance manuals shall be received by the CO prior to the start of the Demonstration period.
4. Training:

a. Comply with Section 01 79 00 - Demonstration and Training.
b. Throughout the Demonstration Period, provide knowledgeable personnel to answer Government's questions, provide final field instruction on select systems (where appropriate) and to respond to problems or failures of the Work.

5. Spare Parts, Tools, and Extra Materials.
   a. Comply with Technical Specifications (Divisions 2 - 46) for furnishing spare parts, tools, and extra materials to Government.
   b. Deliver to the CO all required spare parts, tools, and extra materials prior to commencing the demonstration period, unless earlier delivery is required elsewhere in the Contract Documents.
      1) Provide documentation of CO's receipt of spare parts, tools, and extra materials.

E. Demonstration Plan:
1. Prior to preparing the plan, Contractor shall coordinate a meeting with CO to discuss system demands and limitations for the Demonstration Period with Park staff.
2. Following the meeting, Contractor shall prepare a Draft Demonstration Plan that includes the following information at a minimum:
   a. Schedule break-down by day describing mode of operation (treatment through existing system and/or treatment through new system) and associated WWTP production rates.
   b. Details for temporary bypass piping including size, material, and layout.
   c. Details for discharge flow metering.
   d. Plan to monitor, collect, and submit required water quality data during Demonstration Period.
   e. Data collection and reporting log for sampling, analytical data, and data to be obtained by manually recording data from field or panel indicators for the WWTP.
   f. Proposed certified lab for sampling analysis.
   g. List of Contractor's staff and contact information during the Demonstration Period.
3. Submit Draft Demonstration Plan to CO for review. Allow for a two week review period.
4. Address Government comments and submit Final Demonstration Plan.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Activities described in this Specification shall be conducted without sending effluent to the outfall. At the conclusion of Demonstration, Contractor shall submit and obtain an Interim Approval of Construction (AOC) with an Approval to Commence Operations (ATCO) from ADEQ. Treated effluent shall not be discharged to the outfall until the ATCO is obtained and shall include the following:
   a. Stamped as-built drawings.
   b. Water quality sampling results as defined in this Specification and required by ADEQ to demonstrate system operates within current permittable requirements.
   c. O&M Manual for the WWTP operating as a whole.
      1) Prepared by the Government and provided to the Contractor.
      2) O&M Manuals for specific equipment will be included as appendices to WWTP O&M Manual.

1.4 DEFINITIONS

A. The following defined terms are used in this Specifications Section:
1. Instrumentation Supplier: Entity retained by Contractor, Subcontractor, or Supplier to furnish instrumentation or controls that will be part of the completed Work, including manufacturers, manufacturer representatives, wholesalers, retailers, and others, including entities retained to perform systems integration Work.
2. Project Classified System (PCS): An established, distinct part of the Project, consisting of an arrangement of items, such as equipment, structures, components, piping, cabling, materials, and incidentals, so related or connected to form an identifiable, unified, functional, operational, safe, and independent system. PCSs are specifically indicated in this Specifications section.

3. Pre-Demonstration Period: The period of time, of unspecified duration, after initial construction and installation activities during which Contractor, with assistance from manufacturer's representatives, performs in the following sequence:
    a. Finishing type construction work to ensure each PCS has reached a state of substantial completion.
    b. Equipment start-up.
    c. Personnel training.
4. Demonstration Period: A period of time, of specified duration, following the Pre-Demonstration Period, during which the Contractor initiates process flow through the Project Classified Systems as indicated below and starts up and operates the PCSs, without exceeding specified downtime limitations, to prove the functional integrity of the mechanical and electrical equipment and components and the control interfaces of the respective equipment and components comprising the PCSs as evidence of Substantial Completion.
5. Substantial Completion: See Government website.
6. Beneficial Occupancy (aka Beneficial Use): See Government website.
7. Government website: www.nps.gov/dscw/definitionsdc_**α**.htm
    a. Insert the first letter of the item to be defined for "α".

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Data collection and reporting log for each required Demonstration Period.
    2. Draft and Final Demonstration Plan.

B. Informational Submittals: Submit the following:
    1. Progress Schedules indicating dates for checkout, startup, and field quality control activates.
    2. Completed checkout and startup log.
    3. Manufacturer's installation check letters (also known as Manufacturer's Field Services Report or Certificate of Proper Installation).
    4. Instrumentation Supplier's Instrumentation Installation Certificate.
    5. Letter verifying completion of all Pre-Demonstration startup activities.
    6. Report of data collected during each required Demonstration Period.
    7. Qualifications Statements, including resume' and copy of license of Contractor-retained licensed operator.

1.6 PROJECT CLASSIFIED SYSTEMS

A. Project Classified Systems (PCS's) North Rim Wastewater Treatment established as follows:
    1. PCS #1 – Headworks:
        a. Influent screening.
        b. Flow measurement.
        c. Flow equalization and mixing.
        d. Odor control.
        e. All associated wastewater quality and liquid measurement instrumentation.
    2. PCS #2 – Secondary Treatment:
        a. Mixed liquor recycle pumps.
        b. RAS/WAS pumps.
        c. Deaeration zone mixing.
        d. Anoxic zone mixing.
        e. Membrane system.
            1) Membranes.
            2) Permeate pumps.
            3) Air scour blowers.
        f. Aeration blowers and diffusers.
        g. All associated wastewater quality and liquid measurement instrumentation.
    3. PCS #3 – Aerobic Digestion:
        a. Decant system.

b. Mixer/aerator hyperbolic mixers.
c. Digester blowers.
d. All associated wastewater quality instrumentation.

4. PCS #4 – UV Disinfection:
   a. Closed chamber UV disinfection system.
   b. Effluent flow measurement.
   c. All associated wastewater quality and liquid measurement instrumentation.
5. PCS #5 – Chemical Feed Systems:
   a. Caustic feed system.
   b. Sodium hypochlorite feed system.
   c. Citric acid feed system.
   d. All associated wastewater quality and liquid measurement instrumentation.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 CHECKOUT AND STARTUP – GENERAL

A. Facility Startup Divided into Two Periods:
   1. Pre-Demonstration Period.
   2. Demonstration Period.

B. Provide all consumable items required for checkout and startup including, but not limited to: fuel, oil, grease, and chemicals.
   1. Coordinate with Contracting Officer for delivery of chemicals to site.

C. Provide all temporary bypass piping, bypass valving, temporary pumping, plugs and caps, required to perform checkout and startup.

3.2 PRE-DEMONSTRATION PERIOD

A. Prior to the Pre-Demonstration Period:
   1. Complete the Work to the point where it is ready for checkout and startup, including operation available in all manual, automatic, and other modes.
   2. Obtain the CO's approval or acceptance (as applicable) of Submittals required prior to checkout and startup, including all Shop Drawings, Samples, source quality control (shop testing) submittals, preliminary operation and maintenance manuals, and other Submittals required by the Contract Documents, other than Submittals that cannot be furnished until after startup.

B. Checkout.
   1. Comply with Section 01 61 03 - Equipment - Basic Requirements, including provisions concerning installation checks.

C. Startup:
   1. Comply with requirements for startup of materials, equipment, and systems indicated in the associated Specification sections and elsewhere in the Contract Documents. Specific items of note include:
      a. The Functional Test and Initial Performance Test of PCS #2 Secondary Treatment.
      b. Pipe pressure testing as described in Section 40 05 00.
   2. Prepare the Work so it will operate properly and safely and be ready to demonstrate functional integrity during the Demonstration Period.
   3. Perform startup to extent possible without introducing process flow.
   4. Test tanks, pumping and similar equipment requiring a fluid, using clean water supplied by Government at Contractor's expense.
   5. Test chemical metering pumps using intended product and calibrate pumps.
   6. Dispose of water used for Equipment Start-up to sanitary sewer.

7. Introduce process flow to complete startup for the following:
    a. All PCS systems.
8. Procedures include but are not necessarily limited to the following:
    a. Test or check and correct deficiencies of:
        1) Power, control, and monitoring circuits for continuity prior to connection to power source.
        2) Voltage of all circuits.
        3) Phase sequence.
        4) Cleanliness of connecting piping systems.
        5) Alignment of connected machinery.
        6) Vacuum and pressure of all closed systems.
        7) Lubrication.
        8) Valve orientation and position status for manual operating mode.
        9) Valve actuation for automatic valves.
        10) Tankage for integrity using clean water.
        11) Pumping equipment using clean water.
        12) Instrumentation and control signal generation, transmission, reception, and response.
            a) Comply with Section 40 61 13 - Process Control System General Requirements.
        13) Tagging and identification systems.
        14) Proper connections, alignment, calibration and adjustment.
    b. Calibrate safety equipment.
    c. Calibrate chemical metering pumps.
    d. Manually rotate or move moving parts to assure freedom of movement.
    e. “Bump-start” electric motors to verify proper rotation.
    f. Perform other tests, checks, and activities required to make the Work ready for Demonstration Period.
    g. Checkout and Startup Log:
        1) Prepare a log showing each equipment item and system requiring checkout and startup. Indicate in the log activities to be accomplished during checkout and startup.
        2) Provide a place for Contractor to record date and person performing required checkout and startup. Indicate associated date(s), personnel, and employer of each.
        3) Submit completed checkout and startup log to the COR and obtain the CO’s acceptance.
9. Provide chemicals for Start-up and Demonstration including 55 gallon drums for all drum systems.
10. Obtain Suppliers’ certifications of the installed and operational Work, without restrictions, and submit to the CO:
    a. Manufacturer's installation check letters (sometimes referred to as Manufacturer’s Field Services Report or COPI).
    b. Instrumentation Supplier's Instrumentation Installation Certificate.
11. Submit letter verifying completion of all Pre-Demonstration startup activities including receipt of all specified items from Suppliers as final item prior to initiation of Demonstration Period.
12. Complete training of operations and maintenance personnel.

3.3 DEMONSTRATION PERIOD

A. General:
    1. Demonstrate the operation and performance of mechanical, electrical, instrumentation, and control interfaces of the Work undergoing the Demonstration Period, in accordance with the Contract Documents and without discharging effluent to the outfall.
    2. Duration of Demonstration: 120 consecutive hours (5 days) in full automatic mode.
        a. If the aggregate time used for repair, alteration, or unscheduled adjustments to any part of the Work that renders the affected Work inoperative or operation outside of

recommended ranges exceeds the criteria for acceptance as defined below, the demonstration of operation and performance will be deemed unacceptable and Contractor shall provide appropriate adjustments and remedies and re-perform the Demonstration Test, at no additional cost to the Government, until acceptable results are obtained.

b. Re-performance of the Demonstration Period shall comply with the same requirements as the original Demonstration Period.

3. Perform the demonstration of operation and performance of the Work under minimum and maximum net finished water production rates.
4. Contractor shall develop a Demonstration Plan using the potential modes of operation available to Contractor and outlined below, which allow for flow through the WWTP without discharge to the outfall.

B. Potential Modes of Operation:
   a. Finished Water tanks and pumping shall remain in operation.

   b. Recycle: The Contractor may recycle water using temporary bypass pumps and piping.
      1) In Recycle mode, treated water is sent back through the treatment process. Therefore, it will be necessary for the Contractor to adjust and/or turn off specific chemical feed systems as the duration of Recycle increases.
   c. Once system is tested, raw influent can be introduced. Sampling of effluent will occur once the system is fully operational.

C. Government's Right to Simulate Scenarios:
   1. Government reserves the right to simulate operational variables, equipment failures, routine maintenance scenarios, and similar actions and events during the Demonstration Period to verify the operation and performance of the Work in automatic, manual, and other types of operating modes, backup systems, and alternate operating modes.

D. Demonstration Period, Evaluation, and Acceptance:
   1. Responsibilities for Sampling and Data Collection:
      a. Collect samples, preserve properly and transport to acceptable lab for analysis.
         1) Complete one round of sampling prior to completion of Demonstration Periods.
         2) Sample collection shall be 24 hour composite and include:
            a) Influent: BOD, TSS, alkalinity, ammonia, TKN.
            b) Effluent: BOD, TSS, alkalinity, ammonia, TIN, TKN.
   2. Responsibilities for Data Reporting:
      a. Submit data collected to the COR for evaluation of acceptability of results.
   3. Data Evaluation:
      a. The CO will evaluate the data collected during the Demonstration Period and other information obtained during the Demonstration Period for compliance with the Contract Documents.
      b. The CO will advise Contractor in writing of whether the data and information obtained indicate that the Demonstration Period was successfully completed.
   4. Criteria for Acceptance:
      a. Downtime is less than 5% (6 hours), cumulative, in fully automatic mode.
      b. Treat maximum influent rate without overflowing and minimum effluent rate without failure.
         1) See Contract Drawings for max/min rates.
      c. Treatment facilities can produce water that meets all State and Environmental Protection Agency (EPA) NPDES permit requirements.
      d. At the satisfactory conclusion of the Demonstration Period, Government will take beneficial use of North Rim Temporary Wastewater Treatment Plant.

END OF SECTION 01 75 10

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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

1.2 PROJECT RECORD DRAWINGS

A. Maintain one complete full-size set of contract 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 (CO) 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 shop drawings, sketches, and additional drawings to be included in final set, with clear instructions showing the location of these drawings.
1. Record drawings shall be completed by Drawing Volume as provided in the Contract Drawings.

1.3 CLOSEOUT SUBMITTALS

A. A list of closeout requirements has been attached at the end of the Division 1 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. NPS required forms for occupancy, Fire Sprinkler/Alarm acceptance, and other similar forms or certificates.
3. Project Record Documents, operation and maintenance manuals, final completion construction digital images recorded on USBR Flash Drive with index and descriptions, and similar final record information.
4. Environmental Record Documents:

a. Final Summary of Solid Waste Disposal and Diversion: As specified in Section Insert Specification section 01 74 19 Construction Waste Management and Disposal.

5. 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.
6. 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.

7. 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.
8. Make final changeover of permanent locks and deliver keys to Contracting Officer. Advise Park personnel of changeover in security provisions.
9. Approved pre-functional checklists and functional performance testing reports from commissioning documentation.

10. Test and balance report.
11. Terminate and remove temporary facilities, mockups, construction tools, and similar elements from Project site, complete final cleaning requirements, including touchup painting.
12. Touch up and repair and restore marred exposed finishes to eliminate visual defects.
13. Instruct NPS personnel in operation, adjustment, and maintenance of products, equipment, and systems.

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. Substantially complete is defined by ADEQ approval to operate the TWWTP.

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:

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. Contractor warranty on materials and workmanship:
   1. Period of one year after substantial completion.
   2. Provide one contractor warranty inspection during the warranty period and address any warranty issues.

B. 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.

C. Organize warranty documents into an orderly sequence based on table of contents of Project Manual.

   1. Bind warranties and bonds in heavy-duty, 3-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2 by 11 inch 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.

D. Provide additional copies of each warranty in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 MATERIALS

A. See Division 1 Specification Section "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" (Underwriters Laboratories) 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."

END OF SECTION 01 77 00

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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 Divisions 2 through 49 Sections for additional operation and maintenance manual requirements for Work in those Sections.

C. Operations and Maintenance Manuals for Water Treatment and Wastewater Treatment Facilities. Operations and Maintenance Manuals to meet ADEQ and EPA requirements are not the responsibility of the Contractor and will be provided by the Government. The Contractor will provide information defined in Section 2.3 of this specification for inclusion in the Operations and Maintenance Manuals for Water Treatment and Wastewater Treatment Facilities.

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: Submit operations and maintenance manuals in following format:

1. PDF (portable document format) electronic file. Assemble each manual into composite electronically indexed file. Submit on digital media acceptable to Contracting Officer.

a. Name each indexed document file in composite electronic index with applicable item name. Include a complete electronically linked operation and maintenance directory.
b. 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 4 copies of each corrected manual within 15 days of receipt of Contracting Officers comments.

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: Enclose title page in transparent plastic sleeve. Include:

1. Project Title
2. Location
3. Park
4. Contract Number
5. Prime Contractors Name and Address
6. Date of Substantial Completion
7. 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, 3-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2 by 11 inch 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, water leak, power failure, water outage, and equipment failure.

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. Include:

a. Product name and model number
b. Manufacturer's name
c. Equipment identification with serial number of each component
d. Equipment function
e. Operating characteristics
f. Limiting conditions
g. Performance curves
h. Engineering data and tests

i. 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, 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: Include:

1. Product name and model number
2. Manufacturer's name
3. Color, pattern, and texture

4. Material and chemical composition
5. 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. 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: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:

1. Standard maintenance instructions and bulletins.
2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
3. Identification and nomenclature of parts and components.
4. List of items recommended to be stocked as spare parts.

D. Maintenance Procedures: Include the following and items detailing essential maintenance procedures:

1. Test and inspection instructions
2. Troubleshooting guide
3. Precautions against improper maintenance
4. Disassembly; component removal, repair, and replacement; and reassembly instructions
5. Aligning, adjusting, and checking instructions
6. 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 1 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. 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.
3. 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.

D. Closeout and Operation & Maintenance (O&M) Requirements List: A Closeout and O&M Requirements list has been attached to the end of this Specification Section as a summary of the requirements. The requirements of the individual Specification Sections, terms and conditions of the Contract still apply regardless of what is shown on the Closeout and O&M Requirements list.

END OF SECTION 01 78 23

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:	

CLOSEOUT AND OPERATION & MAINTENANCE (O&M) REQUIREMENTS LIST

Closeout and Operation & Maintenance (O&M) Requirements **GRCA 318719 TWWTP**

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	Final Project Record Drawings			
	01 91 14	Final Project Record Drawings			
	40 61 96	Process Control Descriptions			
	40 67 00	Control System Panels: As-Built Shop Drawings			
	01 75 10	NR WWTP: Pre-demonstration and Demonstration requirements for Wastewater Treatment Facilities			
	33 32 13	NR WW Lift Station: Pre-demonstration and Demonstration requirements for lift station			
System Demonstration and Training	01 79 00	Demonstration of operation of systems, subsystems, and equipment. Training in operation and maintenance of systems, subsystems, and equipment including environmental considerations. Demonstration and training video.			
	22 33 15	Demonstration of operation of instantaneous elcectric water heaters and safety showers.			
	23 80 00	Demonstration of operation of HVAC equipment			
	26 13 23	Demonstration of Sectionalizing Equipment			
	26 28 16	Demonstration of Manual Transfer Switch			
	33 23 13	Demonstration of operation of package lift stations: 1) Influent LS; 2) Filtrate LS			
	46 07 53	Demonstration of operation of package MBR treatment system: 1) Equalization Tank, 2) MBR Treatment Units, 3) UV Skid			
	46 21 40	Demonstration of operation of mechanically cleaned screens in channel auger			
Tools, Spare Parts, and Equipment	07 92 00	Stock Material for Joint Sealants			
	23 80 00	Spare belts and air filters			
	26 09 13	Provide one set of printer ink catridges and one eam of printer paper (500pages)			
	26 09 16	Provide contacts for all required control plus two spares			
	26 12 19	Provide two (2), one (1) quart cans of touch up paint for equipment			
	26 13 23	Provide touch up paint			
	26 29 23	Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses)			
	33 23 13	Spare Pump 1EA per package lift station, 2 total pumps: 1) Influent LS; 2) Filtrate LS. One set of spare level switches per package lift station.			
	40 61 21	Terminal block, fuse, breaker, and other required installed spares			
	40 61 21	General arrangement and space allocation, including spare usable space in panel and on panel door			
	40 61 21	PLC equipment (chassis, power supply, power conditioners, processor, adapters, I/O and specialty modules, installed spares, spare usable space) is appropriate			
	40 63 43	One spare CPU for every four field CPUs or fraction thereof installed			
	40 63 43	One spare communication module by type installed in the Plant			
	40 63 43	One spare I/O card of each card type for every 10 cards or fraction thereof installed			
	40 63 43	One spare power supply for every 10 power supplies or fraction thereof installed			
	40 63 43	A set of spare fuses for all installed types			
	46 07 53	Spare parts for Membrane systems per manufactures reccomendation (2-year operational package)			
	46 21 40	Spare parts for mechanical auger system per manufactures reccomendation			
	46 21 40	Collection Bin and Waste Bags per manufactures reccomendation (1-year supply of bags)			
Reports	01 35 25	Completion of Blasting certification			
	01 74 19	Final Summary of solid waste disposal and diversion			
	01 77 00	Approved pre-functional checklists and functional performance testing reports from commissioning documentation			
	01 77 00	Test and balance report			
	01 61 03	Motor test reports			
	01 61 03	Field noise testing reports			
	01 61 03	Testing and monitoring reports			
	03 01 30	Laboratory test reports			
	03 01 30	Test and Evaluation Reports			
	03 05 05	Test reports and inspection reports			
	03 31 30	Cement and SCM mill certificates for all materials to be supplied			
	03 31 30	Test results for AAR impurities of coarse aggregates within proposed mixes, in accordance with ASTM standards cited in this Section			
	07 84 00	Special Inspection Reports			
	08 70 00	Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency			
	23 05 93	Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems			
	23 74 36	Test reports of the refrigerant piping leak tests for all refrigerant piping systems installed			
	26 05 13	Cable test report(s)			
	26 05 26	grounding systems continuity test and grounding resistance test.			
	26 08 13	Testing and monitoring reports			
	26 09 13	Operating instructions of the meter(s) supplied			
	26 09 13	Operating instructions of the Power Management software			
	26 13 23	manufacturer's certification of installation for sectionalizing equipment			
	26 28 00	Ground fault protection system test reports signed by the projects supervising electrical foreman			
	26 28 02	Short circuit study report			
	26 28 02	Protective coordination study report			
	26 28 02	Arc-flash hazard study			
	26 29 23	Certified factory test reports confirming compliance with specified requirements			
	26 29 23	Certified field service reports			
	26 41 13	UL Master Label Certificate for lightning protection system			
	26 50 00	IESNA LM-79 Test Report for Solid-State Luminaire			
	26 50 00	IESNA LM-80 Test Report Solid-State Light Source			
	31 22 00	Report and certification of aggregate fill and drainage fill			
	31 22 00	Test reports on borrow material			
	31 22 00	Field reports; in-place soil density and moisture tests			
	31 23 00	Report and certification of aggregate fill and drainage fill			
	31 23 00	Test reports on borrow material			
	31 23 00	Field reports; in-place soil density and moisture tests			
	31 23 33	Geotechnical reports			
	32 91 13	Soil Survey Report			
	33 05 15	Copies of source quality control tests, including compressive strength and air content, for units provided			
	33 05 24	Chemical and physical test reports showing data consistent with specified requirements for each heat of steel proposed for use			
	33 05 24	Source Quality Control Test Reports			
	33 05 24	Field Quality Control Test Reports			
	33 31 11	Pipe Joint Testing Eqipment			
	40 05 00	Reports defining results of dielectric testing and corrective action taken			
	40 05 00	Bacteriological reports on samples taken from system			
	40 05 63	One set of any special tools or wrenches required for operation or maintenance for each type valve			
	40 05 63	One 4" Spare actuator (V-52338)			
	40 05 63	One 3" Spare actuator (V-52331)			
	40 41 13	Megger test results			
	40 61 21	Site Acceptance Test (SAT) Reports			

Topic	Specification Section	Requirement	Submittal Date	Completed	Received by Park
	40 61 21	Completed Loop Checkout Sheets			
	40 61 21	Completed Instrument Certification Sheets			
	40 61 21	Completed Final Control Element Certification Sheets			
	40 61 21	All system startup and checkout records, test records, recommendations and information furnished by Manufacturer's representatives during testing and startup			
	40 61 21	Completed Loop Checkout Sheets			
	40 61 21	Completed Instrument Certification Sheets			
	40 61 21	Completed Final Control Element Certification Sheets			
Keys & Keying Schedule	08 70 00	Gate			
O&M Data, Warranties, and Guarantees	06 10 00	Interior fire-retardant treated wood: Manufacturer's standard 20-year warranty			
	08 70 00	Unless otherwise indicated, warranty shall be one year from date of Substantial Completion			
	08 70 00	Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation			
	23 74 36	The completed refrigerant piping system shall be guaranteed to be sufficiently free from leaks so that the loss of refrigerant for 18 months from the date of final payment shall not exceed 5 percent			
	23 80 00	O&M manual for fan coil units			
	23 80 00	O&M manual for condensing units			
	23 80 00	O&M Data for unit heaters			
	26 12 19	O&M manual for distribution transformers			
	26 13 23	O&M Manual for sectionalizing equipment			
	26 22 13	O&M manual for dry-type transformers			
	26 41 13	O&M manual for lightning protection system			
	26 43 13	Minimum of a five year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions			
	26 50 00	Minimum of a five year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15% of the individual light emitting diodes fail to illuminate			
	33 32 13	O&M Data for package lift station. Minimum 2 year warranty from date of Contract Officer acceptance			
	40 05 52	O&M Manual for miscellaneous valves			
	40 05 62	O&M Manual for plug valves			
	40 05 63	O&M Manual for ball valves			
	40 05 64	O&M Manual for butterfly valves			
	40 05 66	O&M Manual for check valves			
	40 61 43	O&M Manual for surge protection devices			
	40 61 43	5 year limited warranty for surge protection devices			
	40 61 93	Post-commissioning final I/O List			
	40 63 43	O&M Manual for Programmable Logic Controllers and associated hardware			
	40 74 00	O&M Manual for temperature instruments			
	46 07 53	Provide manufacturer's warranty against any defects in material or workmanship for the entire treatment system and appurtenances, including but not limited to the tanks, pumps, float switch assembly, discharge assembly, control panel, splice boxes, ventilation fans, and ventilation fan heaters. This warranty shall commence at substantial completion or 14 months following delivery, whichever comes first, and shall be 36 months in duration			
	46 21 40	Provide manufacturer's warranty against any defects in material or workmanship for the entire treatment system and appurtenances, including but not limited to the tanks, pumps, float switch assembly, discharge assembly, control panel, splice boxes, ventilation fans, and ventilation fan heaters. This warranty shall commence at substantial completion or 14 months following delivery, whichever comes first, and shall be 36 months in duration			

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 Divisions 2 through 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 1 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 seven 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: 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:

1. Equipment systems and controls.
2. Environmental Topics

    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 implemented during construction:

        1) Regulatory Requirements
        2) Indoor Air Quality (IAQ) Management
        3) Noise and Acoustics Management
        4) Environmental Management
        5) Construction Waste Management

    d. Review of site-specific procedures and management plans to be implemented during operation and maintenance.

        1) Include review of environmentally related aspects of Operations and Maintenance Manual.
        2) Integrated Pest Management (IPM)

B. Training Modules: 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:

1. 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.
2. Documentation: Review emergency, operations, and maintenance manuals; Project Record Documents; identification systems; warranties and bonds; and maintenance service agreements.
3. 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.
4. 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.
5. Adjustments: Alignments and checking, noise, vibration, economy, and efficiency adjustments.
6. Troubleshooting: Diagnostic instructions and test and inspection procedures.
7. Maintenance: Inspection procedures, types of cleaning agents, methods of cleaning, procedures for preventive and routine maintenance, and instruction on use of special tools.
8. 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 seven 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 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.

3.3 PERSONNEL TRAINING FOR TREATMENT AND PUMP STATION EQUIPMENT

A. Required for the following project components:
1. North Rim Temporary Wastewater Treatment Plant

B. Conduct all personnel training after completion of Equipment Start-up for the equipment for which training is being conducted.
1. Personnel training on individual equipment or systems will not be considered completed unless:
a. All pre-training deliverables are received and approved before commencement of training on the individual equipment or system.
b. No system malfunctions occur during training.

c. All provisions of field and classroom training specifications are met.

2. Training not in compliance with the above will be performed again in its entirety by the manufacturer at no additional cost to the Government.

C. Field and classroom training requirements:

1. Hold classroom training on-site.
2. Notify each manufacturer specified for on-site training that the Government reserves the right to video record any or all training sessions.
   a. Organize each training session in a format compatible with video recording.
3. Training instructor qualification: Factory trained and familiar with giving both classroom and "hands-on" instructions.
4. Training instructors:
   a. Be at classes on time.
   b. Session beginning and ending times to be coordinated with the CO and indicated on the master schedule.
   c. Normal time lengths for class periods can vary, but brief rest breaks should be scheduled and taken.
5. Organize training sessions into maintenance verses operation topics and identify on schedule.
6. Plan for minimum class attendance of **15** at each session and provide sufficient classroom materials, samples, and handouts for those in attendance.
7. Instructors to have a typed agenda and well prepared instructional material.
   a. The use of visual aids, e.g., films, pictures, and slides is recommended for use during the classroom training programs.
   b. Deliver agendas to the Contracting Officer a minimum of seven (7) days prior to the classroom training.
   c. Provide equipment required for presentation of films, slides, and other visual aids.
8. In the on-site training sessions, cover the information required in the Operation and Maintenance Manuals submitted according to 01 78 23 “Operation and Maintenance Data” and the following areas as applicable to PCS's.
   a. Operation of equipment.
   b. Lubrication of equipment.
   c. Maintenance and repair of equipment.
   d. Troubleshooting of equipment.
   e. Preventive maintenance procedures.
   f. Adjustments to equipment.
   g. Inventory of spare parts.
   h. Optimizing equipment performance.
   i. Capabilities.
   j. Operational safety.
   k. Emergency situation response.
   l. Takedown procedures (disassembly and assembly).

D. Address above Paragraphs 1), 2), 8), 9), 10), and 11) in the operation sessions. Address above Paragraphs 3), 4), 5), 6), 7), and 12) in the maintenance sessions.

E. Maintain a log of classroom training provided including: Instructors, topics, dates, time, and attendance.

F. The following table outlines the operator training requirements for this project.

OPERATOR TRAINING REQUIREMENTS LIST

END OF SECTION 01 79 00

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Equipment	Section	No. of Training Days Req'd[(2)]	No. of Training Sessions Per Day Req'd	Duration of Each Training Session (hr.)	Training Session Conducted in Classroom and/or Field	Video Taping Req'd During Training (Yes/No)	Other Special Training Requirements
Temporary Wastewater Treatment Management Plan	01 35 10	5	1	8	Both	Yes	
Plumbing Fixtures and Equipment	22 20 00	1	1	2	Field Only	Yes	
Instantaneous Electric Safety Shower Water Heaters	22 33 15	1	1	2	Field Only	Yes	
HVAC: Equipment	23 80 00	1	1	4	Field Only	Yes	
Sectionalizing Equipment	26 13 23	1	1	1	Field Only	Yes	
Safety Switches: Manual Transfer Switch	26 28 16	1	1	2	Field Only	Yes	
Interior and Exterior Lighting	26 50 00	1	1	1	Field Only	Yes	
Hydropneumatic Tank and Potable Water Booster Pump System	33 16 33, 43 23 31	1	1	4	Field Only	Yes	
Package Sewage Pumping Station (each manf.)	33 32 13	1	1	8	Field Only	Yes	
Package WWT Equipment	46 07 53	2	1	8	Both	Yes	See specification.
Mechanical Cleaned Screens In-Channel Auger	46 21 40	1	1	8	Field Only	Yes	See specification.

Notes:

(1) Training agenda must be submitted to the Contracting Officer minimum 1 week prior to the scheduled training.
(2) Number of training days is per water treatment plant if the equipment/system is installed at both plants.

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SECTION 01 81 10 – WIND, SNOW AND SEISMIC DESIGN CRITERIA

PART 1 - GENERAL

1.1 SUMMARY

A. This Section is intended to be used for all aspects of this project.
   1. When there are conflicts between this Section and other wind and seismic design criteria given in the Contract Documents, the more stringent loading shall govern.
   2. Obtain clarification of all conflicts in writing prior to construction.

B. Section Includes:
   1. The wind, seismic, and snow design criteria for this project including all items directly specified in the Contract Documents as well as all items that are specified to be designed by the Contractor and submitted for approval. Items include but are not necessarily limited to the following:
      a. Anchorage of mechanical and electrical equipment.
      b. Anchorage of pipe support structures.
      c. Design and anchorage of tanks and vessels fabricated off site and shipped to Project site.
      d. Self-contained enclosures
      e. Packaged equipment systems.
      f. Other structures or items as specified or indicated in the Contract Documents.

C. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 40 00 – Structural Testing and Special Inspection
   4. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Civil Engineers (ASCE):
      a. 7-22, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
   2. International Code Council (ICC)
      a. International Building Code and associated standards, 2024 Edition including all amendments, referred to herein as Building Code.
   3. When referenced standards conflict the most stringent shall apply unless specifically indicated otherwise in the Contract Documents or unless approved otherwise in writing by the Contracting Officer.

B. Qualifications:
   1. Engineer for Contractor designed items: Professional Engineer licensed in the State of Arizona.

1.3 GENERAL DESIGN CRITERIA

A. This paragraph is applicable to both wind and seismic design criteria.

B. Design in accordance with the requirements of the Building Code and all applicable referenced standards.

C. Risk Category: As indicated below.
   1. North Rim Temporary Wastewater Treatment: IV

D. Design in accordance with the Building Code load combinations for service level or factored level at Contractor’s option.

1. Mechanical and electrical equipment loads will be considered dead loads.

1.4 SEISMIC DESIGN CRITERIA

A. North Rim Temporary Wastewater Treatment:
   1. Design spectral acceleration at short period: S_{DS} = 0.300.
   2. Design spectral acceleration at 1-second period: S_{D1} = 0.110.
   3. Importance Factor: Ie = 1.25.
   4. Seismic Design Category: C.
   5. Component or system amplification factor, (a_P) and Component response modification factor, (R_P): In accordance with ASCE 7-16, Tables 13.5-1 and 13.6-1.
   6. Component importance factor: I_P = 1.50.

B. Seismic forces must be resisted by direct load transfer through fasteners to all seismic resisting elements.
   1. Do not use connections that use friction to transfer seismic forces.

1.5 WIND DESIGN CRITERIA

A. Wind design load criteria:
   1. North Rim Temporary Wastewater Treatment
      a. Basic wind speed (V_{ULT}): 110 MPH.
      b. Tornado Speed (V_T): Not applicable per ASCE 7 Figures 32.1-1 and 32.1-2
      c. Exposure category: C.
      d. Topographic factor: K_{zt} = 1.0.
      e. Wind importance factor: I_w = Not Applicable.
      f. Building Description for wind design is Enclosed, unless specifically noted otherwise on Drawings.
         1) Internal Pressure Coefficient (GC_{pi}): ±0.18

B. Wind forces must be resisted by direct load transfer through fasteners to wind-resisting elements.
   1. Do not use connections that use friction to transfer wind forces.

1.6 SNOW DESIGN CRITERIA

A. Snow Design Load Criteria:
   1. Design ground snow load: pg = 260 psf
   2. Design exposure factor: Ce = 0.90
   3. Design thermal factor: Ct = 1.1
   4. Design slope roof factor: Cs = 0.91
   5. Minimum flat roof snow load: pf = 200 psf
   6. Design considerations for partial loading, unbalanced snow, snow drift in the vicinity of adjacent structures or projections, sliding snow, and other applicable factors shall be considered at locations required by Laws and Regulations, including applicable building codes.
   7. In no event shall snow design load criteria or minimum snow load be less than required by authority having jurisdiction.

1.7 SUBMITTALS

A. Informational Submittals:
   1. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Structural Calculations:
      a. Submit calculations for each Contractor designed item under the Specification Section number for that item.
      b. Indicate compliance with specific referenced documents of the Building Code.

c. Provide basis of design and lateral analysis as required to derive all loads and to show system stability including compatibility of deflections and compatibility with allowable soil parameters as applicable.
d. Indicate design load to each connection.
e. Provide a complete lateral load resisting system that transfers all wind and seismic loads through a load path to ground.
f. Sealed by a professional engineer licensed in the State of Arizona.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION - (NOT USED)

END OF SECTION 01 81 10

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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:

1. See Divisions 1 through 49 Sections for sustainability requirements specific to work of each of these Sections.

1.2 DEFINITIONS

A. 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.

B. LEED™: Leadership in Energy & Environmental Design. Sustainability rating system developed by United States Green Building Council (USGBC).

C. 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.

D. 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.

E. 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.

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 building materials with recycled content such that post-consumer recycled content plus one-half of pre-consumer recycled content constitutes a minimum of 10 percent of cost of materials used for Project.

1. Determine cost of post-consumer recycled content by dividing weight of post-consumer recycled content in item by total weight of item and multiplying by cost of item.
2. Determine cost of pre-consumer recycled content of an item by dividing weight of pre-consumer recycled content in item by total weight of item and multiplying by cost of item.

3. Do not include mechanical and electrical components, and specialty items such as elevators and equipment in calculation.

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 Divisions 2 through 49.

B. For field applications inside the weatherproofing system, use paints and coatings that comply with VOC content limits in Specification Divisions 2 through 49.

C. Do not use composite wood or agrifiber products or adhesives that contain urea-formaldehyde resin.

PART 3 - EXECUTION

3.1 REFRIGERANT REMOVAL

A. Remove Chlorofluorocarbons **(**CFC)-based refrigerants from existing Heating, Ventilation, Air Conditioning, and Refrigeration (HVAC&R) equipment indicated to remain and replace with refrigerants that are not CFC based. Replace or adjust existing equipment to accommodate new refrigerant as described in Division 23 Sections.

B. Remove clean-agent fire-extinguishing agents that contain Hydrochlorofluorocarbons (HCFCs) or halons and replace with agent that does not contain HCFCs or halons. See Division 21 Section "Clean-Agent Fire Extinguishing Systems" for additional requirements.

3.2 MEASUREMENT AND VERIFICATION

A. Coordinate with Divisions 2 through 49 for project requirements regarding installation of building level metering equipment to measure energy, water, and electric usage.

END OF SECTION 01 81 13

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SECTION 01 81 33
CYBER SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:
   1. The supplier and all other parties providing parts and services under this contract are subject to these conditions. This includes hardware and software, licensing, intellectual equipment, patent restrictions and use, copyright, and similar equipment, systems, and appurtenances covered under this Section.
   2. Requirements for vendors, suppliers and / or Contractor-furnished equipment with microprocessor-based equipment including:
      a. Providing full and unrestricted use by the Government for equipment supplied under this contract including access, review, updates, and modification of software code, firmware and configurations of PLCs, PACs, RTUs, HMIs, OITs or any other microprocessor-based equipment.
      b. Allowing the Government to transfer to designated agents the right to perform this work on their behalf.
      c. Furnishing software source code for the system supplied. Coordinate with the COR to remove default usernames and passwords, to remove contractor passwords at the time of system acceptance and turn-over of all passwords utilized in the system.
   3. Requirements for vendors, suppliers and / or Contractor-furnished items for furnishing program code, passwords, keys, and configuration files upon project milestones and / or as requested by the COR after project completion.

B. Scope:
   1. The supplier agrees to assist in cybersecurity basic hygiene practices as dictated by best practices included in this section, government regulation at time of bid, and as provided by the Government's cyber security team. At a minimum, the supplier will coordinate with the COR and assign IP addresses and subnet masking, utilization of managed switches with unused ports disabled, and provide all equipment with latest firmware at time of field installation.
   2. To this end the following are expected standard industry practices that vendors shall abide by:
      a. All equipment supplied will be current and not obsolete or subject to a manufacturer's end-of-life notice of less than 2 years after startup.
      b. Provide any notices of manufacturer's end-of-life notices for all equipment at the time of submittal for approval of equipment. This shall include searching equipment websites during the submittal process to ensure the products are not nearing end of life.
   3. The Government shall be granted full use of equipment and services provided by equipment and its associated automation under this Section and shall include:
      a. Full access and use of supplied software within any equipment supplied including PLCs, OITs, networking and communications equipment, gateways, and HMI code (including fully documented source code), internal function blocks or code shall be ceded to the Government for their exclusive use at the location(s) of the equipment. These rights shall transfer to future locations.
      b. Right to modify, enhance or make changes to the equipment as deemed necessary or desired by the Government, including hardware, software, network settings, passwords or other information or settings that the Government may change for maintenance, upgrade, or cyber security reasons.
      c. Full release of claims to Intellectual Equipment, Trade Secrets, or Sensitive Information as supplied with this equipment as may be claimed by the supplied or any of their

subcontractors, subconsultants, and the like as regards equipment or services provided herein to the Government.

d. No provisions for Non-Disclosure Agreements (NDAs) or other restrictions to restrict or prevent the Government from obtaining or using information, licenses, electronic data, or software are allowable.

4. The supplier shall furnish software source code for the equipment supplied. The code or any part of the system may not be hidden or protected by encryption, passwords, or other means without providing these passwords or access to the Government's dedicated personnel.
5. The supplier shall take measures to limit the distribution of information on Government's SCADA network to the minimum personnel required. The supplier shall not publish to public facing media this information at any time.

C. Related Requirements:
1. Section 01 33 23 – Submittal Procedures.
2. Section 01 75 10 – Checkout and Startup Procedures.

1.2 REFERENCES

A. Terminology:
1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the meaning indicated below:
a. "Code and configuration files" mean any and all code or equipment configuration backup files, whether created by or for Contractor, Supplier, or Subcontractor, needed for Owner or facility manager to restore equipment and systems to final condition of equipment and systems prevailing at the time of Substantial Completion. Code and configuration files do not include original equipment manufacturer (OEM) software's underlying proprietary code such as firmware or operating system code. For example, for variable frequency drives (VFD), the configuration file of parameters of each individual VFD furnished or modified under the Project is required. However, the OEM's source code that runs the VFD firmware need not be furnished to Owner or facility manager.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
1. Comprehensive asset inventory of all networked components:
a. Provide in Excel spreadsheet format.
b. Coordinate with the COR to determine the preferred method of delivery to assure security of information contained in asset inventory.
c. Submittal shall include the following for each device:
1) Device identification designation.
2) Manufacturer.
3) Model number.
4) Serial number.
5) IP Address.
6) Device use description.
7) Firmware.
2. Network Diagrams:
a. Provide in both AUTO CAD and PDF formats.
b. Coordinate with the Government to determine the preferred method of delivery to assure security of information contained in Network Diagrams.
c. Logical Network Diagram(s): Show information flow through network(s), and include:
1) Major network devices, subnets, and virtual local area networks (VLAN).
2) Include all wireless communication devices.
3) Indicate the following information for each networked device:
a) Device identification designation.
b) Device description.
c) Manufacturer and model number.

d) MAC address.
e) IP address.
f) Ports and Protocols

d. Physical Network Diagram(s): Show all physical network components, ports, protocols, connections, and cables. Show or indicate wireless communication devices including physical location.

3. Software source code for all PLCs, HMIs, OITs and other devices.
4. Configuration files, passwords, encryption information and other sensitive information for the full project scope.

B. Timing: Submittals will be required at the following project stages:
1. Network Diagrams and Asset Inventory – with control panel submittals.
2. Draft Software and Configuration Files, and As-Manufactured Network Diagrams – Available at Factory Acceptance Testing.
3. All documents available on-site upon equipment delivery to project site.
4. All documents contained within Operation & Maintenance Manuals.
5. Final As-Builts of all documents and electronic files at project closeout.

1.4 CODE AND CONFIGURATION REQUIREMENTS

A. Copies of Code and Configuration Files – General:
1. Submit as Electronic Documents only. Paper Submittals are not required for program code and configuration files.
2. Files to be securely transferred with limited distribution as requested by the COR to protect sensitive information. Provide proof of file transfer for Submittal record purposes.
3. In accordance with the Contract Documents, promptly following Substantial Completion, Government shall have right to: (a) modify program code and configuration files, (b) update software and firmware, (c) revise system security settings, such as passwords, IP addresses, and other security settings, and (d) implement related modifications, without restriction or interference from Contractor, Subcontractor, Supplier, and others.
4. The Government agrees to use program code and configuration files only with the Government's facilities, as may be transferred to the Government's assignees.
5. The Government will not be subject to any Supplier-requested non-disclosure agreement that is not part of the Contract Documents.
6. The COR agrees to not distribute program code and configuration files obtained under the Project, except in exchanging such files with the Government or their assignees. The COR will not be party to any Supplier-requested non-disclosure agreement.

B. Configuration Files:
1. Submit copies of system configuration prepared for the Project, such as setpoints for programmable controllers, facility SCADA display configurations, and similar configuration files.
2. Files to be securely transferred with limited distribution as requested by the Government or supplier to protect sensitive information. Proved proof of file transfer for submittal record purposes.
3. Submit as separate files configuration files for each separate control and monitoring devices for which configuration files are furnished. Clearly distinguish the device(s) associated with each file.
4. Contractor (including Subcontractors and Suppliers) is not responsible for configurations of control setpoints subsequently changed by the Government, facility manager, or others for whom either is responsible, not in accordance with Supplier's written recommendations and operation and maintenance instructions.

C. Program Code:
1. Submit copies of program code for programmable logic controllers (PLC), human-machine interfaces (HMI), operator interface terminals (OIT), and other programmable controllers, subject to the following:

a. Submit for all PLCs, HMIs, OITs, and other programmable controllers furnished as part of the Work regardless of whether such program code is manufacturer's standard, or developed specifically for the Project, or a combination of manufacturer's standard program code and Project-specific program code. Contractor and associated Subcontractors and Suppliers are not responsible for the program code modifications made by the Government that result in improper operation of materials, equipment, or systems that invalidate applicable warranties and manufacturer's recommended operation instructions.
b. Third-party, licensed, commercially available software (such as, but not limited to, Microsoft operating system software sold at retail, and commercial SCADA system software platforms, PLC programming software) is excluded from requirements of this Article. Furnish copies of commercially-available, licensed, third-party software, where required, in accordance with the Contract Documents.

2. Submit complete logic listings in all formats (ladder logic, function block diagram, sequential function chart, instruction list, structured text).
3. Format Requirements:
   a. For ladder diagram logic, include complete cross-referencing of all logic elements. Annotate all elements with clearly understandable tags or descriptive labels.
   b. For function block diagram, label each function block with understandable tags or descriptive labels. Describe purpose and action of each function block.
   c. For sequential function chart, include extensive comments for each step to describe program step function.
   d. For instruction list and structure text, include extensive comments for each program line to describe program line function.
4. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
5. Submit complete manufacturer's program code materials.

1.5 REMOTE ACCESS

A. Suppliers will not be allowed to open access to the furnished equipment after installation on the site due to Cyber Security Requirements.

B. Remote access appliances for interaction with programmable devices will not be accepted during construction or operation.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND SYSTEMS

A. Controls:
   1. Micro-processor based, computing and network equipment furnished shall be current and not be obsolete or subject to a manufacturer's end-of-life notice of less than two years after Substantial Completion.
   2. Submit Suppliers' end-of-life notices, if any, for equipment as part of Shop Drawing or product data Submittal for the subject item.
   3. Demands for non-disclosure agreements (NDAs) or other measures that would restrict or prevent the Government from obtaining or using information, licenses, operational and performance data, and software are unacceptable.

PART 3 - EXECUTION

3.1 CONTRACTOR'S ONSITE ACCESS TO FACILITY NETWORKS

A. Contractor's Onsite Access to Facility Networks – General:

1. Devices, whether laptop computers, tablets, or others, owned or operated by Contractor, Subcontractor, or Supplier, used for programming and startup of programmable devices that are part of the Work, will not be allowed to connect to the Government's programmable device network.

END OF SECTION

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SECTION 02 41 00
DEMOLITION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General provisions applicable to all demolition and removals.
   2. Civil/site demolition and removals.
   3. Architectural and structural demolition and removals.
   4. Mechanical demolition and removals
   5. Electrical demolition and removals.
   6. Disposal of demolition debris, materials, and equipment.

B. Scope:
   1. Contractor shall provide all labor, materials, equipment, tools, and incidentals as shown, specified and required for demolition, removals, and disposal Work.
   2. The Work under this Specifications section includes, but is not necessarily limited to:
      a. Demolition and removal of existing materials and equipment as shown or indicated in the Contract Documents. The Work includes demolition of structural concrete, foundations, walls, doors, windows, structural steel, metals, roofs, masonry, attachments, appurtenances, piping, electrical and mechanical systems and equipment, pavement, sidewalks, gutters, fencing, and similar existing materials, equipment, and items.
   3. Demolitions and removals indicated in other Specifications sections shall comply with requirements of this Specifications section.
   4. Perform demolition Work within areas shown or indicated.
   5. Pay all costs associated with transporting and, as applicable, disposing of materials and equipment resulting from demolition and removals Work.

C. Related Requirements:
   1. Section 31 10 00 - Site Clearing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Fire Protection Association (NFPA):
      a. 241, Safeguarding Construction, Alteration, and Demolition Operations.

B. Regulatory Requirements:
   1. Demolition, removals, and disposal Work shall be in accordance with 29 CFR 1926.850 through 29 CFR 1926.860 (Subpart T – Demolition), and all other Laws and Regulations.
   2. Comply with requirements of authorities having jurisdiction.

C. Qualifications:
   1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician(s) legally qualified to perform electrical construction and electrical work in the jurisdiction where the Site is located.
   2. Plumbing Removals: Entity and personnel performing plumbing removals shall be plumber(s) legally qualified to perform plumbing construction and plumbing work in the jurisdiction where the Site is located.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Review procedures under this and other Specifications sections and coordinate the Work that will be performed with or before demolition and removals.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Procedure Submittals:
      a. Demolition and Removal Plan: Not less than ten days prior to starting demolition Work, submit acceptable plan for demolition and removal Work, including:
         1) Plan for coordinating shut-offs, capping, temporary services, and continuing utility services.
         2) Other proposed procedures as applicable.
         3) Equipment proposed for use in demolition operations.
         4) Recycling/disposal facility(ies) proposed, including facility owner, facility name, location, and processes. Include copy of appropriate permits and licenses, and compliance status.
         5) Planned demolition operating sequences.
         6) Detailed schedule of demolition Work in accordance with the Schedule accepted by Contracting Officer.
   2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Specifications Section.
   3. Field Quality Control Test Results:
      a. Results of megger-testing of existing motors to remain Governments's property.
   4. Qualifications Statements:
      a. Name and qualifications of entity performing electrical removals, including copy of licenses required by authorities having jurisdiction.
      b. Name and qualifications of entity performing plumbing removals,

1.5 SITE CONDITIONS

A. Government makes no representation of condition or structural integrity of area(s) to be demolished or where removals are required by the Contract Documents.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Notification:
   1. Not less than 48 hours prior to commencing demolition or removal, advise Contracting Officer in writing of planned start of demolition Work. Do not start removals without permission of Contracting Officer.
   2. Where demolition or removals has potential to affect adjacent properties, occupants, streets, or other public thoroughfare, transportation facilities, and utilities, furnish required notices to owners and occupants of properties, buildings, and structures that may be affected by the demolition of removal.
   3. In accordance with Laws and Regulations, furnish to authorities having jurisdiction, including emergency services as necessary, appropriate notices of planned demolition and removals.
   4. Submit to Contracting Officer copies of notices furnished to adjacent property owners, occupants, and authorities having jurisdiction.

B. Protection of Adjacent Areas and Facilities:
   1. Perform demolition and removal Work in manner that prevents damage and injury to property, structures, occupants, the public, and facilities. Do not interfere with use of, and free and safe access to and from, structures and properties unless allowed by the Contract Documents otherwise allowed in writing by Contracting Officer.

2. Closing or obstructing of roads, drives, sidewalks, and passageways adjacent to the Work is not allowed unless indicated otherwise in the Contract Documents. Conduct the Work with minimum interference to vehicular and pedestrian traffic.
3. Provide temporary partitions between demolition work areas and (a) areas that will be occupied during demolition and removals, and (b) areas accessible to the public or visitors. Temporary partitions shall be sturdy, braced plywood in good condition, of dimensions sufficient to adequately screen demolition work from view of occupants, public, and visitors. Maintain temporary partitions in place until demolition and removals work in the subject area is complete or until other Work requires removal of temporary partitions.
4. Provide appropriate temporary barriers, lighting, sidewalk sheds, and other necessary protection.
5. Repair damage to facilities that are to remain which such damages results from Contractor's operations.

C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, perform the following:
1. Should unforeseen, unknown, or incorrectly shown or indicated Underground Facilities be encountered, Contractor responsibilities shall be in accordance with the General Conditions as may be modified by the Supplementary Conditions. Cooperate with utility owners in keeping adjacent services and facilities in operation.
2. Sanitary Sewerage: Before proceeding with demolition, locate and cap all sewer lines and service laterals discharging from the building or structure being demolished.
3. Storm Water Sewerage: Existing storm water system shall remain in place until demolition of existing building or structure is complete. Upon completing demolition, cut and cap storm sewerage at locations shown on the Drawings. Remove existing storm water piping and related structures between points of cutting, and backfill, restore to grade, and stabilize the area over the removed facilities in accordance with the Contract Documents.
4. Water Piping and Related Facilities: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished. Ensure compliance with Laws and Regulations regarding water quality.
5. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; compressed air; heating, ventilating, and air conditioning; electric; and communications; and service laterals serving the building or structure being demolished.
6. Shutdown of utility services shall be coordinated by Contractor, assisted by Contracting Officer as required relative to contacting utility owners.

D. Remediation:
1. If unanticipated Hazardous Environmental Condition is believed to be encountered during demolition and removals, comply with requirements of the General Conditions, as may be modified by the Supplementary Conditions.

3.2 DEMOLITION - GENERAL

A. Locate construction equipment used for demolition Work and remove demolished materials and equipment to avoid imposing excessive loading on supporting and adjacent walls, floors, framing, facilities, and Underground Facilities.

B. Pollution Controls:
1. Use water sprinkling, temporary enclosures, and other suitable methods to limit emissions of dust and dirt to lowest practical level. Comply with Section 01 50 00 - Temporary Facilities and Controls, and Laws and Regulations.
2. Do not use water when water may create hazardous or objectionable conditions such as icing, flooding, or pollution.
3. Clean adjacent structures, facilities, properties, and improvements of dust, dirt, and debris caused by demolition Work, in accordance with the General Conditions and Section 01 73 40 - Execution.

C. Explosives:
   1. Explosives are not allowed at the Site. Do not use explosives for demolition and removal Work.

D. Comply with Section 01 73 29 - Cutting and Patching and NFPA 241.

E. Building or Structure Demolition and Removals:
   1. Unless otherwise approved by Contracting Officer, proceed with demolition from top of building or structure to the ground. Complete demolition Work above each floor or tier before disturbing supporting members of lower levels.
   2. Demolish concrete and masonry in small sections.
   3. Remove structural framing members and lower to ground using hoists, cranes, or other suitable methods. Do not throw or drop to the ground.
   4. Break up and remove foundations, mats, and slabs-on-grade unless otherwise shown or indicated as remaining in place.
   5. Temporary Bracing and Supports:
      a. Provide temporary bracing and supports sufficient to maintain safety, stability, and resist all loads to which the structure may be subject during demolition and removals, until entirety is permanently removed or permanently stabilized.
      b. Temporary bracing and supports shall be sufficient for associated dead load, live load, transient loading, and dynamic loads such as wind, seismic, and other loads to which the temporary bracing or support may be subject.
      c. Where appropriate, retain a professional structural engineer, duly licensed and registered in the same jurisdiction as the Site, to design temporary bracing and supports.

F. Salvage and Ownership:
   1. Materials and equipment to remain Government's property shall be:
      a. Carefully removed and appropriately handled by Contractor to avoid damage and invalidation of warranties in effect. Brace motors attached to flexible mountings until reinstallation or delivery to Government's storage location. Fully remedy to pre-construction condition or replace items damaged during removal or handling by Contractor.
      b. Removed as functional units, together with all appurtenances required for operation.
      c. Cleaned, listed, and tagged for storage.
      d. Protected from damage.
      e. Delivered to designated storage location at the Site or other site indicated in the Contract Documents, at place designated by Contracting Officer or Government.
   2. Items to be and delivered to Government are as indicated in Table 02 41 00-A.

Table 02 41 00-A – Items to be Salvaged

Equipment Name/ Designation	Equipment Location	Deliver to Government Location
N/A	N/A	N/A

   3. Preparation of Government's existing equipment for storage:
      a. Where appropriate, identify each component with markings or tags to indicate its position in the assembly and the assembly of which it is part.
      b. Place small parts in appropriate, durable boxes and clearly mark contents on the outside of box or container.
      c. Remove oil from oil-lubricated bearings and gear boxes and replace with storage oil.
      d. Grease grease-lubricated bearings.
      e. Replace breather plugs with solid plugs.

f. Megger-test motor windings: Attach report of the test results to the associated motor and submit copy to Contracting Officer's Representative.
g. Attach unit to suitable crate bottom.
h. Enclose unit in polyethylene film and seal all seams and the film to the base of the unit with tape.
i. Construct crate of wood slats around top and sides of unit.
j. Attach permanent instruction tag to outside of crate stating "This unit has been prepared for storage. Replace oil, vent plugs, and lubricant in accordance with manufacturer's instructions before start-up."

G. Finishing of Surfaces Exposed by Removals: Unless otherwise shown or indicated in the Contract Documents, surfaces of walls, floors, ceilings, and other areas exposed by removals, and that will remain as finished surfaces, shall be repaired and re-finished with materials that match existing adjacent surface, or as otherwise approved by Contracting Officer's Representative.

3.3 STRUCTURAL REMOVALS

A. Remove structures to lines and grades shown or indicated, unless otherwise directed by Contracting Officer. Where limits are not shown or indicated, limits shall be four inches outside item to be installed. Removals beyond limits shown or indicated shall be at Contractor's risk and expense and such excess removals shall be reconstructed to satisfaction of Contracting Officer without additional cost to Government.

B. Recycling and Reuse of Demolition Materials:
1. All concrete, brick, tile, masonry, roofing materials, reinforcing steel, structural metals, miscellaneous metals, plaster, wire mesh, and other items contained in or upon building or structure to be demolished shall be removed, transported, and disposed of away from the Site, unless otherwise approved by Contracting Officer.
2. Do not use demolished materials as fill or backfill adjacent to structures, in pipeline trenches, or as subbase under structures or pavement.

C. After removing concrete and masonry walls or portions thereof, mats, slabs, and similar construction that ties in to the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.

D. Where parts of existing structures are to remain in service following demolition, remove the portions shown or indicated for removal, repair damage, and leave the building or structure in proper condition for the intended use.
1. Remove concrete and masonry to the lines shown or indicated by sawing, drilling, chipping, and other suitable methods. Leave the resulting surfaces true and even, with sharp, straight corners that will result in neat joints with new construction and be satisfactory for the purpose intended.
2. Do not damage reinforcing bars beyond the area of concrete and masonry removal. Do not saw-cut beyond the area to be removed.
3. Reinforcing bars that are exposed at surfaces of removed concrete and masonry that will not be covered with new concrete or masonry shall be removed to 1.5 inches below the final surface. Repair the resulting hole, with repair mortar for concrete and grout for masonry, to be flush with the surface.
4. Where existing reinforcing bars are shown or indicated to extend into new construction, remove existing concrete so that reinforcing bars are clean and undamaged.

E. Removal of Anchorages and Protruding Metals:
1. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, and where existing metals (and to be removed) protrude from concrete, remove the anchors and other metal to not less than 1.5 inches beneath surface of concrete or masonry member. Repair the resulting hole, using repair mortar for concrete and grout for masonry, to be flush with the surface.

2. Alternately, when the anchor is stainless steel, the anchor may be cut flush with the surface of the concrete or masonry, when so approved by Contracting Officer's Representative.

F. Jambs, sills and heads of windows, passageways, doors, or other openings (as applicable) cut-in to the Work or to existing construction shall be dressed with masonry, concrete, or metal to provide smooth, finished appearance.

G. Where anchoring materials, including bolts, nuts, hangers, welds, and reinforcing steel, are required to attach the Work to existing construction, provide such materials under this Specifications section, unless specified elsewhere in the Contract Documents.

3.4 MECHANICAL REMOVALS

A. Mechanical demolition and removal Work includes dismantling and removing existing:
   1. Piping systems and ductwork systems.
   2. Mechanical equipment and appurtenances.
   3. Mechanical elements of instrumentation and control systems, such as sensors and transmitters and similar items.
   4. Mechanical removals include cutting and capping as required, except that cutting of existing piping and ductwork to make connections is included under Section 01 73 29 - Cutting and Patching; Specifications sections in which requirements for coordination with Government operations are indicated; and applicable Specifications of Division 21 - Fire Suppression, Division 22 - Plumbing, Division 23 - Heating, Ventilating, and Air Conditioning, Division 40 - Process Interconnections, and others as applicable.
   5. Mechanical removals as required herein apply to systems exposed to view, hidden from view, and Underground Facilities. Mechanical removals may require work in spaces that may be classified confined spaces.

B. Life-Safety Systems:
   1. Retain existing life-safety systems, including but not limited to fire suppression systems, in place for as long as possible prior to performing associated demolition and removals.
   2. Where demolishing buildings or structures equipped with life-safety systems, remove or deactivate life-safety systems only in the area where active demolition operations are in progress.

C. Demolition and Removals of Piping, Ductwork, and Similar Items:
   1. Scope:
      a. Safety purge piping and tanks (as applicable) of chemicals, fuel, solids, liquids, and gases (as applicable) and make safe for removal and capping. Discharge contents of existing piping appropriately while avoiding damaging property; restricting access to or use of property; and cresting unsafe, unsanitary, nuisances, and noisome conditions.
      b. To the extent shown or indicated, remove existing piping conveying water (potable and non-potable), waste and vent, fuel (liquids and gases), heating fluids (such as water-glycol solutions), chemicals, solids and slurries, sludge, wastewater, other fluids, and processes gases, and other piping.
      c. Remove piping to the nearest structurally sound (or "solid") piping support, and provide caps on ends of remaining piping.
      d. Where piping to be demolished passes through existing walls to remain, cut off and cap pipe on each side of the wall.
   2. Caps, Closures, Blind Flanges, and Plugs – General (All Piping and Ducts):
      a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.
      b. Where used in this Specifications section, the term "cap" means the appropriate type closure for the piping or ductwork being closed, including caps, blind flanges, and other closures.
      c. Caps shall be compatible with the piping or ductwork on which the cap is installed, fluid-tight and gastight, and appropriate for the fluid or gas conveyed in the pipe or duct.

d. Unless otherwise shown or indicated, caps shall be mechanically fastened, fused, or welded to pipe or duct. Plug piping with means other than specified in this Specifications section only when expressly so shown or indicated in the Contractor Documents or when allowed by Contracting Officer's Representative.

3. Underground Facilities:
   a. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.
4. Waste and Vent Piping; Ductwork:
   a. Remove waste and vent piping, and ductwork to extent shown and cap as required.
   b. Where demolished vent piping, stacks, and ductwork passes through existing roofing, patch the roof with the same or similar materials as existing, and fully compatible with ensign materials. Completed patch shall be watertight and comply with roofing manufacturer's recommendations.
5. Potable Water Piping; Plumbing; Fire Suppression Piping and Systems; Heating Piping:
   a. Modifications to potable water piping, fire suppression systems, other plumbing piping, and heating system piping shall comply with Laws and Regulations.
   b. All portions of potable water systems that have been modified or opened shall be hydrostatically tested and disinfected in accordance with the Contract Documents, and Laws and Regulations. Hydrostatically test other, normally-pressurized, plumbing and fire suppression piping and heating piping systems.

D. Equipment Demolition and Removals:
1. To the extent shown or indicated and as required for the Work, remove existing mechanical equipment, including (but not limited to):
   a. Facility equipment, such as food service equipment, laundry equipment, dumbwaiters, and similar facility items.
   b. Conveying equipment such as elevators, escalators, and similar general-use conveying systems.
   c. Fire suppression and plumbing equipment.
   d. Heating, ventilating, and air conditioning equipment.
   e. Standby power generators.
   f. Security systems equipment.
   g. Transportation-related equipment.
   h. Flow control gates and valves.
   i. Hoisting equipment.
   j. Bulk materials conveying equipment.
   k. Process heating and cooling equipment.
   l. Blowers, compressors, air filters, air dryers, and similar equipment.
   m. Pumps.
   n. Tanks.
   o. Process equipment, including purification equipment, pollution control and solid waste equipment, and treatment process equipment.
   p. Turbines.
   q. Appurtenances (including motors, drive systems, controls, cooling water and seal water systems) as shown, indicated, and required for completion of the Work.
2. Where required, disassemble equipment to avoid imposing excessive loading on supporting walls, floors, framing, facilities, and Underground Facilities. Disassemble equipment as required for access through and egress from building or structure. Disassembly and removal shall comply with Laws and Regulations. Provide required means to remove equipment from building or structure.
3. Remove control panels, operator stations, and instruments associated with equipment being removed, unless shown or indicated otherwise.
4. Tanks and Equipment Containing Process Material:
   a. Purge contents in accordance with Paragraph 3.5.A of this Specifications Section and other requirements of the Contract Documents, as applicable.

b. When removing generators, remove associated fuel storage tanks unless otherwise indicated to remain.
c. Where contents of tank or equipment item may pose a potential hazard, such as hydrocarbon fuels or chemicals, properly dispose of contents in accordance with Laws and Regulations and the Contract Documents.
d. Where tank or equipment contains wastewater or liquid sludge, and the Site is a wastewater treatment facility, transport and dispose of stored contents onsite at location acceptable to Contracting Officerunless otherwise indicated in the Contract Documents. If Site is other than a wastewater treatment facility, dispose of contents appropriately in accordance with Laws and Regulations.
e. Where tank or equipment contains solid or slurry-type material, remove, handle, and transport the contents and appropriately dispose of the materials offsite in accordance with Laws and Regulations, unless otherwise indicated in the Contract Documents.

5. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the "Structural Removals" Article in this Specifications section.
6. Remove small-diameter piping back to header unless otherwise indicated.
7. Remove access platforms, ladders, and stairs related to equipment being removed, unless otherwise shown or indicated.
8. Instrumentation and Control Systems Removal:
   a. Remove instrumentation and controls equipment in accordance with this Specifications section's requirements for mechanical removals and electrical removals.
   b. Comply with this Specifications section's "Disposal of Demolition Debris" Article for restrictions on sales of removed items.

3.5 ELECTRICAL REMOVALS

A. Electrical demolition Work includes removing existing:
   1. Disconnecting cabling from motors, electrical sources, control panels, control stations, instrumentation and control items, and similar devices and equipment.
   2. Conduits, raceways, cable trays, hangers and supports, cabling, and related items.
   3. Switches, panelboards, control stations, and similar items.
   4. Transformers, distribution switchboards, control panels, motors, starters, variable speed controllers, and similar items.
   5. Lighting fixtures and related items.
   6. Utility poles, site lighting standards, and overhead cabling.
   7. Appurtenances and miscellaneous electrical equipment, as shown, specified, or required.

B. Electrical Removals – General:
   1. Comply with Laws and Regulations, including the National Electric Code.
   2. Lock Out and Tagging:
      a. Contractor shall lock out and tag circuit breakers and switches operated by Government and shall verify that affected cabling are de-energized to ground potential before commencing electrical removals Work.
      b. Upon completion of electrical removals Work, remove the locks and tags and promptly advise Contracting Officer that existing facilities are available for use.
   3. Remove existing electrical equipment, fixtures, and systems to avoid damaging systems to remain, to keep existing systems in operation, and to maintain integrity of grounding systems.
   4. Disconnect and remove motors, control panels, and other electrical gear where shown or indicated.
   5. Store removed motors, microprocessors and electronics, and other electrical gear to be reused in accordance with its manufacturer's recommendations and requirements of the Contract Documents.

C. Motor Control Centers and Switchgear:
   1. Remove or modify motor control centers and switchgear as shown or indicated.

2. Modified openings shall be cut square and dressed smooth to dimensions required for installation of equipment.

D. Removal of Cabling, Conduits, Raceways and Similar Items:
   1. Verify the function of each cable before disconnecting and removing.
   2. Remove cabling, conduits, hangers and supports, and similar items back to the power source or control panel, unless otherwise shown or indicated.
   3. Remove cabling, conduits, and similar items where shown or indicated for removal. Abandoned conduits concealed in floor, ceiling slabs, or in walls shall be cut flush with the slab or wall (as applicable) at point of entrance, suitably capped, and the area repaired in a flush, smooth manner acceptable to Contracting Officer's Representative.
   4. Disassemble and remove exposed conduits, junction boxes, other electrical appurtenances, and their supports.
   5. Repair all areas of the Work to prevent rusting on exposed surfaces.
   6. Underground Electric:
      a. Conduits in Underground Facilities not scheduled for reuse shall be suitably capped watertight where each enters building or structure to remain.
      b. Where shown or indicated, remove direct-burial cabling. Openings in buildings for entrance of direct-burial cabling shall be patched with repair mortar or other material approved by Contracting Officer's Representative for such purpose, and made watertight.

E. Electrical Service Entrances and Outdoor, Overhead Electrical Utilities:
   1. Existing poles and overhead cabling shall be removed or abandoned as shown and specified.
   2. Completely remove from the Site poles not owned by electric utility, including site lighting standards and appurtenances, shown or indicated for removal.
   3. Existing substation(s) and poles owned by electric utility will be removed by the electric utility.
   4. Make necessary arrangements with electric utility owner for removal of utility owner's transformers and metering equipment after new electrical system has been installed and energized.

F. Lighting fixtures, wall switches, receptacles, starters, and other miscellaneous electrical equipment, not designated as remaining as Government property, shall be removed and properly disposed off-Site as required in accordance with Laws and Regulations.

3.6 DEMOLITION OF SITE IMPROVEMENTS

A. Pavement, Sidewalks, Curbs, and Gutters:
   1. Demolition of asphalt or concrete pavement, sidewalks, curbs, and gutters, as applicable, shall terminate at cut edges. Edges shall be linear and have a vertical cut face.
   2. To cut pavement, sidewalks, curbs, and gutters, use machinery or tools that provides a smooth-cut edge, appropriate for the required. Where cut edges are not smooth, repair the cut edge to remain to provide a smooth, even appearance.

B. Fencing, Guardrails, and Bollards:
   1. Remove to the limits shown or indicated on the Drawings.
   2. Completely remove below-grade posts and concrete.

C. Manholes, Vaults, Chambers, and Handholes:
   1. Remove to the limits shown or indicated on the Drawings.
   2. If not shown or indicated on the Drawings, remove to not less than three feet below finished grade indicated on the Drawings.

D. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes:
   1. Remove to the extent shown or indicated on the Drawings.
   2. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Specifications section.

E. Landscaping: Comply with Section 31 10 00 - Site Clearing.

F. Other Site Improvements: When the Contract Documents require removal of other site improvements not addressed above, copy with Contract requirements for removal of buildings or structures.

3.7 DISPOSAL OF DEMOLITION DEBRIS

A. Disposal – General:
   1. Promptly remove from the Site all debris, waste, rubbish, material, and equipment resulting from demolition and removal operations. Promptly upon completion of demolition and removal operations, remove from the Site construction equipment used in demolition Work.
   2. Do not sell at the Site demolition materials or removed equipment. If materials, equipment or debris will be sold by Contractor, remove the items from the Site and perform the sale or transaction elsewhere, in accordance with Laws and Regulations.
   3. Cleaning and Removal of Debris: Comply with the General Conditions, Supplementary Conditions, and Section 01 74 19 - Construction Waste Management and Disposal.

B. Transportation and Disposal:
   1. Non-Hazardous Materials, Equipment, and Debris: Properly transport and dispose of non-hazardous demolition materials, equipment, and debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Constituents of Concern such as (but not limited to) asbestos, PCBs, petroleum, hazardous waste, radioactive material, or other material designated as hazardous in Laws or Regulations.
   2. Hazardous Materials, Equipment, and Debris: When handling and disposal of items containing Constituents of Concern is included in the Work, properly transport and dispose of such items in accordance with the Contract Documents and Laws and Regulations.

C. Submit to Contracting Officer's Representative information required in this Specification Section on proposed facility(ies) where demolition materials, equipment, and debris will be recycled. Upon request, Contracting Officershall be allowed to visit recycling facility(ies) to verify adequacy and compliance status. During such visits, recycling facility operator shall cooperate and assist Contracting Officerand Government.

END OF SECTION

SECTION 03 01 30
REPAIR AND REHABILITATION OF EXISTING CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Preparation and assessment of existing concrete for repair and rehabilitation:
      a. Concrete removal for repairs.
      b. Preparation of exposed reinforcing steel.
      c. Preparation for joint sealant installation.
   2. Repair of damaged (and deteriorated) concrete.
      a. Application of repair mortar.
      b. Repair of exposed items embedded in concrete.
   3. Expansion joint repair.

B. Scope:
   1. Contractor shall provide all materials, equipment, labor, tools, services, and incidentals necessary to repair and rehabilitate existing concrete, whether damaged or deteriorated, at locations shown on the Drawings or at locations indicated by Contracting Officer Representative, in accordance with the Contract Documents.
   2. Re-sealing concrete joints as shown on the Drawings, and at other locations directed by Contracting Officer Representative, and indicated in this Section.
      a. Included in the unit price(s) for joint sealant Work are repairs of existing concrete adjacent to the associated joint sealant Work, in accordance with this Section.
   3. Surface repairs of new concrete Work are addressed in Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

C. Related Requirements: Include but are not necessarily limited to:
   1. Section 03 15 19 - Anchorage to Concrete.
   2. Section 03 21 00 - Reinforcement.
   3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   4. Section 07 92 00 - Joint Sealants.

1.2 PRICE AND PAYMENT PROCEDURES

A. Unit Prices:
   1. The Work of this Section is Unit Price Work unless otherwise shown or indicated. Work covered by this Section but not eligible for payment under Unit Price Work bid/pay items shall be performed at Contractor's expense.
   2. Bid/pay item classifications of Unit Price Work addressed in this Section are indicated in the Bid Form, the Agreement (or an exhibit thereto), and Section 01 27 00 – Definition of Contract Line Items.
   3. Unit Price Work of this Section is classified as follows:
      a. Concrete Surface Repair - Type I (Thin): Repair of spalled, delaminated, or deteriorated concrete up to 1.5 inches deep below concrete's original surface.
      b. Concrete Surface Repair - Type II (Moderate): Repair of spalled, delaminated, or deteriorated concrete greater than 1.5 inches deep to 3 inches below original concrete surface.
      c. Concrete Surface Repair - Type III (Severe): Repair of spalled, delaminated, or deteriorated concrete greater than 3 inches below original concrete surface.
      d. Expansion Joint Repair - Type A: Replacement of existing expansion joint material including removing existing backer rod, joint filler, and sealant and providing new materials and repair, in accordance with this Section. Expansion joint repair not

designated in the Contract Documents as other types is Type A unless directed otherwise by Contracting Officer Representative.

e. Expansion Joint Repair - Type B: Provide where shown or indicated on the Drawings or where directed by Contracting Officer Representative. Includes sealing existing expansion joints by providing new epoxy resin adhesive sealant system over existing expansion joints.

f. Expansion Joint Repair - Type C: Provide where shown or indicated on the Drawings or where directed by Contracting Officer Representative. Includes sealing existing expansion joints by providing new polyurethane joint sealing system over existing expansion joints.

B. Measurement:

1. Criteria for measurement for payment of this Section's Unit Price Work are in the General Conditions (as may be modified by the Supplementary Conditions), 01 27 00 – Definition of Contract Line Items, and this Section.
2. Quantities of this Section's Unit Price Work:
   a. Unit Price Work of this Section shall be measured for payment prior to commencement of the associated Work in each work area.
   b. Work not measured in advance for payment will not be eligible for payment by Contracting Officer.
   c. Contracting Officer Representative will observe the associated concrete repair and rehabilitation Work performed. Such Work shall be in accordance with the Contract Documents for to such Work to be eligible for payment by Contracting Officer, even when such Work was measured (for payment) in advance.
3. Repair of new concrete Work provided by Contractor is not eligible for payment under the Unit Price Work bid/pay items covered by this Section. Such repairs are included in the Work of the associated bid/pay item under which the subject new concrete Work was provided.

1.3 REFERENCES

A. Terminology:

1. This provision indicates terminology used in this Section and in other Contract Documents that coordinate with this Section. Such terminology may or may not be indicated using initial capital letters and, when used in relation to the Work of this Section, have the meanings indicated below.
2. "Existing concrete damage" means damage to existing concrete surfaces deeper than 1/8 inches, such as:
   a. Concrete corrosion.
   b. Corroded items embedded within concrete or through the concrete surface.
   c. Spalls.
   d. Cracking at depth and arrangement that, in Contracting Officer Representative's sole opinion, cannot be repaired in accordance with Section 03 35 00 – Concrete Finishing and Repair of Surface Defects.
3. "Installer" means the entity installing or applying repair materials at the Site. The terms "installer" and "applicator" have the same meaning. Installer or applicator may be Contractor or Subcontractor.
4. "MPII" means, "manufacturer's printed installation instructions".
5. "Rehabilitation" means repairing and restoring concrete to structurally-sound, durable condition suitable for the structure's intended purpose as determined by Contracting Officer Representative, including repair of existing concrete damage in accordance with this Section and other applicable provisions of the Contract Documents.
6. "Water-bearing structure" means concrete structure with a surface that is normally, or may be, in contact with water or process fluids or slurries during typical operation of the completed Project, including, but not limited to: tanks, channels, wet wells, distribution chambers, dams, and the like. Also, where specifically indicated on the Drawings, "water-

bearing structures" includes basements and structures extending below the ordinary, wet-season groundwater surface.

7. Other terminology used in this Section is consistent with terminology of ACI CT.

B. Reference Standards:

1. American Concrete Institute (ACI):
   a. CT, Concrete Terminology.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 308, Standard Practice for Curing Concrete.
2. ASTM International (ASTM):
   a. C150, Standard Specification for Portland Cement.
   b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   c. C881, Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete.
   d. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
   e. D1682, Breaking Load and Elongation of Textile Fabric.
   f. D1876, Standard Test Method for Peel Resistance of Adhesives (T-Peel Test).
   g. D4060, Abrasion Resistance of Organic Coatings by the Taber Abraser.
   h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
   i. D4259, Standard Practice for Abrading Concrete.
   j. D4263, Indicating Moisture in Concrete by the Plastic Sheet Method.
   k. D7234, Standard Test Method for Pull-off Adhesion Strength of Coatings on Concrete Using Portable Pull-off Adhesion Tests.
3. International Concrete Repair Institute (ICRI).
   a. 310.1R, Guide for Surface Preparation.
   b. 310.1R, Guide for Surface Preparation for the Repair of Deteriorated Concrete Resulting from Steel Corrosion.
4. Society for Protective Coatings/NACE International (SSPC/NACE):
   a. SP 13/NACE No. 6, Surface Preparation of Concrete.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Installer:
   a. Installer of materials for rehabilitation of existing concrete shall possess not less than five years of relevant experience performing concrete rehabilitation of similar type, scope, and complexity to that required for this Project.
   b. Certification or Approval by Materials Manufacturer:
      1) Installer (as either business entity or individual) of materials associated with rehabilitation of existing concrete shall be certified or expressly approved in writing, by manufacturer of materials to be provided.
      2) As an option, installer may be certified or approved, in writing, at the Site during initial Work of this Section, in accordance with this Section's Paragraph 3.4.D.
   c. Submit documentation of qualifications and experience in sufficient detail to demonstrate to Contracting Officer Representative's satisfaction compliance with requirements of this Section's qualifications requirements.
2. Structural Concrete Repairer:
   a. This provision is in addition to qualifications requirements applicable to installers of the Work under this Section. This provision applies to business entities physically performing rehabilitation of structural concrete.
   b. Structural concrete repairer shall have not less than five years' current, relevant experience in repairing and rehabilitating concrete structures in facilities of generally similar environmental exposures as the Work of this Section for this Project
   c. Submit documentation of qualifications and experience in sufficient detail to demonstrate to Contracting Officer Representative's satisfaction compliance with requirements of this Section's qualifications requirements.

3. Joint Sealant System Installer:
    a. This provision is in addition to qualifications requirements applicable to all installers of the Work of this Section. This provision applies to entities performing concrete joint sealant system repair or rehabilitation Work.
    b. Entity performing joint sealant system Work shall possess not less than 10 years' relevant experience in waterproofing concrete joints, crack and leak repair, and concrete coating application on projects of similar size, complexity, and environment as the concrete joint sealing Work on this Project.
    c. Entity performing concrete joint sealant system Work shall have completed not less than five projects of size, type, and complexity similar to the Work under this Section within the most-recent period indicated in the paragraph immediately above, on structures that have been in service for not less than three years each. Projects shall have utilized the required type of joint sealant system materials indicated for the Work.
    d. Entity performing concrete joint sealant system Work shall be certified or approved, in writing, by joint sealant system manufacturer (whose product is used in the Work) to furnish and install the required concrete joint sealant system materials.
    e. Submit documentation of qualifications and experience in sufficient detail to demonstrate to Contracting Officer Representative's satisfaction compliance with requirements of this Section's qualifications requirements

B. Mock-Ups:
1. Mock-ups are Samples that, when approved by Contracting Officer Representative, indicate minimum standard of quality for the associated Work. Standard of quality of mock-ups shall be not less than that required by the Contract Documents.
2. If so approved by Contracting Officer Representative, mock-ups may become part of completed Work.
3. Maintain, segregate, identify, and protect mock-ups during performance of the Work to allow Contracting Officer Representative to readily compare the Work with approved mock-up.
4. When mock-up is not part of the completed Work, remove mock-ups when directed by Contracting Officer Representative. If mock-up is part of the completed Work, remove protection and indication of mock-up when so directed by Contracting Officer Representative.
5. Provide mock-up for each type of concrete rehabilitation required by this Section for which the Contract has an associated bid/pay item, including finish.
6. Size of each mock-up shall be acceptable to Contracting Officer. Concrete surface repair mock-ups shall be not less than 2 feet by 2 feet each. Expansion joint repair mock-ups shall be not less than 3 feet long, each.
7. Where mock-ups will be part of the completed Work, Contractor and Contracting Officer will jointly select the location of each mock-up.
8. Concrete surface repair mock-ups shall include:
    a. Sample of patched tie or bughole.
    b. Sample of all jointing specified.
    c. Sample of mortar repair.
9. Expansion joint repair mock-ups shall include:
    a. Repaired expansion joint.
    b. Expansion joint seal.
    c. Rehabilitation of adjacent concrete surfaces.
10. Also provide concrete surface repair mock-up of wall having polymer-modified cementitious coating.
    a. Mock-up shall be stepped to show surface preparation, repairs and coating in all stages of application.
11. Mock-up areas shall be readily identifiable during construction. Provide appropriate temporary signage indicating status as mock-up and protect the mock-up.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule (table) indicating, for each type of concrete rehabilitation Work required by this Section, the material type and product manufacturer proposed for each application.
   2. Product Data:
      b. Manufacturer's published, technical data for each manufactured material proposed for use in the Work of this Section.
      c. Manufacturer's written certification that proposed materials comply with associated reference standards cited in this Section.
   3. Samples:
      a. Advise Contracting Officer in writing when required mock-ups will be provided and the location proposed for each.
   4. Test Procedures:
      e. Procedure for pre-repair condition survey required in this Section's Article 3.1, including method for recording results of survey.
      f. Written method of performing pull-off testing of repair material and testing equipment information and accessory materials proposed for use in testing.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Laboratory test reports (for previously-tested materials identical to those to be furnished) and material manufacturer's certificates verifying that ingredients comply with the Contract Documents and have a minimum of six months' residual shelf life at the time of shipment to the Site.
      b. Certification from Supplier stating that material is suitable for the intended use on this Project.
      c. Certification that materials proposed for use are compatible with each other, when such materials will contact each other, and will not interfere with bonding of future floor or wall finishes.
   2. Test and Evaluation Reports:
      a. Results of pre-rehabilitation condition survey required in this Section's Article 3.1.
   3. Manufacturer's Instructions:
      a. Manufacturer's instructions for all concrete rehabilitation materials, for handling, storing, and installing materials.
   4. Field Quality Control Submittals:
      a. In-situ pull-off test results for joint sealant system.
   5. Qualifications Statements:
      a. Installer: Documentation of qualifications in accordance with this Section's "Quality Assurance" Article.
      b. Manufacturer's written approval of installer or certification of training performed at the Site in accordance with Paragraph 3.4.D of this Section.
         1) Affidavit, signed by either materials manufacturer or by installer's business entity, indicating that manufacturer of rehabilitation materials has instructed installer in proper handling and installation of each rehabilitation material to be used in the Work.
      c. Entity performing structural concrete repair Work.
      d. Entity performing joint sealant system Work.

C. Closeout Submittals: Submit the following:
   1. Affidavit of compliance from joint sealant system manufacturer, certifying that sealants were installed at the Site in accordance with manufacturer's written instructions and recommendations.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Comply with material manufacturer's written instructions and recommendations regarding delivery, handling, and storage or materials to be incorporated into the Work.

B. Storage:
   1. Store materials in tightly-sealed, original containers, off the ground and in dry location with humidity controls.
   2. Do not store in direct sunlight.
   3. Protect materials from temperature extremes and avoid freezing temperatures.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Anti-Corrosion Bonding Agent:
      a. Euclid Chemical Company.
      b. Or equal..
   2. Epoxy Bonding Adhesive:
      a. Euclid Chemical Company.
      b. Or equal.
   3. Repair Mortar:
      a. Euclid Chemical Company.
      b. Or equal.
   4. Submit request for substitution in accordance with Specification Section 01 33 23.

2.2 MATERIALS

A. Materials that will be in direct contact with potable water or water that will be treated to become potable shall be certified in accordance with ANSI/NSF 61 and suitable for prolonged immersive exposure to chlorinated water with a total residual of up to 5 mg/l.

B. Bonding Agents:
   1. Bonding agents and adhesives shall have pot life that allows proper placement of new material against existing material in accordance with manufacturer's written instructions.
   2. For repair of existing concrete damage, when no reinforcing steel is exposed, and where specifically shown or indicated on the Drawings, use epoxy bonding adhesive.
   3. For repair of existing concrete damage, when reinforcing steel is exposed, and where specifically shown or indicated on the Drawings, use anti-corrosion bonding agent.
   4. For repair of new concrete: Comply with Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

C. Water:
   1. Potable.
   2. Clean and free from deleterious substances.
   3. Free of oils, acids and organic matter.

D. Reinforcing Steel: In accordance with 03 21 00 - Reinforcement.

E. Epoxy Patch Seal:

1. For use as seal on patches at repair of existing concrete damage and as otherwise shown or specified in the Contract Documents.
   a. Sikadur 32 Hi-Mod LPL by Sika Corporation.
   b. Or equal.
2. Submit request for substitution in accordance with Specification Section 01 33 23.

F. Anti-Corrosion Bonding Agent:
1. Three-component, moisture tolerant, cementitious bonding agent manufactured for purpose of bonding fresh concrete to hardened concrete and providing anti-corrosion coating to embedded reinforcing materials.
   a. Duralprep A.C. by Euclid Chemical Company.
   b. Or equal.
2. Submit request for substitution in accordance with Specification Section 01 33 23.

G. Epoxy Bonding Adhesive:
1. For use where bonding new concrete or patch material to existing concrete.
2. Two-component, moisture insensitive adhesive manufactured for purpose of bonding fresh concrete to hardened concrete.
   a. Euco No. 452 MV by Euclid Chemical Company.
   b. Or equal.
3. Submit request for substitution in accordance with Specification Section 01 33 23.

H. Repair Mortar:
1. Pre-packaged cement-based, modified (polymer or latex) product specifically formulated for repair of concrete surface defects, with the following properties:

Physical Property	Value	ASTM Standard
Compressive strength (minimum)		C109
at one day	2000 psi	
at 28 days	6000 psi	
Bond strength (minimum)		C882 (*)
at 28 days	1800 psi	

(*) Modified for use with repair mortars.

2. Trowelable, selection based on horizontal, vertical, or overhead application.
3. Where the least dimension of the placement, in width or thickness, exceeds 1.5 inches, repair mortar shall be extended by addition of aggregate per MPII.
4. Acceptable Products:
   a. SikaRepair SHA, SikaTop 123 Plus, SikaTop 111 Plus by Sika Corporation.
   b. Or equal.
5. Submit request for substitution in accordance with Specification Section 01 33 23.

I. Epoxy Coating:
1. Use as a coating over concrete repairs and at repaired embedded items in concrete where shown or indicated on the Drawings.
2. Pigmented, two-component, 100% solids, moisture-tolerant epoxy resin specifically formulated to serve as a protective, corrosion-resistant coating to all common structural substrates.
3. Acceptable Products:
   a. Sikagard 62 by Sika Corporation.
   b. Or equal.

4. Submit request for substitution in accordance with Specification Section 01 33 23.

J. Epoxy Resin Adhesive Sealing System:
   1. Provide sealing system consisting of the following components:
      a. Epoxy Resin Adhesive:
         1) Two-component, 100% solids, high-strength, non-sag structural epoxy paste adhesive.
         2) Color: Gray.
         3) Minimum Pot Life: 30 minutes.
         4) Acceptable Products:
            a) Sikadur 31 Hi-Mod Gel .
            b) Or equal.
      b. Hypalon Sheeting:
         1) Composed of Hypalon rubber with perforations along bonding edges of sheeting to provide mechanical key.
            a) Shall have the ability to be vulcanized with aromatic hydrocarbon solvent to allow its adhesion to an epoxy resin adhesive.
            b) Sheet Dimensions: 8 inches wide and 40 mils thick.
            c) Provided with a removable center expansion strip.
      c. Activating Solvent:
         1) Aromatic hydrocarbon with a specific gravity of 0.86.
         2) All sealing system components shall be fully compatible with each other.
         3) Acceptable Products:
            a) Sikadur Combiflex System by Sika Corporation.
            b) Or equal.
   2. Submit request for substitution in accordance with Specification Section 01 33 23.
      a.

K. Polyurethane Joint Sealing System:
   1. Provide high-solids, two-component liquid, cold-applied, asphalt extended urethane elastomer that cures to durable abrasion-resistant film, forming flexible, water-impermeable barrier.
   2. Provide all components from a single manufacturer to ensure compatibility of components with each other, except for hydrophobic polyurethane grout material.
   3. Concrete Surface Primer: Acceptable products:
      a. CIM 61BG Epoxy Primer, by CIM Industries.
      b. Or equal.
   4. Tack Coat and Top Coat: Acceptable products:
      a. CIM 1061, by CIM Industries.
      b. Or equal.
   5. Joint/Crack Filler: Acceptable products:
      a. CIM 1000TG, by CIM Industries.
      b. Or equal.
   6. Cant Strip Material: Acceptable products:
      a. CIM 1000 TG Cartridges, by CIM Industries
      b. Or equal..
   7. Reinforcing Fabric (Scrim): Acceptable Products:
      a. CIM Scrim, by CIM Industries.
      b. Or equal.
   8. Bonding Agent (for re-application of CIM 1061 if recoat window exceeded):
      a. Acceptable products:
         1) CIM Bonding Agent, by CIM Industries.
         2) Or equal.
      b. Material:
         1) Organo-silane compound dispersed in isopropyl alcohol.
   9. Hydrophobic Polyurethane Grout: Acceptable products:

a. De Neef Hydro Active Flex LV, by GCP Applied Technologies.
b. Or equal.

10. Submit request for substitution in accordance with Specification Section 01 33 23.

L. Expansion Joint Sealant and Backer Rod:
1. Provide in accordance with Section 07 92 00 - Joint Sealants.

PART 3 - EXECUTION

3.1 PREPARATION AND ASSESSMENT

A. As indicated in Article 1.1 of this Section, repair of surface defects in new concrete provided under the Contract and repair of cracks in concrete are addressed in other Specification Sections.

B. Condition Survey:
1. Contractor and Contracting Officer Representative shall jointly perform condition survey of each existing concrete structure included in the scope of the concrete repair Work before scheduling and performing the associated repair Work.
2. Contracting and payment for specialty inspections and tests by third-parties will be by Contracting Officer.
3. Prior to Condition Survey:
a. Submit to Contracting Officer, and obtain Contracting Officer's acceptance, of procedure for performing condition survey. Indicate proposed date(s) of the condition survey and other procedures for inspecting and documenting extent of concrete repair Work to be performed.
b. Prior to the condition survey, power-wash all concrete surfaces within the scope of the concrete repair Work. Power-wash at not less than 4,000 psi using orbital nozzle.
4. Condition survey shall include, but is not necessarily limited to:
a. Visual inspection for:
1) Deficiencies in joints.
2) Cracks.
3) Leakage and efflorescence.
4) Scaling.
5) Spalling
6) Exposed reinforcing.
7) Previous repairs.
b. Extent of chemical attack using phenolphthalein.
c. Delamination survey.
d. Half-cell measurements for corrosion potential of reinforcing.
5. Results of Condition Survey:
a. Submit written results of condition survey to Contracting Officer Representative promptly following the condition survey at the Site.
b. Condition survey results shall clearly indicate the location, nature, size, length, width, and depth of all deficiencies in existing concrete in the area(s) surveyed.
c. Contracting Officer will use results of condition survey to determine extent of repair Work required.
6. Contracting Officer's Direction to Contractor:
a. After consulting with Contracting Officer Representative as necessary, Contracting Officer will transmit to Contractor written direction on extent of concrete repairs required.
b. Contracting Officer will issue such direction promptly after Contracting Officer Representative's receipt of acceptable results of condition survey. Allow in the Progress Schedule 14 days for issuance of Contracting Officer's written direction.
c. Where such Work would either exceed Contract quantities of associated Unit Price Work or requires Work not in the Contract's bid/pay items, an appropriate Contract modification will be issued.

C. Concrete Removal:
   1. Remove all loose and unsound concrete from areas to be repaired, in accordance with ICRI Guideline 310.1R, as modified by the Contract Documents.
   2. Removals:
      a. At areas of damage or deterioration of existing concrete, saw-cut the perimeter of unsound concrete surface areas, to depth of not less than 1/2 inches.
      b. Saw-cuts to be perpendicular to or slightly undercutting existing concrete surface. Concrete removal boundaries shall be straight and aligned parallel to opposite boundary edges resulting in repair areas that are approximately rectangular.
      c. Remove all existing concrete from within the saw-cut repair boundary to of not less than 1/2 inches.
      d. Featheredges are unacceptable.
   3. Clean surfaces of repair areas in accordance with ASTM D4258 to remove dust, dirt, grease, and other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
   4. Abrasive-blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
   5. Chip concrete substrate to obtain a surface profile of 1/16 inches to 1/8 inches deep with new fractured aggregate surface. The area to be repaired shall not be less than 1/2 inches in depth.
   6. Concrete removal shall extend along any exposed existing reinforcing to locations along the bar that are free of bond inhibiting corrosion and where the bar is well-bonded to surrounding concrete.
   7. Rinse surface with clean water and allow surface water to evaporate prior to repairing the surface.

D. Preparing Exposed Steel Reinforcing:
   1. Clean and prepare exposed embedded steel reinforcing in accordance with ICRI Guideline 310.1R and the Contract Documents.
   2. Where one-half or more of the steel reinforcing diameter is exposed, either by existing conditions or concrete removal, bond between concrete and steel reinforcing is inhibited or lost completely, or corrosion is present, remove concrete to provide not less than 1 inch clearance around the entire perimeter and along the entire exposed length of the steel reinforcing.
   3. If existing, exposed steel reinforcing is cut through, cracked, or cross-sectional area is reduced by more than 20%, provide new steel reinforcing bar the same size as existing steel reinforcing. Lap the new bar with existing in accordance with ACI requirements. Coat all new and existing steel reinforcing with anti-corrosion bonding agent, as specified in this Section. Abrasive-blast exposed reinforcing to remove contaminants and corrosion to provide white-metal, bright steel finish.

E. Preparation for Joint Sealant System Installation:
   1. Provide adequate surface preparation in area of each joint sealant repair, to not less than 6 IN from face of joint, on each side of joint.
   2. Surface preparation shall remove existing concrete laitance, loose material, oil, grease, and shall expose tops of underlying aggregate to an ICRI concrete surface profile of 4-6. The following methods may be used:
      a. Abrasive-blasting in accordance with ASTM D4259.
      b. High-pressure water blasting at not less than 5,000 psi, in accordance with ASTM D4259.
      c. Shot-blasting in accordance with ASTM D4259, at horizontal surfaces only.
   3. Concrete joint areas to receive joint sealant system shall be fully dried prior to application of joint sealant system. Test substrate moisture at not less than three locations per structure to confirm moisture. The following methods may be used to determine moisture:
      a. Plastic Sheet Method (ASTM D4263): Pass/fail.
      b. Relative Humidity Test (ASTM F2170): Less than 85%.
      c. Calcium Chloride Test: Less than 5 pounds per 1000 square feet per 24 hours.
      d. Radio Frequency Test: Less than 5% moisture.

4. Perform adhesion tests at not less than three locations per structure in mock-up (non-joint) areas to verify adequacy of the joint surface preparation. Perform modified T-Peel (ASTM D1876) field test:
    a. Apply duct tape on substrate.
    b. Apply the coating top coat material to the substrate, fully lapping onto the duct tape.
    c. After coating material has fully cured, cut 1 inch wide strips through coating material, perpendicular to duct tape strip: a minimum of three pull tests per testing location.
    d. Peel up the outside edge of duct tape and provide tarp clip.
    e. Hook a fish weighing or similar scale through the tarp clip and pull perpendicular to the substrate to point of coating adhesion failure and record the load at failure. Scale used for this field measurement shall be calibrated immediately prior to testing.
    f. Minimum acceptable coating adhesion force at failure shall be 15 pounds; no test performed shall demonstrate adhesion below this threshold for surface preparation to be acceptable.
5. Inspect concrete surfaces in area of surface preparation and repair as follows:
    a. Blast/expose all bug-holes to eliminate blind side surfaces.
    b. Cracks less than 1/16 inches wide that extend through the joint coating areas do not require special treatment.
    c. Cracks 1/16 inches to 1/8 inches wide that extend through the joint coating areas shall be stripe-coated for not less than 2 inches on each side and filled with CIM (trowel grade) prior to application of the joint sealant system (after moisture content and surface preparation are acceptable in accordance with the Contract Documents)
    d. Cracks greater than 1/8 inches wide and cracks that experience movement (that extend through the joint coating areas) shall be reinforced with scrim material, similar to the joint coating, prior to sealing the joints.
    e. Cracks greater than 1/4 inches -wide: Provide backer rod, in addition to complying with the paragraph immediately above.
    f. In areas of joint coatings, patch surface spalls and other concrete defects in accordance with requirements for concrete repairs indicated in this Section.
6. Inspect existing joint filler material. If defects in existing joint filler material extend greater than 1/2 inches deep, or if determined by sealant installer to be unsatisfactory, remove not less than 1 inch of existing filler material and pack joint with appropriately sized backer rod soaked in polyurethane grout. Trim grout foam/backer rod flush with surface of concrete once cured. Joints to be coated shall be filled according to this provision and trimmed flush prior to application of coating system.
7. Provide and tool 1 inch minimum cant strips at wall-slab and slab-column joints to be coated. Allow cant strips to cure prior to applying coating system.
8. Perform surface preparation, substrate moisture field tests, adhesion test results, treatment of defects in joint coating areas, and filling (as required) of existing joints for approved by coating manufacturer's technical representative prior to installing joint coating system.

3.2 INSTALLATION AND APPLICATION

A. Environmental Conditions for Installation:
    1. Comply with material manufacturer's written instructions for substrate temperature and moisture content, ambient temperature, and ambient humidity, ventilation, and other conditions affecting performance of concrete repair materials.
    2. Do not repair existing concrete damage when ambient temperature is or is expected to be below 50 degrees F. If necessary to maintain the progress Schedule, enclose and heat area to between 50 and 70 degrees F during repair of surface defects and curing of patching material. Use only indirect fired heating using clean-burning fuel.
    3. If proper environmental conditions do not comply with the Contract Documents and manufacturer's instructions, do not perform the Work until such conditions are acceptable. Provide means to bring conditions into compliance by providing temporary environmental controls, enclosures, and other temporary construction and temporary facilities.
    4. Contractor is not eligible for changes in Contract Times or Contract Price for delays or costs incurred to bring environmental conditions for installation into compliance.

B. Existing Concrete Damage Repair:
   1. Type I Repair:
      a. Provide epoxy bonding adhesive and repair mortar.
   2. Type II Repair:
      a. Provide epoxy bonding adhesive, if no reinforcing steel is exposed. Use anti-corrosion bonding agent, if reinforcing steel is exposed.
      b. Prepare exposed reinforcing steel in accordance with Paragraph 3.1.D of this Section.
      c. Provide repair mortar:
         1) Provide 3/8 inches aggregate in accordance with MPII.
   3. Type III Repair:
      a. Provide anti-corrosion bonding agent.
      b. Prepare exposed steel reinforcement per the requirements of Paragraph 3.1.B.
      c. Provide new adhesive anchor dowels as shown on the Drawings and as indicated in Section 03 15 19 - Anchorage to Concrete.
      d. Provide repair mortar:
         1) Provide 3/8 inches aggregate in accordance with MPII.

C. Repair Mortar Application:
   1. Comply with MPII for mixing and placement of repair mortar.
   2. After initial mixing of repair mortar, do not introduce additional water to change consistency. Discard repair mortar if consistency becomes too stiff to place.
   3. Place repair mortar to not less than recommended minimum thickness indicated in the MPII and in no event less than 3/8 inches.
      a. Apply repair mortar in accordance with the following minimum requirements:
         1) Not less than 3/8 inches over existing sound, exposed coarse aggregate.
         2) Not less than 2 inches of cover (unless otherwise required) over exposed reinforcing steel.
   4. At horizontal applications, repair mortar shall be screeded and bullfloated to the proper elevation, to ensure all surface moisture will drain freely and properly without puddle areas.
   5. Provide repair mortar in even, uniform plane to restore the concrete member to its original surface finish and plane.
      a. Tolerance for being out-of-plane shall be such that gap between a 1 foot straight edge and repair mortar surface shall not exceed 1/4 inches, and gap between a 4 feet straight edge and repair mortar surface shall not exceed 3/8 inches. This shall apply to straight edges placed in any orientation at any and all location on the repair mortar surface.
   6. Prevention of Drying:
      a. Prevent exposed plastic mortar surfaces from drying. Provide windbreaks, foggers, and evaporation retarders, as necessary, during finishing.
      b. Foggers shall maintain humidity at height of 2 feet to 3 feet above surface of concrete.
      c. If necessary, apply evaporation retarder between finishing operations.
   7. Repair mortar shall receive smooth, steel troweled finish.

D. Repair of Exposed Embedded Items in Concrete:
   1. This provision addresses repair and rehabilitation of corroded metal items embedded in existing concrete and to other locations as expressly shown or indicated on the Drawings. Existing concrete damage by corrosion of embedded metal shall be repaired in accordance with this Section's Paragraph 3.2.B.
   2. Preparation:
      a. Fully expose extent of metal corrosion within each embedded item by chipping to sound material. Where specifically shown or indicated on the Drawings, completely remove exposed metal item to extent shown or indicated.
      b. Prepare exposed reinforcing steel attached to or adjacent to embedded, corroded metal items in accordance with this Section's Paragraph 3.1.D.
      c. If existing concrete has been removed during chipping and repair of metal item, prepare repair area in accordance with this Section's Paragraph 3.1.C.
      d. Remove corrosion on embedded metal item and corrosion on exposed reinforcing steel by abrasive blasting to a white-metal finish.

3. Repair:
    a. Where no existing concrete has been removed or damaged adjacent to embedded metal item:
        1) On surface of embedded metal item, provide two coats of epoxy coating in accordance with coating manufacturer's recommendations.
            a) Color of First Coating: Red.
            b) Color of Second Coating: Gray.
        2) Before applying second coat, allow first coat of epoxy coating to fully cure in accordance with coating manufacturer's recommendations.
    b. Where areas of existing concrete have been removed or damaged adjacent to embedded metal item:
        1) Patch area of removed or damaged concrete in accordance with this Section's Paragraph 3.2.B.
        2) Provide on surface of embedded metal item two coats of epoxy coating in accordance with coating manufacturer's recommendations.
            a) Color of First Coat: Red.
            b) Color of second Coat: Gray.
        3) Before applying second coating, allow first coat of epoxy coating to fully cure in accordance with coating manufacturer's recommendations.

E. Extend existing control, construction, and expansion joints through concrete repairs.

F. For repairs of existing concrete damage, finish of repaired areas shall match the finish of existing adjacent concrete surface.

G. Expansion Joint Repair – Type A:
1. Provide materials and installation methods in accordance with sealant manufacturer recommendations and the Contract Documents.
2. Provide sealant and backer rod at moderate, reasonably stable, concrete temperature to optimize repair performance.
3. Comply with Section 07 92 00 - Joint Sealants.

H. Expansion Joint Repair – Type B:
1. Provide epoxy resin adhesive sealing system, in accordance with joint sealant system manufacturer's instructions and the Contract Documents, at locations shown or indicated on the Drawings:
    a. Existing sealant, backer rod, and joint filler material in acceptable condition are to remain in-place at existing joint locations to receive sealing system.
    b. Concrete substrate on both sides of existing joint must be clean, dry, sound, and free of surface contaminants to not less than 10 inches wide strip centered on existing joint or greater when recommended by sealant manufacturer.
        1) Remove dust, laitance, grease, oils, curing compounds, form release agents, and foreign matter by sandblasting or other mechanical means acceptable to the Contracting Officer.
    c. Mix epoxy resin adhesive and install hypalon sheeting in accordance with adhesive manufacturer's printed installation instructions and the Contract Documents.
    d. Cleanup:
        1) Leave finished Work and work area in a neat, clean condition without evidence of spillovers on adjacent surfaces.
        2) Clean uncured epoxy resin adhesive with approved solvent appropriate for the application and area.
        3) Remove cured epoxy resin adhesive only by mechanical means.

I. Expansion Joint Repair – Type C (Joint Sealant System):
1. Installation of joint coating system shall comply with applicable material manufacturer's published recommendations and the Contract Documents.
2. Do not install concrete joint coating when substrate is in a rising-temperature mode.

3. Substrate, air, and coating material temperatures shall comply with applicable material manufacturer's recommendations and the Contract Documents.
4. Primer:
    a. Provide epoxy primer to concrete prior to installing final coating materials.
    b. Applied Thickness: 5 to 10 wet mils.
    c. Reapply coating as necessary to achieve pinhole/holiday-free surface
5. Comply with material manufacturer's recoat time. If recoat time(s) are exceeded, comply with material manufacturer's recommended procedures for surface abrasion, cleaning, and application of bonding agent.
6. Application of Coatings:
    a. Provide primer, base coat, scrim, and top coat in accordance with material manufacturer's requirements, as shown in the Drawings, and in accordance with other Contract Documents.
    b. Install primer (see item 4 above)
    c. Provide initial tack coat at thickens of 10 to 20 wet mils, to 6 inches on each side of joints to be coated.
    d. Push scrim material evenly into wet tack coat and allow to cure one to four hours, as recommended by coating manufacturer.
    e. Provide not less than thickness of 60 wet mils of top coat over scrim material.
    f. Protect and cure in accordance with material manufacturer's recommendations and the Contract Documents.
7. Should substrate temperatures be less than sealant system manufacturer's written recommended minimum temperature, comply with material manufacturer's modified procedures provide materials approved by the Contracting Officer and suitable for installation in cold conditions.

3.3 CURING

A. Curing of Repair Mortar:
    1. Perform curing of repair mortar immediately after final finishing.
    2. Perform curing by combination of covering repair Work with wet burlap and applying liquid membrane-forming curing compound.
    3. Employ methods and sequence to maintain moisture for not less than seven days.

3.4 FIELD QUALITY CONTROL

A. Field Tests:
    1. In-Situ Pull-Off Tests:
        a. Perform in-situ pull-off tests on repaired areas at locations indicated by Contracting Officer Representative.
            1) Perform not less than one pull-off test, in accordance with ASTM C1583, for each surface (wall, roof, floor, and other). In event of unacceptable pull-off test, repair the defective Work in accordance with the Contract Documents and perform additional test(s) at location(s) indicated by Contracting Officer Representative.
        b. Submit written results of testing, indicating: date of test, entity performing testing, personnel present during testing, time of test, location of test, pertinent results recorded, and other relevant observations.
        c. Criteria for Acceptance: Pull-off test will be deemed as passing (acceptable results) when failure occurs within the existing concrete substrate (cohesive concrete failure). If failure occurs at the joint surface with existing concrete (bond failure), within the repair material, or at connection to testing device, pull-out test will be deemed as passing (acceptable results) when the unit tensile stress acting on the core cross section at failure exceeds 300 psi. If failure occurs within the repair material, additional test samples of the repair material in the area of the test shall be taken for compressive testing to verify strength of repair material.
        d. Remedy all damage resulting from in-situ testing, in accordance with the Contract Documents.

B. Observations and Inspections:
   1. Contracting Officer Representative will witness surface preparation, substrate moisture conditions, and installation of materials indicated in this Section. Such observations do not relieve Contractor from obligation to comply with the Contract Documents.
   2. Contracting Officer-retained special inspector shall be present while material manufacturer's technical representatives are at the Site instructing Contractor's structural concrete repair personnel, Contractor's joint sealant system personnel, and installers in the use of the associated material(s).

C. Defective Work:
   1. Defective Repair:
      a. Any and all repairs are defective Work when one or more of the following occurs:
         1) Pull-off test fails.
         2) When grout cube tests yield results less than 3500 psi for repair mortars in seven days.
         3) Repair is not properly finished and in accordance with specified tolerances.
      b. Promptly remove and remedy defective concrete repair Work in accordance with the Contract Documents.
   2. Damaged Work:
      a. Before acceptance of the Work (following final inspection in accordance with the General Conditions and other Contract Documents), neatly repair damaged surfaces, corners of concrete, and finish.
      b. When performing surface remedial repairs, finish areas to smooth, dense watertight condition.
      c. Replace unsatisfactory concrete patching Work.
   3. Corrective Work:
      a. If correction of defective Work (under this Section) is necessary, remove defective Work. Key area to be remedied, clean, and soak surface with water and patch with approved materials. Patch concrete to match existing adjacent concrete surfaces.
      b. Clean surface cavities resulting from form ties, other holes, honeycomb spots, broken corners and edges, and other effects. Saturate with water and point with a mortar of patching material paste. Comply with patching material manufacturer's recommendations concerning placement, pot life, and curing.
      c. Prepare pointing material not more than 30 minutes prior to use. Cure mortar patches properly. Carefully tool contraction and articulated joints in completed Work and keep them free of concrete. Where necessary, leave joint filler exposed for its full length with clean and true edges.
      d. Tolerance deviations and other surface defects may also be corrected, when approved by Contracting Officer Representative, by grinding high areas of swales.
      e. Where remedial work is unsatisfactory, completely remove such Work and replace with new Work in accordance with the Contract Documents.
   4. Special inspection of remedial work is required. Special inspection will be performed after completion of surface preparation and during installation of remedial Work. Refer to Structural Statement of Special Inspections for additional requirements. .
   5. Defective Joint Sealant System Work:
      a. Any and all locations where joint sealant system has separated from concrete or exhibits cracking or tearing is defective Work.
      b. Remove defective joint sealant system Work, clean the surface, and re-provide new joint sealant system materials.
      c. Unless directed otherwise by Contracting Officer, when area of defective joint sealant Work exceeds 25% of total area of joint sealant system Work provided, replace all joint sealant system Work in accordance with the Contract Documents.

D. Suppliers' Services:
   1. Manufacturers' factory-trained technical representatives of concrete repair materials and joint sealant system shall be at the Site prior to and during first installation of the materials furnished under this Section to review surface preparation, surface moisture conditions and

adhesion testing, and proposed installation methods. Joint sealant system manufacturer's representative shall also inspect the entire completed installation and submit, through Contractor, an affidavit of compliance certifying that installed materials comply with manufacturer written instructions and recommendations. Compensation for which is part of the associated unit price for such Work.

3.5 POST-CONSTRUCTION OBLIGATIONS

A. Warranty Inspection:
   1. Perform warranty inspections during eleventh month after Substantial Completion of the Work of this Section.
   2. For the inspections, Contrtacting Officer will dewater and reasonably clean water-bearing structures.
   3. Operational constraints preclude removing all water-bearing structures from service simultaneously for warranty inspection. It is anticipated that ONE separate warranty inspections will be necessary due to operational constraints, each on different, non-consecutive days.
   4. One warranty inspection of each joint sealed is required, unless defective Work is evident. When defective joint sealant Work is apparent, an additional warranty inspection of the repaired joint is required in the eleventh month after the defective joint sealant is remedied.
   5. Contractor, joint sealant Subcontractor (if any), joint sealant system manufacturer's technical representative, Contracting Officer, shall be present at each warranty inspection.
   6. Contractor shall promptly remedy and replace defective Work, whether evident during the warranty inspection or otherwise, in accordance with the Contract Documents.
   7. If contractor is unable or unavailable to remedy defective Work promptly when water-bearing structures are dewatered and cleaned for the warranty inspection, Contracting Officer may place such structures back into service and Contractor will be responsible for appropriately dewatering and cleaning the structure to perform the necessary remedial Work.
   8. Regarding remedy of defective joint sealant system Work, refer to this Section's Paragraph 3.4.C.

B. Item 1 – Concrete Surface Repair - Type I (Thin):
   1. Measurement will be the area, in square feet, of existing, concrete surface area repaired, measured in one or more appropriate geometric shapes such as rectangles, squares, triangles, and trapezoids, at the concrete surface.
   2. Item Includes (all in accordance with the Contract Documents):
      a. As indicated in Section 03 01 30 - Repair and Rehabilitation of Existing Concrete.
   3. Not included in this bid/pay item:
      a. As indicated in Section 03 01 30 - Repair and Rehabilitation of Existing Concrete.
   4. Payment: Unit price per square foot for this item will be full compensation for Work for surface repair of the type indicated for existing concrete, and all related Work, performed under this item, complete in accordance with the Contract Documents, and not specifically included under other bid/pay items or contracts.

C. Item 2 – Expansion Joint Repair - Type A:
   1. Measurement will be the length, in linear feet, of existing, concrete expansion joint repaired, measured at the concrete surface.
   2. Item Includes (all in accordance with the Contract Documents):
      a. As indicated in Section 03 01 30 - Repair and Rehabilitation of Existing Concrete.
   3. Not included in this bid/pay item:
      a. As indicated in Section 03 01 30 - Repair and Rehabilitation of Existing Concrete.
   4. Payment: Unit price per linear foot for this item will be full compensation for all expansion joint repair Work of the type indicated, and all related Work, performed under this item, complete in accordance with the Contract Documents, and not specifically included under other bid/pay items or contracts.

END OF SECTION

SECTION 03 05 05
CONCRETE TESTING AND INSPECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Contractor requirements for testing of concrete and grout.
   2. Definition of Government provided testing.
   3. Acceptance criteria for concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 21 00 - Reinforcement.
   2. Section 03 31 30 - Concrete, Materials and Proportioning.
   3. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.
   4. Section 03 41 33 - Precast and Prestressed Concrete.

1.2 RESPONSIBILITY AND PAYMENT

A. Construction Management Representative will hire an independent Testing Agency/Service Provider to perform the following testing and inspection and provide test results to the Contracting Officer's Representative and Contractor.
   1. Testing and inspection of concrete and grout produced for incorporation into the work during the construction of the Project for compliance with the Contract Documents.
   2. Additional testing or retesting of materials occasioned by their failure, by test or inspection, to meet requirements of the Contract Documents.
   3. Strength testing on concrete required by the Contracting Officer's Representative or Special Inspector when the water-cement ratio exceeds the water-cement ratio of the typical test cylinders.
   4. In-place testing of concrete as may be required by Contracting Officer's Representative when strength of structure is considered potentially deficient.
   5. Other testing services needed or required by Contractor such as field curing of test specimens and testing of additional specimens for determining when forms, form shoring or reshoring may re-removed.
   6. Government will pay for services defined in Paragraph 1.2A.1.
   7. See Specification Section 01 42 00.

B. Hire a qualified testing agency to perform the following testing and provide test results to the Contracting Officer.
   1. Testing of materials and mixes proposed by the Contractor for compliance with the Contract Documents and retesting in the event of changes.
   2. Additional testing and inspection required because of changes in materials or proportions requested by Contractor.
   3. Pay for services defined in Paragraphs 1.2B.1. and 1.2B.2.
   4. Reimburse Government for testing services defined in Paragraphs 1.2A.2., 1.2A.3., 1.2A.4. and 1.2A.5.
   5. See Specification Section 01 42 00.

C. Duties and Authorities of Testing Agency/Service Provider:
   1. Any Testing Agency/Service Provider or agencies and their representatives retained by Contractor or Contracting Officer for any reason are not authorized to revoke, alter, relax, enlarge, or release any requirement of Contract Documents, nor to reject, approve or accept any portion of the Work.
   2. Testing Agency/Service Provider shall inform the Contractor and Contracting Officer's Representative regarding acceptability of or deficiencies in the work including materials

furnished and work performed by Contractor that fails to fulfill requirements of the Contract Documents.

3. Testing Agency to submit test reports and inspection reports to Contracting Officer's Representative and Contractor immediately after they are performed.
    a. All test reports to include exact location in the work at which batch represented by a test was deposited.
    b. Reports of strength tests to include detailed information on storage and curing of specimens prior to testing.
4. Contracting Officer retains the responsibility for ultimate rejection or approval of any portion of the Work.

1.3 QUALITY ASSURANCE

A. Referenced Standards:
    1. American Concrete Institute (ACI):
        a. 318, Building Code Requirements for Structural Concrete.
    2. ASTM International (ASTM):
        a. ASTM Cement and Concrete Reference Laboratory (CCRL).
        b. C31, Standard Practice for Making and Curing Concrete Test Specimens in the Field.
        c. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
        d. C42, Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
        e. C94, Standard Specification for Ready-Mixed Concrete.
        f. C143, Standard Test Method for Slump of Hydraulic-Cement Concrete.
        g. C172, Standard Practice for Sampling Freshly Mixed Concrete.
        h. C1019, Standard Test Method for Sampling and Testing Grout.
        i. C1218, Standard Test Method for Water-Soluble Chloride in Mortar and Concrete.
        j. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

B. Qualifications:
    1. Contractor's Testing Agency:
        a. Meeting requirements of ASTM E329 and ASTM C94.
        b. Provide evidence of recent inspection by CCRL of NBS, and correction of deficiencies noted.

C. Use of Testing Agency and approval by Contracting Officer's Representative of proposed concrete mix design shall in no way relieve Contractor of responsibility to furnish materials and construction in full compliance with Contract Documents.

1.4 DEFINITIONS

A. Testing Agency/Service Provider: An independent professional testing/inspection firm or service hired by Contractor or by Contracting Officer to perform testing, inspection or analysis services as directed, and as provided in the Contract Documents.

1.5 SUBMITTALS

A. Shop Drawings:
    1. Product technical data including:
        a. Concrete materials and concrete mix designs proposed for use.
            1) Include results of all testing performed to qualify materials and to establish mix designs.
            2) Place no concrete until approval of mix designs has been received in writing.
            3) Submittal for each concrete mix design to include:
                a) Sieve analysis and source of fine and coarse aggregates.
                b) Test for aggregate organic impurities.
                c) Proportioning of all materials.

d) Type of cement with mill certificate for the cement.
e) Brand, quantity and class of fly ash proposed for use along with other submittal data as required for fly ash by Specification Section 03 31 30.
f) Slump.
g) Brand, type and quantity of air entrainment and any other proposed admixtures.
h) Shrinkage test results.
i) Total water soluble chloride ion concentration in hardened concrete from all ingredients determined per ASTM C1218.
j) 28-day compression test results and any other data required by Specification Section 03 31 30 to establish concrete mix design.

2. Certifications:
   a. Testing Agency qualifications.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 TESTING SERVICES TO BE PERFORMED SERVICE PROVIDER/TESTING AGENCY

A. The following concrete testing will be performed by the Service Provider/Testing Agency:
   1. Concrete strength testing:
      a. Secure concrete samples in accordance with ASTM C172.
         1) Obtain each sample from a different batch of concrete on a random basis, avoiding selection of test batch other than by a number selected at random before commencement of concrete placement.
      b. For each strength test, mold and cure cylinders from each sample in accordance with ASTM C31.
         1) Record any deviations from requirements on test report.
         2) Cylinder size: Per ASTM C31.
            a) 4 inches cylinders shall not be used for concrete mixes with maximum aggregate size larger than 1 inch.
            b) Use the same size cylinder for all tests for each concrete mix.
         3) Quantity:
            a) 6 inches diameter by 12 inches high: Four cylinders.
            b) 4 inches diameter by 8 inches high: Six cylinders.
      c. Field cure one cylinder for the seven day test.
         1) Laboratory cure the remaining.
      d. Test cylinders in accordance with ASTM C39.
         1) 6 inches diameter cylinders:
            a) Test two cylinders at 28 days for strength test result and the one field cured sample at seven days for information.
            b) Hold remaining cylinder in reserve.
         2) 4 inches diameter cylinders:
            a) Test three cylinders at 28 days for strength test result and the one field cured cylinder at seven days for information.
            b) Hold remaining cylinders in reserve.
      e. Strength test result:
         1) Average of strengths of two, 6 inches diameter cylinders or three, 4 inches diameter cylinders from the same sample tested at 28 days.
         2) If one cylinder in a test manifests evidence of improper sampling, molding, handling, curing, or testing, discard and test reserve cylinder(s); average strength of remaining cylinders shall be considered strength test result.
         3) Should all cylinders in any test show any of above defects, discard entire test.
      f. Frequency of tests:

1) Concrete sand cement grout: One strength test for each 4 hour period of grout placement or fraction thereof.
   a) Test grout in accordance with ASTM C1019.
2) Concrete topping, concrete fill and lean concrete: One strength test for each 10 CUYD of each type of concrete or fraction thereof placed.
3) Precast concrete: Frequency per Specification Section 03 41 33.
4) All other concrete:
   a) One strength test to be taken not less than once a day, nor less than once for each 60 cubic yards or fraction thereof placed in any one day.
   b) Once for each 5000 square feet of slab or wall surface area placed each day
   c) If total volume of concrete on Project is such that frequency of testing required in above paragraph will provide less than five strength tests for each concrete mix, tests shall then be made from at least five randomly selected batches or from each batch if fewer than five batches are provided.

2. Slump testing:
   a. Determine slump of concrete sample for each strength test.
      1) Determine slump in accordance with ASTM C143.
   b. If consistency of concrete appears to vary, the Contracting Officer's Representative shall be authorized to require a slump test for each concrete truck.
      1) This practice shall continue until three consecutive batches are determined to be consistent and meet the slump requirements specified.
3. Air content testing: Determine air content of concrete sample for each strength test in accordance with ASTM C231 , ASTM C173 , or ASTM C138.
4. In-place concrete testing (if required).

3.2 SPECIAL INSPECTIONS

A. See Section 01 40 00.
   1. Special Inspections listed are for the Contractor reference only and is not part of the Contract Documents.
   2. It is included to assist the Contractor in understanding the Government-provided Services so that those services may be factored into the Contractor's pricing and schedule.

B. Formwork Special Inspections:
   1. Shape, location, and dimensions.
      a. Inspect in accordance with dimensions and details on Drawings.
      b. Frequency: Inspect prior to each concrete pour.

C. Reinforcing Special Inspections:
   1. Reinforcing size, spacing, lap length and concrete cover.
      a. Inspect in accordance with Drawings and Specification.
      b. Frequency: Inspect prior to each concrete pour.
   2. Reinforcing adhesive anchoring system:
      a. Inspect in accordance with ICC-ES report.
      b. Frequency:
         1) Inspect all adhesive anchors for the first 4 hours of installation.
         2) Inspect approximately 25% of adhesive anchors thereafter.
         3) Additional inspection will be required for different installer or if the quality of installation appears to vary.
   3. Mechanical splices:
      a. Inspect in accordance with ICC-ES report.
      b. Frequency:
         1) Inspect all mechanical splices prior to placing concrete .
         2) Inspect approximately 25% of mechanical splices thereafter.
         3) Additional inspection will be required for different installer or if the quality of installation appears to vary.

D. Mixing, Placing, Jointing, and Curing Special Inspections:

1. Perform concrete tests per the requirements of this Specification Section.
2. Verification of proper mix design.
    a. Frequency: Periodically, prior to each concrete pour.
3. Proper concrete placement techniques.
    a. Inspect per requirements of Section 03 31 31.
    b. Frequency: During each concrete pour.
4. Proper curing temperature and techniques.
    a. Inspect per requirements of Section 03 31 31.
    b. Frequency: Periodically, but not less than every third day.
5. Joints:
    a. Inspect joints for proper joint type, dimensions, reinforcing, dowel alignment, surface preparation and location.
    b. Frequency: Prior to each concrete pour.

E. Anchorage to Concrete Special Inspection:
1. Post installed anchors as required by the building code, ICC-ES Evaluation Reports, and as specified by the Contracting Officer's Representative.
    a. Frequency: Per ICC-ES Report.
2. Cast-in-place concrete anchors, including anchor size, embedment, material and location.
    a. Frequency: Prior to each concrete pour.

3.3 SAMPLING ASSISTANCE AND NOTIFICATION FOR OWNER

A. To facilitate testing and inspection, perform the following:
1. Furnish any necessary labor to assist Testing Agency in obtaining and handling samples at site.
2. Provide and maintain for sole use of Testing Agency adequate facilities for safe storage and proper curing of test specimens on site for first 24 hours as required by ASTM C31.
3. Take samples at point of placement into concrete member.

B. Notify Contractor's Testing Agency sufficiently in advance of operations (minimum of 24 hours) to allow for assignment of personnel and for scheduled completion of quality tests.

3.4 ACCEPTANCE

A. Completed concrete work which meets applicable requirements will be accepted without qualification.

B. Completed concrete work which fails to meet one or more requirements but which has been repaired to bring it into compliance will be accepted without qualification.

C. Completed concrete work which fails to meet one or more requirements and which cannot be brought into compliance may be accepted or rejected as provided in these Contract Documents.
1. In this event, modifications may be required to assure that concrete work complies with requirements.
2. Modifications, as directed by Contracting Officer's Representative, to be made at no additional cost to Government.

D. Dimensional Tolerances:
1. Formed surfaces resulting in concrete outlines smaller than permitted by tolerances shall be considered potentially deficient in strength and subject to modifications required by Contracting Officer's Representative.
2. Formed surfaces resulting in concrete outlines larger than permitted by tolerances may be rejected and excess material subject to removal.
    a. If removal of excess material is permitted, accomplish in such a manner as to maintain strength of section and to meet all other applicable requirements of function and appearance.
3. Concrete members cast in wrong location may be rejected if strength, appearance or function of structure is adversely affected or misplaced items interfere with other construction.

4. Inaccurately formed concrete surfaces exceeding limits of tolerances and which are exposed to view, may be rejected.
    a. Repair or remove and replace if required.
5. Finished slabs exceeding tolerances may be required to be repaired provided that strength or appearance is not adversely affected.
    a. High spots may be removed with a grinder, low spots filled with a patching compound, or other remedial measures performed as permitted or required.

E. Appearance:
1. Concrete surfaces exposed to view with defects which, in opinion of Contracting Officer's Representative, adversely affect appearance as required by specified finish shall be repaired by approved methods.
2. Concrete not exposed to view is not subject to rejection for defective appearance unless, in the opinion of the Contracting Officer's Representative, the defects impair the long-term strength or function of the member.

F. High Water-Cement Ratio:
1. Concrete with water in excess of the specified maximum water-cement ratio will be rejected.
2. Remove and replace concrete with high water-cement ratio or make other corrections as directed by Contracting Officer's Representative.

G. Strength of Structure:
1. Strength of structure in place will be considered potentially deficient if it fails to comply with any requirements which control strength of structure, including but not necessarily limited to following:
    a. Low concrete strength:
        1) Test results for standard molded and cured test cylinders to be evaluated separately for each mix design.
            a) Such evaluation shall be valid only if tests have been conducted in accordance with specified quality standards.
            b) For evaluation of potential strength and uniformity, each mix design shall be represented by at least three strength tests.
            c) A strength test shall be the average of two, 6 inches diameter cylinders or three, 4 inches diameter cylinders from the same sample tested at 28 days.
        2) Acceptance:
            a) Strength level of each specified compressive strength shall be considered satisfactory if both of the following requirements are met:
                (1) Average of all sets of three consecutive strength tests equal or exceed the required specified 28 day compressive strength.
                (2) No individual strength test falls below the required specified 28 day compressive strength by more than 500 psi.
    b. Reinforcing steel size, configuration, quantity, strength, position, or arrangement at variance with requirements in Specification Section 03 21 00 or requirements of the Contract Drawings or approved Shop Drawings.
    c. Concrete which differs from required dimensions or location in such a manner as to reduce strength.
    d. Curing time and procedure not meeting requirements of this Specification Section.
    e. Inadequate protection of concrete from extremes of temperature during early stages of hardening and strength development.
    f. Mechanical injury, construction fires, accidents or premature removal of formwork likely to result in deficient strength.
    g. Concrete defects such as voids, honeycomb, cold joints, spalling, cracking, etc., likely to result in deficient strength or durability.
2. Structural analysis and/or additional testing may be required when strength of structure is considered potentially deficient.

3. In-place testing of concrete may be required when strength of concrete in place is considered potentially deficient.
    a. Testing by impact hammer, sonoscope, or other nondestructive device may be permitted by Contracting Officer's Representative to determine relative strengths at various locations in the structure or for selecting areas to be cored.
        1) Such tests shall not be used as a basis for acceptance or rejection.
    b. Core tests:
        1) Where required, test cores will be obtained in accordance with ASTM C42.
            a) If concrete in structure will be dry under service conditions, air dry cores (temperature 60 to 80 degrees F, relative humidity less than 60%) for seven days before test then test dry.
            b) If concrete in structure will be wet or subjected to high moisture atmosphere under service conditions, test cores after immersion in water for at least 40 hours and test wet.
            c) Testing wet or dry to be determined by Contracting Officer's Representative.
        2) Three representative cores may be taken from each member or area of concrete in place that is considered potentially deficient.
            a) Location of cores shall be determined by Contracting Officer's Representative so as least to impair strength of structure.
            b) If, before testing, one or more of cores shows evidence of having been damaged subsequent to or during removal from structure, damaged core shall be replaced.
        3) Concrete in area represented by a core test will be considered adequate if average strength of three cores is equal to at least 85% of specified strength and no single core is less than 75% of specified strength.
        4) Fill core holes with non-shrink grout and finish to match surrounding surface when exposed in a finished area.
4. If core tests are inconclusive or impractical to obtain or if structural analysis does not confirm safety of structure, load tests may be required and their results evaluated in accordance with ACI 318, Chapter 27.
5. Correct or replace concrete work judged inadequate by structural analysis or by results of core tests or load tests with additional construction, as directed by Contracting Officer's Representative, at Contractor's expense.
6. Contractor to pay all costs incurred in providing additional testing and/or structural analysis required.

END OF SECTION

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SECTION 03 11 13
FORMWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Formwork requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 05 05 - Concrete Testing and Inspection.
   2. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   3. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 347R, Guide to Formwork for Concrete.

B. Qualifications:
   1. Formwork, shoring and reshoring to be designed by a licensed professional engineer currently registered or having a minimum of three years of experience in this type of design work.
      a. Above qualifications apply to slabs and beams not cast on the ground.

C. Miscellaneous:
   1. Design and engineering of formwork, shoring and reshoring as well as its construction is the responsibility of the Contractor.
   2. Design requirements:
      a. Design formwork for loads, lateral pressures and allowable stresses outlined in ACI 347R and for design considerations, wind loads, allowable stresses and other applicable requirements of the controlling local building code.
         1) Where conflicts occur between the above two standards, the more stringent requirements shall govern.
      b. Design formwork to limit maximum deflection of form facing materials reflected in concrete surfaces exposed to view to 1/240 of span between structural members.
   3. For slabs and beams not cast on the ground, develop a procedure and schedule for removal of shores and installation of reshores and for calculating the loads transferred to the structure during this process in accordance with ACI 347R.
      a. Perform structural calculations as required to prove that all portions of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its own weight plus the loads placed thereon. Calculations shall be performed by a licensed professional engineer in the state of Arizona.
      b. When developing procedure, schedule and structural calculations, consider the following at each stage of construction:
         1) The structural system that exists.
         2) Effects of all loads during construction.
         3) Strength of concrete.
         4) The influence of deformations of the structure and shoring system on the distribution of dead loads and construction loads.
         5) The strength and spacing of shores or shoring systems used, as well as the method of shoring, bracing, shore removal, and reshoring including the minimum time intervals between the various operations.

6) Any other loading or condition that affects the safety or serviceability of the structure during construction.

1.3 DEFINITIONS

A. Words and terms used in these Specifications are defined in ACI CT-13.

B. SCC: Self-Consolidating Concrete.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Manufacturer and type of proposed form ties.

B. Samples:
   1. A 12 inches SQ sample of each of the following form finishes.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

2.1 MATERIALS

A. Forms for Surfaces Exposed to View:
   1. Wood forms:
      a. 5/8 or 3/4 inches 5-ply structural plywood of concrete form grade.
      b. Built-in-place or prefabricated type panel.
   2. Metal forms:
      a. Metal forms may be used except for aluminum in contact with concrete.
      b. Forms to be tight to prevent leakage, free of rust and straight without dents to provide members of uniform thickness.

B. Forms for Surfaces Not Exposed to View:
   1. Wood or metal sufficiently tight to prevent leakage.
   2. Do not use aluminum forms.

2.2 ACCESSORIES

A. Form Ties:
   1. Commercially fabricated for use in form construction.
      a. Field fabricated ties are unacceptable.
   2. Constructed so that ends or end fasteners can be removed without causing spalling at surfaces of the concrete.
   3. Embedded portion of ties to be not less than 1-1/2 inches from face of concrete after ends have been removed.
   4. Cone size:
      a. 3/4 inches minimum diameter cones on both ends.
      b. Depth of cone not to exceed the concrete reinforcing cover.
   5. Provide ties with built-in waterstops in all walls that will be in contact with below grade soil.
   6. Through-wall ties that are designed to be entirely removed are not allowed in all walls that will be in contact with liquids during plant operation.

B. Form Release Material:
   1. If project contains self-consolidating concrete, provide reactive, vegetable-based product, not barrier type.

PART 3 - EXECUTION

3.1 PREPARATION

A. Form Surface Treatment:
   1. Before placing of reinforcing steel or concrete, cover surfaces of forms with an approved release material that will effectively prevent absorption of moisture and prevent bond with concrete, will not stain concrete or prevent bonding of future finishes.
      a. A field applied form release agent or sealer of approved type or a factory applied nonabsorptive liner may be used.
   2. Do not allow excess form release material to stand in puddles in forms nor in contact with hardened concrete against which fresh concrete is to be placed.

B. Apply form release material to minimize bugholes and pinholes. Follow manufacturer's printed installation instructions specific to the form facing material.

C. Provide temporary openings at base of column and wall forms and at other points where necessary to facilitate cleaning and observation immediately before concrete is placed, and to limit height of free fall of concrete to prevent aggregate segregation.
   1. Temporary openings to limit height of free fall of concrete shall be spaced no more than 8 feet apart.

D. Clean surfaces of forms, reinforcing steel and other embedded materials of any accumulated mortar or grout from previous concreting and of all other foreign material before concrete is placed.

3.2 ERECTION

A. Install products in accordance with manufacturer's instructions.

B. Tolerances:
   1. Conform to ACI 117.
   2. Variation from plumb:
      a. In lines and surfaces of columns, piers, walls, and in risers.
         1) Maximum in any 10 feet of height: 1/4 inches.
         2) Maximum for entire height: 1/2 inches.
      b. For exposed corner columns, control-joint grooves, and other exposed to view lines:
         1) Maximum in any 20 feet length: 1/4 inches.
         2) Maximum for entire length: 1/2 inches.
   3. Variation from level or from grades specified:
      a. In slab soffits, ceilings, beam soffits and in arises, measured before removal of supporting shores.
         1) Maximum in any 10 feet of length: 1/4 inches.
         2) Maximum in any bay or in any 20 feet length: 3/8 inches.
         3) Maximum for entire length: 3/4 inches.
      b. In exposed lintels, sills, parapets, horizontal grooves, and other exposed to view lines:
         1) Maximum in any bay or in 20 feet length: 1/4 inches.
         2) Maximum for entire length: 1/2 inches.
   4. Variation of linear structure lines from established position in plan and related position of columns, walls, and partitions:
      a. Maximum in any bay: 1/2 inches.
      b. Maximum in any 20 feet of length: 1/2 inches.
      c. Maximum for entire length: 1 inch.
   5. Variation in sizes and location of sleeves, floor openings, and wall openings: Maximum of +1/2 inches.
   6. Variation in horizontal plan location of beam, column and wall centerlines from required location: Maximum of +1/2 inches.
   7. Variation in cross sectional dimensions of columns and beams and in thickness of slabs and walls: Maximum of -1/4 inches, +1/2 inches.

8. Footings and foundations:
    a. Variations in concrete dimensions in plan: -1/2 inches, +2 inches.
    b. Misplacement or eccentricity:
        1) 2% of footing width in direction of misplacement but not more than 2 inches.
    c. Thickness:
        1) Decrease in specified thickness: 5%.
        2) Increase in specified thickness: No limit except that which may interfere with other construction.
9. Variation in steps:
    a. In a flight of stairs:
        1) Rise: +1/8 inches.
        2) Tread: +1/4 inches.
    b. In consecutive steps:
        1) Rise: +1/16 inches.
        2) Tread: +1/8 inches.
10. Establish and maintain in an undisturbed condition and until final completion and acceptance of Project, sufficient control points and benchmarks to be used for reference purposes to check tolerances.
11. Regardless of tolerances listed allow no portion of structure to extend beyond legal boundary of Project.
12. To maintain specified tolerances, camber formwork to compensate for anticipated deflections in formwork prior to hardening of concrete.

C. Make forms sufficiently tight to prevent loss of mortar from concrete.

D. Place 3/4 inches chamfer strips in exposed to view corners of forms to produce 3/4 inches wide beveled edges.

E. At construction joints, overlap contact surface of form sheathing for flush surfaces exposed to view over hardened concrete in previous placement by at least 1 inch.
    1. Hold forms against hardened concrete to prevent offsets or loss of mortar at construction joint and to maintain a true surface.
    2. Where possible, locate juncture of built-in-place wood or metal forms at architectural lines, control joints or at construction joints.

F. Where circular walls are to be formed and forms made up of straight sections are proposed for use, provide straight lengths not exceeding 2 feet wide.
    1. Brace and tie formwork to maintain correct position and shape of members.

G. Construct wood forms for wall openings to facilitate loosening, if necessary, to counteract swelling.

H. Anchor formwork to shores or other supporting surfaces or members so that movement of any part of formwork system is prevented during concrete placement.

I. Provide runways for moving equipment with struts or legs, supported directly on formwork or structural member without resting on reinforcing steel.

J. Provide positive means of adjustment (wedges or jacks) of shores and struts and take up all settlement during concrete placing operation.
    1. Securely brace forms against lateral deflection.
    2. Fasten wedges used for final adjustment of forms prior to concrete placement in position after final check.

K. Stay-In-Place Forms:
    1. Support stay-in-place forms as required to maintain the formwork in proper position.
    2. Hold the edge of stay-in-place forms back a minimum of 2 inches from all smooth formed concrete surfaces.
    3. Stay-in-place forms may be used at the Contractor's option at:
        a. Surfaces that will be backfilled with soil.

1) Maintain a minimum of 3 inches of concrete cover over all reinforcing.

b. Roughened construction joints.

c. Other locations approved by Contracting Officer Representative.

3.3 REMOVAL OF FORMS

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads places thereon.

B. When required for concrete curing in hot weather, required for repair of surface defects or when finishing is required at an early age, remove forms as soon as concrete has hardened sufficiently to resist damage from removal operations or lack of support.

C. Remove top forms on sloping surfaces of concrete as soon as concrete has attained sufficient stiffness to prevent sagging.

1. Perform any needed repairs or treatment required on such sloping surfaces at once, followed by curing specified in Specification Section 03 31 31.

D. Loosen wood forms for wall openings as soon as this can be accomplished without damage to concrete.

3.4 RESHORING

A. No construction loads shall be supported on, nor any shoring removed from, any part of the structure under construction except when that portion of the structure in combination with remaining forming and shoring system has sufficient strength to safely support its weight and loads placed thereon.

B. While reshoring is underway, no superimposed dead or live loads shall be permitted on the new construction.

C. During reshoring do not subject concrete in structural members to combined dead and construction loads in excess of loads that structural members can adequately support.

D. Place reshores as soon as practicable after stripping operations are complete but in no case later than end of working day on which stripping occurs.

E. Tighten reshores to carry their required loads without overstressing.

F. Shoring, reshoring and supporting formwork may be removed when concrete has reached the concrete strength required by the formwork designer's structural calculations.

G. For floors supporting shores under newly placed concrete leave original supporting shores in place or reshore.

1. Reshoring system shall have a capacity sufficient to resist anticipated loads.
2. Locate reshores directly under a shore position above.

H. In multi-story buildings, extend reshoring over a sufficient number of stories to distribute weight of newly placed concrete, forms, and construction live loads in such a manner that design superimposed loads of floors supporting shores are not exceeded.

3.5 FIELD QUALITY CONTROL

A. Special Inspection:

1. See Section 01 40 00.
2. See Section 03 05 05.

END OF SECTION

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SECTION 03 15 19
ANCHORAGE TO CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for anchorages in concrete, including: cast-in-place anchor bolts, anchor rods, reinforcing anchorage adhesive, and post-installed concrete anchors required for the Project but not specified elsewhere in the Contract Documents.
   2. Delegated design requirements for concrete anchors not expressly shown or indicated on the Drawings or elsewhere in the Contract Documents, including, but not limited to, anchorages in concrete for the following structural and nonstructural components:
      a. Structural members and accessories.
      b. Metal, wood, and plastic fabrications.
      c. Architectural Work, including building components, finishes, specials, facility equipment and conveying equipment, furnishings, and special construction Work.
      d. Mechanical and electrical Work, including process-mechanical Work, site and infrastructure Work, electrical Work, communications Work, electronic safety and security systems Work, and others.
      e. Fire suppression, plumbing, and HVAC Work.
      f. Other components requiring anchorages to concrete.

B. Related Requirements: Include, but are not necessarily limited to:
   1. Section 01 35 73 - Delegated Design Procedures.
   2. Section 01 81 10 - Wind and Seismic Criteria
   3. Section 03 05 05 - Concrete Testing and Inspection.

1.2 REFERENCES

A. Definitions and Terminology:
   1. This provision presents definitions and terminology, which have the meanings indicated in this provision, applied to the singular or plural thereof, and without regard to use of initial capital letters.
      a. Adhesive Anchors:
         1) Post-installed anchors developing their strength primarily from chemical bond between the concrete and the anchor.
         2) Includes anchors using acrylics, epoxy and other similar adhesives.
      b. Anchor Bolt: Any cast-in-place anchorage that is made of a headed (i.e. bolt) material.
      c. Anchor Rod: Any cast-in-place or post-installed anchorage made from unheaded, threaded, rod or deformed bar material.
      d. Concrete Anchor: Generic term for either an anchor bolt or an anchor rod.
      e. Galvanizing: Hot-dip galvanizing in accordance with ASTM A123, ASTM A153 or ASTM F2329 with minimum coating of 2.0 ounces of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by reference standard.
      f. Hardware: As defined in ASTM A153.
      g. MPII: Manufacturer's printed installation instructions.
      h. Mechanical Anchors:
         1) Post-installed anchors developing their strength from attachment other than thru adhesives or chemical bond to concrete.
         2) Includes expansion anchors, expansion sleeve, screw anchors, undercut anchors, specialty inserts and other similar types of anchorages.
         3) Drop-in anchors and other similar non-ICC ES approved anchors are unacceptable.
      i. Post-Installed Anchor: Adhesive or mechanical anchor installed into previously placed and adequately cured concrete.

B. Reference Standards:
   1. American Concrete Institute (ACI):
      a. 318, Building Code Requirements for Structural Concrete and Commentary.
      b. 350, Code Requirements for Environmental Engineering Concrete Structures and Commentary.
   2. American Concrete Institute/Concrete Reinforcing Steel Institute (ACI-CRSI):
      a. Adhesive Anchor Installation Certification Program: Adhesive Anchor Installer.
   3. American Institute of Steel Construction (AISC):
      a. 303, Code of Standard Practice for Steel Buildings and Bridges.
      b. 355.2, Seismic Testing of Post-Installed Concrete and Masonry Anchors in Cracked Concrete.
      c. 355.4, Qualification of Post-Installed Adhesive Anchors in Concrete.
   4. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      c. A123, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      d. A153, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      e. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.
      f. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      g. A563, Standard Specification for Carbon and Alloy Steel Nuts.
      h. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
      i. F436, Standard Specification for Hardened Steel Washers.
      j. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
      k. F594, Standard Specification for Stainless Steel Nuts.
      l. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
      m. F2329, Standard Specification for Zinc Coating, Hot-Dip, Requirements for Application to Carbon and Alloy Steel Bolts, Screws, Washers, Nuts, and Special Threaded Fasteners
   5. International Code Council Evaluation Service (ICC-ES):
      a. AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
      b. AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. For post-installed anchors and other anchorages installed in existing concrete, comply with Section 01 73 29 - Cutting and Patching.
   2. Comply with coordination requirements in accordance with Contract Documents.

B. Pre-Design Conference:
   1. Pre-design conference for anchorages to concrete (where such anchorages are delegated design Work) is not required.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Code-required Special Instructions:
      a. Special Inspection is required in accordance with the building code for all concrete anchorages.
      b. Notify the Special Inspector that an inspection is required prior to concrete placement (or during post-installed anchorage installation).
      c. See the “Field Quality Control” Article in “Part 3 – Execution” of this Section for additional requirements.

B. Qualifications:
   1. Delegated Design Professional:
      a. Delegated design professional's qualifications and responsibilities shall be in accordance with Contract Documents.
   2. Installer:
      a. Installer for post-installed anchors shall be trained by the manufacturer or certified by a training program approved by the Contracting Officer.
      b. Installer for adhesive anchors installed in horizontal, upward incline, or overhead applications shall be certified by ACI-CRSI Adhesive Anchor Installation Certification Program.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit schedule (table or listing) of types, sizes (diameter, length, embedment length), material, finish, and proposed manufacturers of anchorages to concrete to be provided. Apportion by Project-specific application (for example, "Anchorages for cooling water pumps in basement") and indicate where anchorages are fully-designed by Contracting Officer's Representative and those for which final design was prepared by delegated design professional.
      b. Contracting Officer's approval of such Shop Drawing will be only for anchorages fully designed by Engineer. For anchorages for which final design is by delegated design professional, include on such Shop Drawing delegated design professional's approval stamp.
   2. Product Data: Submit as Action Submittals product data for anchorages to concrete fully designed by Contracting Officer's Representative. For anchorages to concrete for which final design is by delegated design professional, submit as Informational Submittals bearing approval stamp of delegated design professional.
      a. Manufacturer's express, written acknowledgement that proposed items comply with referenced standards indicated in this Section and, as applicable, by delegated design professional.
      b. Manufacturer published data and information for each anchor.
         1) Clearly indicate items that are proposed for the Work. Neatly strike out or obscure materials and products not proposed.
      c. Manufacturer's published installation instructions and instructions for code-required special inspections and tests.
      d. Post-Installed Anchors: In addition, submit for each post-installed anchor system current ICC-ES report , indicating the following:
         1) Manufacturer's certification that anchors comply with requirements indicated in the Contract Documents.
         2) Performance data indicating that anchor is approved by its manufacturer for use in cracked concrete.
         3) Seismic design categories for which anchor system is approved by ICC-ES report.
      e. Anchorage layout drawings and details:
         1) Drawings showing location, configuration, spacing and edge distance.
   3. Delegated Design Professional's Instruments of Service Submittals: Submit, in accordance with this Section and Contract Documents, for each anchorage to concrete for which final design is by delegated design professional:
      a. Certification of compliance, in accordance with Contract Documents. Indicate design tension and shear loads used for anchor design.
      b. Delegated design professional's drawings.
      c. Delegated design professional's specifications, if any, when prepared by delegated design professional.

d. Post-Installed Anchors (for which final design is by delegated design professional): Submittal shall also include the following for post-installed anchors for which final design was by delegated design professional:
    1) Show diameter, embedment depth and edge distance of each anchor.
    2) Indicate compliance with ACI 318 Chapter 17, or, ACI 350-20 Appendix E.
    3) Type of post-installed anchor system used.
        a) Provide manufacturer's ICC-ES report for the following:
            (1) Mechanical anchorage per ICC-ES AC193.
            (2) Adhesive anchorage per ICC-ES AC308.

4. Samples:
    a. Submit representative Samples of anchorages to concrete, when requested by Contracting Officer. Contracting Officer's approval of Samples will be for type and finish only.

B. Informational Submittals: Submit the following:
1. Shop Drawings and Product Data Approved by Delegated Design Professional:
    a. Submit with delegated design professional's approval stamp those Shop Drawings and product data Submittals indicated in this Article but for which final design was performed by delegated design professional.
2. Calculations by Delegated Design Professional:
    a. Submit sealed and signed calculations for sizing and determining embedment length of anchorages to concrete not fully designed by Contracting Officer's Representative.
    b. Post-Installed Anchors Designed by Delegated Design Professional: In addition, also submit design calculations:
        1) Indicate design load to each anchor.
        2) When design load is not indicated on the Drawings, include calculations to develop anchor forces based on performance and design criteria indicated in this Section.
3. Supplier's Instructions:
    a. Submit manufacturer's published instructions for installation.
4. Field Quality Control Submittals:
    a. Submit written results of required field quality control activities indicated in this Section.
5. Reports of Supplier's Visits to Site:
    a. Submit each written report of visit to the Site by Supplier's factory trained representative and delegated design professional. For each, indicate date and time of visit, purpose of visit, observations made, decisions made, problems encountered, and other pertinent information.
6. Qualifications Statements:
    a. Delegated design professional.
    b. Each installer.

PART 2 - PRODUCTS

A. Product requirements are to conform with the following salient characteristics.

2.2 MATERIALS – ALL ANCHORAGES

A. Materials – General:
1. This Article applies to all anchorages to concrete, regardless of whether fully designed by Contracting Officer Representative or delegated design professional. Requirements for delegated designs are in the following Article.
2. Additional requirements for anchorages fully designed by Contracting Officer Representative are indicated in the Article following requirements for delegated design anchorages.
3. For structural applications, do not use powder actuated fasteners and other types of bolts or fasteners not specified in this Section unless approved by Contracting Officer Representative or otherwise required by the Contract Documents.

B. Description:
   1. Provide anchorages to concrete, of the types shown or indicated, to secure to concrete materials, equipment, and appurtenances installed as part of the Work.
   2. Locations where anchorages are required are generally shown or indicated on the Drawings. Where not shown or indicated on the Drawings provide anchorages or the types required for materials, equipment, and systems where such materials, equipment, and systems are shown on the Drawings.
   3. Anchorages required include those for materials, equipment, and systems shown on the structural Drawings and Drawing other than the structural Drawings.
   4. Design loads for concrete anchorages are shown or indicated on the Drawings for anchorages where design responsibility is delegated to Contractor's delegated design professional. For such anchorages, embedment depths are not shown or indicated.

C. Cast-in-place Concrete Anchors:
   1. Buildings, non-building structures, and equipment, unless otherwise specified:
      a. ASTM F1554, Grade 36 or Grade 55 with weldability supplement S1 for galvanized threaded rods.
      b. ASTM A307, Grade A for galvanized headed bolts.
   2. All other cast-in-place concrete anchors:
      a. Stainless steel with matching nut and washer.
      b. Submerged application: ASTM F593, Type 316, minimum yield strength of 45,000 psi.
      c. Non-submerged application: ASTM F593, Type 304 or Type 316, minimum yield strength of 45,000 psi.

D. Post-Installed Mechanical and Adhesive Concrete Anchors:
   1. Submerged application: ASTM F593, Type 316, minimum yield strength of 45,000 psi with matching nut and washer.
   2. Non-submerged application: ASTM F593, Type 304 or Type 316, minimum yield strength of 45,000 psi with matching nut and washer.
   3. Post-installed anchors and related materials shall be listed by ICC-ES or Contracting Officer Representative-approved equivalent.

E. Reinforcing: Comply with Section 03 21 00 - Reinforcement.

F. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

G. Deformed Bar Anchors: ASTM A496 with minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

H. Washers:
   1. ASTM F436 unless indicated otherwise, finish to match bolt.
   2. When stainless steel anchorage is provided for cast-in-place anchorages, provide washers of the same material and alloy as in the associated anchorage.
   3. Plate washers: Minimum 1/2 inch thick fabricated ASTM A36 square plates as required.
   4. Comply with manufacturer's written instructions for all post-installed anchorages.

I. Nuts:
   1. ASTM A563 for cast-in-place anchorages.
   2. When stainless steel anchorages are provided for cast-in-place anchorages, nuts shall comply with ASTM F594 and shall match material and alloy of the associated anchorage.
   3. Follow manufacturer's requirements if using post-installed anchorage.

J. Galvanizing Repair Paint:
   1. High zinc dust content paint for regalvanizing welds and abrasions.
   2. ASTM A780.
   3. Zinc content: Minimum 92 percent in dry film.
   4. Products and Manufacturers: "ZRC Cold Galvanizing", by ZRC; or "High Performance Zinc Spray", by Clearco; or equal.

K. Dissimilar Materials Protection: Provide separation between dissimilar materials with neoprene sheeting as necessary.

2.3 DELEGATED DESIGN ANCHORAGES TO CONCRETE

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Post-installed anchor systems for indicated manufacturers are acceptable only when a current ICC-ES evaluation report is furnished as a Submittal and the subject anchorage system is approved by a delegated design professional.
   2. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.
   3. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
      a. Hilti.
      b. Or equal.

B. Description: Perform delegated design for anchorages when one or more of the following applies:
   1. Design load for concrete anchorage is shown or indicated on the Drawings and anchorage embedment depth is not shown or indicated.
   2. When specifically required by the Contract Documents.
   3. When an anchorage is necessary but is not shown or indicated on the Drawings.
   4. Anchorages shown on the Drawings other than the structural Drawings.

C. Performance and Design Criteria for Delegated Design Anchorages:
   1. Determine design loads, including wind and seismic loads, in accordance with applicable building code and other Laws and Regulations.
   2. For anchorage of equipment and non-structural components, use actual dead load and operating loads obtained by Contractor or delegated design professional from manufacturer. Design loads shall include operating conditions when equipment or element of the Work is in operation, dynamic loads, and other loads as appropriate or required by the building code or other Laws or Regulations.
   3. Design assuming cracked concrete.

2.4 ANCHORAGES FULLY DESIGNED BY ENGINEER

A. When size, length, and details of anchorage are shown or indicated on the structural Drawings, such anchorages are considered as fully designed by Engineer and delegated design of such anchorage is not required.

B. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

C. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

:

   1. For post-installed anchor systems regardless of whether proposed manufacturer is indicated below, furnish as Submittal current evaluation agency report and anchor system is certified by ICC-ES for cracked concrete conditions.
   2. Mechanical Anchors:

a. Hilti:
    1) Kwik Bolt TZ2 (ICC-ESR-4266).
b. Or equal.

3. Adhesive Anchors for Concrete:
    a. Hilti:
        1) HIT RE 500 V3 (ICC ESR-3814).
        2)
    b. Or equal.
4. Screw Anchors for Concrete:
    a. Hilti:
        1) Kwik HUS-EZ Screw (ICC-ES ESR-3027).
    b. Or equal.
5. Requests, if any, for Contracting Officer's approval of "or-equals" or substitutes shall indicate proposed anchor has at least the same tension and shear strength as the associated anchorage products indicated by name in this Article.
6. Submit requests for substitution in accordance with Specification Section 01 33 23.

PART 3 - EXECUTION

3.1 PREPARATION

A. For cast-in-place concrete anchorages, allow adequate time for proper installation, inspection, and observation prior to placing concrete.

B. Prior to installation, inspect and verify areas and conditions under which concrete anchorages will be installed.
1. Notify Contracting Officer Representative of conditions detrimental to proper and timely completion of the Work.
2. Do not proceed with the Work until unsatisfactory conditions are properly remedied.

3.2 INSTALLATION

A. Installation Requirements - General:
1. Install items in accordance with the Contract Documents, manufacturer's written instructions, and Laws and Regulations. Where such requirements conflict, obtain interpretation or clarification from Contracting Officer's Representative prior to commencing the associated Work.
2. Perform the following unless shown or indicated otherwise:
    a. Provide stainless steel anchorages for connecting aluminum and steel members to concrete and masonry. Provide dissimilar materials protection in accordance with Section 09 96 00 – High-Performance Industrial Coatings.
    b. Provide washers for all anchorages.
    c. Where exposed, extend threaded anchorage a maximum of 0.75 inch and a minimum of 0.5 inch above top of fully-engaged nut. If anchorage is cut off to required maximum height, dress the threads to allow nuts to be removed without damage to nuts.
3. Tightening of nuts: Do the following after nuts are snug-tightened down:
    a. Upset anchorage threads to prevent nuts from backing off. Provide double nut or lock nut in lieu of upset threads for items that may require future removal.
    b. For cast-in-place anchorages (excluding post-installed anchorages), tighten nuts an additional 1/8 turn beyond snug tight to prevent nuts from backing off.
    c. When two nuts are used per concrete anchor above the base plate, tighten top nut an additional 1/8 turn to "lock" the two nuts together.
    d. For post-installed anchorages, comply with MPII.
4. Secure architectural components to avoid aesthetic distortion and to avoid overstressing fasteners from expansion, contraction, or installation.

B. Cast-in-Place Anchorages:

1. Provide where anchor rods or anchor bolts are indicated on the Drawings, unless another anchor type is approved by Contracting Officer's Representative.
2. Provide concrete anchorages as shown on the Drawings or as required to secure the Work to concrete.
3. Tie cast-in-place anchorage in position to embedded reinforcing steel using wire.
4. Tack welding of anchorage is prohibited.
5. Chase threads as required and coat projected portion of carbon steel anchors and nut threads with a heavy coat of clean grease after concrete has cured.
6. Anchorage location Tolerance: in accordance with AISC 303.
7. Provide steel or durable wood templates for all column and equipment anchorages. Place templates above top of concrete; do not impede proper concrete placement and consolidation.

C. Mechanical Anchorages:
1. Use only where specifically indicated on the Drawings or when approved for use by the Contracting Officer's Representative.
2. Do not use where subjected to vibration.
3. May be used in overhead applications.
4. Contact Contracting Officer's Representative for clarification when anchors will not be installed in compliance with the manufacturer's printed installation requirements.

D. Post-installed Anchorages:
1. For post-installed anchors, comply with MPII regarding hole diameter and depth required to fully develop the tensile strength of anchor or reinforcing bar.
2. Use hammer drills to create holes.
3. Properly clean out holes in accordance with the associated ICC-ES report using non-metallic, fiber bristle brush and compressed air, or as otherwise necessary to remove all loose material from each hole prior to installing anchor in the presence of Special Inspector.
4. Adhesive Anchorages:
   a. Provide only where specifically indicated on the Drawings or when approved for use by Contracting Officer's Representative.
   b. May be provided where subjected to vibration or at buried or submerged locations.
   c. Do not install for overhead applications or sustained tension loading conditions such as utility hangers.
   d. Install adhesive anchors in concrete aged not less than 21 days.

E. Finishes:
1. Coat aluminum surfaces in contact with dissimilar materials in accordance with Section 09 96 00 – High-Performance Industrial Coatings.
2. Repair of damaged galvanized surfaces:
   a. Prepare damaged surfaces by abrasive blasting or power sanding.
   b. Repair damaged galvanized surfaces in accordance with ASTM A780.
   c. Apply galvanizing repair paint to not less than 6 mils dry film thickness in accordance with galvanizing repair material manufacturer's instructions and ASTM A780.

F. Ensure that embedded items are protected from damage and are not filled in with concrete or related materials.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
1. Special Inspections: Comply with Section 01 40 00 – Quality Requirements.
2. Comply with Section 03 05 05 - Concrete Testing and Inspection.
3. Tests and inspections of anchorages shall comply with ACI 355.2 and/or ACI 355.4 as applicable.
4. The Contracting Officer reserves the right to inspect and test completed anchorages at a minimum of 25 to 50 percent of provided anchorages.

B. Supplier's services:

1. Post-installed anchor manufacturer's representative shall demonstrate and observe the proper installation procedures for the post-installed anchors.

C. Defective Work:
   1. Anchorages that do not successfully pass required field tests and inspections or that are otherwise deemed defective by the Contracting Officer's Representative shall be remedied, in accordance with the Contract Documents, at no cost to the Contracting Officer.

3.4 CLEANING

A. After concrete has been placed, remove protection and clean all anchorage of all concrete, dirt, and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings when specified in Specification Section 09 96 00.

END OF SECTION

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SECTION 03 21 00
REINFORCEMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Reinforcing bar requirements for concrete construction.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 05 05 - Concrete Testing and Inspection.
   2. Section 03 15 19 - Anchorage to Concrete.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. SP 66, ACI Detailing Manual.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 315, Manual of Standard Practice for Detailing Reinforced Concrete Structures.
      d. 318, Building Code Requirements for Structural Concrete.
      e. 350, Code Requirements for Environmental Engineering Concrete Structures.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A276, Standard Specification for Stainless Steel Bars and Shapes.
      c. A615, Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
      d. A706, Standard Specification for Low-Alloy Steel Deformed and Plain Bars for Concrete Reinforcement.
      e. A970, Standard Specification for Headed Steel Bars for Concrete Reinforcement.
      f. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
   3. Concrete Reinforcing Steel Institute (CRSI):
      a. Manual of Standard Practice.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Mill certificates for all reinforcing.
      d. Manufacturer and type of proprietary reinforcing mechanical splices.
   2. Qualifications of welding operators, welding processes and procedures.
   3. Reinforcing number, sizes, spacing, dimensions, configurations, locations, mark numbers, lap splice lengths and locations, concrete cover and reinforcing supports.
   4. Sufficient reinforcing details to permit installation of reinforcing.
   5. Reinforcing details in accordance with ACI SP 66 and ACI 315.
   6. Locations where proprietary reinforcing mechanical splices are required or proposed for use.
   7. Shop Drawings shall be in sufficient detail to permit installation of reinforcing without reference to Contract Drawings.
      a. Shop Drawings shall not be prepared by reproducing the plans and details indicated on the Contract Drawings but shall consist of completely redrawn plans and details as necessary to indicate complete fabrication and installation of all reinforcing steel.

b. Where multiple types of supports for reinforcing steel (such as chairs, runners, bolsters, and other types of supports) will be used in the Work, clearly indicate on the Shop Drawings the support types and materials of supports.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Support and store all reinforcing above ground.

B. Ship to jobsite with attached plastic or metal tags with permanent mark numbers which match the Shop Drawing mark numbers.

PART 2 - PRODUCTS

2.1 MANUFACTURES

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Reinforcing adhesive anchors:
      a. See Specification Section 03 15 19.
   2. Reinforcing mechanical splices:
      a. Lenton Rebar Splicing by Erico, Inc.
      b. Or Equal.
   3. Submit requests for substitution in accordance with Specification Section 01 33 23.

2.2 MATERIALS

A. Reinforcing Bars: ASTM A615, grade 60, deformed.

B. Reinforcing Bars to be Welded: ASTM A706, Grade 60, deformed.

C. Welded Wire Reinforcement: ASTM A1064.

D. Smooth Dowel Bars:
   1. Water containing structures: ASTM A276, Type 316.
   2. All other locations: ASTM A36, with metal end cap to allow longitudinal movement equal to joint width plus 1 inch.

E. Proprietary Reinforcing Mechanical Splices: To develop in tension and compression a minimum of 125% of the yield strength of the reinforcing bars being spliced.

F. Headed Deformed Bars:
   1. ASTM A970, Class A.

G. Reinforcing Adhesive Anchors:
   1. See Specification 03 15 19.

2.3 ACCESSORIES

A. Chairs, Runners, Bolsters, Spacers, Hangers, and Other Reinforcing Supports:
   1. Metal fabrications with plastic-coated tips in contact with forms.
      a. Plastic coating meeting requirements of CRSI Manual of Standard Practice.
   2. All plastic construction meeting the requirements of CRSI Manual of Standard Practice.
      a. 100% non-metallic, non-corrosive.

b. Required for all walls and elevated construction exposed to liquid containing structures.

B. Protective plastic caps at mechanical splices.

2.4 FABRICATION

A. Tolerances:
1. Conforms to ACI 117, expect as modified herein.
2. Sheared lengths: +1 inches.
3. Overall dimensions of stirrups, ties and spirals: +1/2 inches.
4. All other bends: +0 inches, -1/2 inches.

B. Minimum diameter of bends measured on the inside of the reinforcing bar to be as indicated in ACI 318 Paragraph 7.2.

C. Ship reinforcing to jobsite with attached plastic or metal tags.
1. Place on each tag the mark number of the reinforcing corresponding to the mark number indicated on the Shop Drawing.
2. Mark numbers on tags to be so placed that the numbers cannot be removed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Tolerances:
1. Conform to ACI 117, except as modified herein.
2. Reinforcing placement:
a. Clear distance to formed surfaces: +1/4 inches.
b. Minimum spacing between bars: -1/4 inches.
c. Top bars in slabs and beams:
1) Members 8 inches deep or less: +1/4 inches.
2) Members between 8 inches and 2 feet deep: -1/4 inches, +1/2 inches.
3) Members more than 2 feet deep: -1/4 inches, +1 inches.
d. Crosswise of members: Spaced evenly within +1 inches.
e. Lengthwise of members: +2 inches.
3. Minimum clear distances between reinforcing bars:
a. Beams, walls and slabs: Distance equal to bar diameter or 1 inch, whichever is greater.
b. Columns: Distance equal to 1-1/2 times the bar diameter or 1-1/2 inches, whichever is greater.
c. Beam and slab reinforcing shall be threaded through the column vertical rebars without displacing the column vertical bars and still maintaining the clear distances required for the beam and slab reinforcing bars.

B. Minimum concrete protective covering for reinforcement: As shown on Drawings.

C. Unless indicated otherwise on Drawings, provide splice lengths for reinforcing as follows:
1. For reinforcing: As indicated on the Drawings.
2. For welded wire reinforcement:
a. Splice lap length measured between outermost cross wires of each fabric sheet shall not be less than one spacing of cross wires plus 2 inches, nor less than 1.5 x development length nor less than 6 inches.
b. Development length shall be as required for the yield strength of the welded wire reinforcement in accordance with ACI 318 and ACI 350.
3. Provide splices of reinforcing not specifically indicated or specified subject to approval of Contracting Officer's Representative.
a. Mechanical proprietary splice connectors may only be used when approved or indicated on the Contract Drawings.

D. Welding:
1. Welding reinforcing is not permitted.

E. Placing Reinforcing:
1. Assure that reinforcement at time concrete is placed is free of mud, oil or other materials that may affect or reduce bond.
2. Reinforcement with rust, mill scale or a combination of both will be accepted as being satisfactory without cleaning or brushing provided dimensions and weights including heights of deformations on a cleaned sample is not less than required by applicable ASTM specification that governs for the reinforcing supplied.
3. Reinforcing support:
   a. Uncoated reinforcing:
      1) Support reinforcing and fasten together to prevent displacement by construction operations.
         a) Locate and support reinforcement with bar supports to maintain minimum concrete cover.
         b) Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
         c) Reinforcement shown on the Contract Documents may not be repositioned for use a support for reinforcement. Additional drop bars may be provided for support of reinforcing,
      2) Reinforcing supported on ground:
         a) Slab on grade and other members with only one mat of reinforcing:
            (1) Provide metal bar supports with bottom plate.
            (2) Do not use concrete blocks to support slab-on-grade reinforcing.
         b) All other members: Provide supporting concrete blocks or metal bar supports with bottom plate.
      3) Reinforcing supported on formwork:
         a) Concrete surfaces in contact with or over process liquid: All-Plastic chairs, runners and bar supports.
         b) All other formed surfaces:
            (1) Provide plastic-coated metal chairs, runners, bolsters, spacers, hangers and other reinforcing support.
            (2) Only tips in contact with the forms need to be plastic coated.
4. Support reinforcing over cardboard void forms by means of concrete supports which will not puncture or damage the void forms during construction nor impair the strength of the concrete members in any way.
5. Where parallel horizontal reinforcement in beams is indicated to be placed in two or more layers, bars in the upper layers shall be placed directly above bars in the bottom layer with clear distance between layers to be 1 inch.
   a. Place spacer bars at 3 feet maximum centers to maintain the required 1 inch clear distance between layers.
6. Extend reinforcement to within 2 inches of concrete perimeter edges.
   a. If perimeter edge is formed by earth, extend reinforcement to within 3 inches of the edge.
7. To assure proper placement, furnish templates for all column vertical bars and dowels.
8. Do not bend reinforcement after embedding in hardened concrete unless approved by Contracting Officer's Representative.
   a. Do not bend reinforcing by means of heat.
9. Do not tack weld reinforcing.
10. Embed reinforcing into hardened concrete utilizing adhesive anchor system specifically manufactured for such installation:
    a. See Specification Section 03 15 19.

3.2 FIELD QUALITY CONTROL

A. Reinforcement Congestion and Interferences:
1. Notify Contracting Officer's Representative whenever the specified clearances between bars cannot be met.

2. Do not place any concrete until the Contracting Officer's Representative submits a solution to reinforcing congestion problem.
3. Reinforcing may be moved as necessary to avoid interference with other reinforcing steel, conduits, or embedded items.
4. If bars are moved more than one bar diameter, obtain Contracting Officer's Representative's approval of resulting arrangement of reinforcing.
5. No cutting of reinforcing shall be done without written approval of the Contracting Officer.

B. Special Inspection:
1. See Section 01 40 00.
2. See Section 03 05 05.

END OF SECTION

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SECTION 03 31 30
CONCRETE MATERIALS AND PROPORTIONING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Requirements for concrete materials, including:
   a. Materials, including various types of grout, admixtures, cement, sand, aggregate, and other materials.
   b. Concrete strength and proportioning, including design mixes for:
      1) Normal weight concrete.
      2) Flowable fill (Controlled low strength material).
      3) Grout.

B. Scope:
1. Unless shown or indicated otherwise in the Contract Documents, concrete Work shall comply with:
   a. ACI 301.
   b. Laws and Regulations, including applicable building code.
2. In this Section, material is apportioned into the following grouting types:
   a. Base plates for columns and equipment.
   b. As otherwise shown or indicated in the Contract Documents.
3. This Section addresses materials for concrete. Other Specifications sections present other requirements for complete concrete Work, including, but not necessarily limited to:
   a. Section 03 05 05 - Concrete Testing and Inspection.
   b. Section 03 11 13 - Formwork.
   c. Section 03 21 00 - Reinforcement.
   d. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
   e. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   f. Others as indicated in the Contract Documents.

C. Related Requirements: Include but are not necessarily limited to:
1. Section 03 05 05 - Concrete Testing and Inspection.
2. Section 03 15 19 - Anchorage to Concrete.
3. Section 03 21 00 - Reinforcement.
4. Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
5. Section 03 41 33 - Precast and Prestressed Concrete.

1.2 REFERENCES

A. Abbreviations and Terminology:
1. Abbreviations: The following abbreviations are used in this Section:
   a. “AAR” means deleterious “alkali-aggregate reaction”, resulting from either alkali-silica reactive (ASR) or alkali-carbonate reactive (ACR) aggregates.
   b. “SCM” means “supplementary cementitious materials”, with the meaning indicated below.
   c. “CLSM” means controlled low strength material in accordance with requirements of this Section.
2. Terminology: Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Section have the meanings indicated below:
   a. “Supplementary cementitious materials” (SCM) means fly ash, silica fume, and GGBFS.
   b. “Water-bearing concrete” is concrete surface to be in contact (whether continuously or intermittently) with water, process liquid, or slurries during intended operation of the

facility, including, but not limited to, concrete tanks, channels, wet wells, distribution chambers, and secondary containment structures.

c. Independent Laboratory:
   1) Testing shall be performed by an independent laboratory complying with requirements of the generally recognized accrediting entity for the jurisdiction where the Site is located.
   2) Testing laboratory shall obtain all concrete samples and waterproofing product samples from the manufacturer of the associated product or material.

B. Reference Standards:
1. American Concrete Institute (ACI):
   a. CT-13, Concrete Terminology.
   b. 117, Specification for Tolerances for Concrete Construction and Materials.
   c. 211.1, Standard Practice for Selecting Proportions for Normal, Heavyweight, and Mass Concrete.
   d. 212.3R, Chemical Admixtures for Concrete.
   e. 232.2R, Use of Fly Ash in Concrete.
   f. 301, Specifications for Structural Concrete for Buildings.
   g. 318, Building Code Requirements for Structural Concrete.
   h. 350, Code Requirements for Environmental Engineering Concrete Structures.
2. ASTM International (ASTM):
   a. C33, Standard Specification for Concrete Aggregates.
   b. C39, Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   c. C94/C94M, Standard Specification for Ready-Mixed Concrete.
   d. C125, Terminology Relating to Concrete and Concrete Aggregates.
   e. C150, Standard Specification for Portland Cement.
   f. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement, Mortar, and Concrete.
   g. C192, Standard Practice for Making and Curing Concrete Test Specimens in the Laboratory.
   h. C260, Standard Specification for Air-Entraining Admixtures for Concrete.
   i. C494, Standard Specification for Chemical Admixtures for Concrete.
   j. C595, Standard Specification for Blended Hydraulic Cements.
   k. C618, Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete.
   l. C1107, Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Non-shrink).
   m. C1116, Standard Specification for Fiber-Reinforced Concrete.
   n. C1399, Standard Test Method for Obtaining Average Residual-Strength of Fiber-Reinforced Concrete.
   o. C1609, Standard Test Method for Flexural Performance of Fiber-Reinforced Concrete (Using Beam With Third-Point Loading).
   p. C1602, Standard Specification for Mixing Water Used in the Production of Hydraulic Cement Concrete.
   q. C1778, Standard Guide for Reducing Risk of Deleterious Alkali-Aggregate Reaction in Concrete.
3. State of Arizona Department of Transportation (ADOT):
   a. Standard Specification for Road and Bridge Construction.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
   a. Schedule (table) of concrete materials proposed, listed by each specified grouping of concrete Work, including, but not limited to, aggregates, sand, cement (by type), SCM,

admixtures, synthetic fibers, grouts, and other materials. For each separate material and product, indicate the manufacturer and type of material.

b. Mix Designs:
   1) Proposed mix design for each concrete grouping required. For each, indicate concrete designation (type) indicated in the Contract Documents, proposed materials and proportioning, and intended special uses, such as concrete intended for placement in cold weather or warm weather, concrete to be placed by pumping, concrete intended for specific locations in the Work, and others.
   2) Contracting Officer's approval of mix design Shop Drawing is only for limited purposes indicated in the Contract Documents, including the General Conditions, and in no way reduces or mitigates Contractor's responsibility for construction means, methods, techniques, procedures, and sequences.

2. Product Data:
   a. Written affidavit stating materials proposed comply with requirements of reference standards indicated in this Section and, where applicable, compliance with Arizona Department of Transportation standard specifications for highway and bridge construction in the jurisdiction of the Site. Clearly indicate specific reference standards applicable to each specific material.
   b. For aggregate and sand, indicate source (quarry) and gradation of materials proposed for use. Indicate the specific concrete mix design(s) proposed for each.
   c. For cement and SCM, indicate material source and submit manufacturer's technical data (except safety data sheets).
   d. For each proposed admixture and type of grout material (including non-shrink grouts, epoxy grout, and grout cure/seal compound), submit manufacturer's published technical data (except safety data sheets).

B. Informational Submittals: Submit the following:
1. Certifications: Submit concurrent with, but separate from, associated Shop Drawings and product data Submittals:
   a. Certification of standard deviation, in units of pounds per square inch, for ready mix plant furnishing concrete.
   b. SCM: Certification that SCM complies with quality requirements of this Section, and SCM Supplier's certified test reports of SCM delivered to concrete Supplier.
   c. ASTM C33: Certification that class of coarse aggregate complies with ASTM C33 for type and location of concrete Work.
   d. Aggregate:
      1) Certification of aggregate gradation.
      2) Certification of coarse aggregate impurities relative to alkali-aggregate reactivity in accordance with ASTM C1778.
   e. Certification of shrinkage test results.
2. Test Reports:
   a. Cement and SCM mill certificates for all materials to be supplied.
   b. Test results for AAR impurities of coarse aggregates within proposed mixes, in accordance with ASTM standards cited in this Section.
3. Supplier's Instructions: Submit concurrent with, but separate from, associated product data Submittals:
   a. Manufacturer's written instructions on proper storage, handling, mixing, and use of materials furnished.

1.4 DELIVERY, STORAGE AND HANDLING

A. Storage of Materials:
1. Admixtures:
   a. Store admixtures in manner that avoids contamination, evaporation, and damage.
   b. For admixtures used in form of suspensions or non-stable solutions, perform agitating as recommended by manufacturer to ensure uniform distribution of ingredients.

c. Protect liquid admixtures from freezing and temperature changes that adversely affect admixture characteristics and performance.

2. Cement and SCM:
   a. Store cement and SCM in containers in weathertight space that prevent contamination with moisture and other contaminants.
3. Aggregates:
   a. Store and access aggregates in manner avoiding excessive segregation and preventing contamination with other materials and other sizes of like aggregate.
   b. Do not use frozen or partially frozen aggregate.
4. Sand: Allow natural sand to drain until sand has relatively uniform moisture content, prior to use.
5. If stockpiled materials contact the ground, unless such materials are stored on a clean, firm, reasonably impervious surface such as concrete or asphalt paving, do not use in the concrete Work bottom six inches of stockpiled materials.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Cement:
   1. Provide ASTM C150 Type I/II cement or ASTM C595 Type IL, unless otherwise required by the Contract Documents.

B. SCM:
   1. Fly Ash:
      a. ASTM C618, Class F .
      b. Non-staining.
      c. Appropriate for providing hardened concrete of uniform, light-gray color.
      d. Compatible with all other concrete ingredients. Fly ash shall have no deleterious effect on hardened concrete Work.
      e. Produced by source approved, by the Arizona Department of Transportation for use in concrete for highway bridges.
      f. Evaluate and use in accordance with ACI 232.2R.
   2. SCM type used shall match SCM type used in associated approved mix design.

C. Admixtures:
   1. Admixtures – General:
      a. Provide admixtures of same type, manufacturer and quantity as used in establishing required concrete proportions in mix design approved by Contracting Officer.
      b. Provide admixtures certified by manufacturers as compatible with other admixtures proposed.
   2. Air Entraining Admixtures: Comply with ASTM C260.
   3. Water Reducing Admixtures:
      a. Provide water-reducing admixtures in all concrete mixes to provide and maintain required water-to-cement ratio without additional cement.
      b. Water Reducing, Retarding and Accelerating: Comply with ASTM C494 Types A through E, and ACI 212.3R.
      c. High Range Water Reducers (Superplasticizers):
         1) Required for pumped concrete.
         2) Comply with ASTM C494 Types F and G.
   4. Hydration Stabilizer:
      a. Comply with ASTM C494 Type D.
   5. Admixture Chlorides – General:
      a. Provide chloride-free admixtures.
      b. Do not use calcium chloride.

D. Macro Synthetic Fibers:

1. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
    a. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.
    b. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.
2. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    a. Master Builders Solutions, MasterFiber MAC Series.
    b. GCP Applied Technologies, Strux 90/40.
    c. Euclid Chemical Company, Tuf-Strand SF.
    d. Or equal.
3. Manufacturers and Products: Subject to compliance with the Contract documents, the following are acceptable:
    a. Master Builders Solutions, MasterFiber, MAC Series.
    b. Or equal
4. Comply with ASTM C1116.
5. Provide dosage to obtain average residual strength (at net deflection of L/150) of not less than 170 psi, in accordance with ASTM C1609 and ASTM C1399.
6. Submit requests for substitution in accordance with Specification Section 01 33 23.

E. Water:
1. Potable in accordance with Laws and Regulations.
2. Clean and free from deleterious substances.
3. Free of oils, acids, and organic matter. Comply with ASTM C1602.

F. Aggregates for Normal Weight Concrete:
1. Comply with ASTM C33.
2. Fine aggregates and coarse aggregates are separate ingredients.
3. Coarse Aggregate:
    a. Material shall be well-graded, washed aggregate, free of organic material, of the Arizona Department of Transportation.
    b. Gradation: In accordance with Table 03 31 30-A in this section's "Mixes" Article.
4. Alkali-Reactive Aggregates:
    a. Aggregates that may be deleteriously reactive, when combined with alkalis in cement, are unacceptable.
    b. Evaluate proposed aggregates for potential deleterious alkali-aggregate reaction in concrete in accordance with ASTM C1778.
        1) Submit to Contracting Officer results of source quality control testing for alkali-aggregate reactivity presenting the following:
            a) Analysis and classification of aggregates in accordance with ASTM C1778
            b) Results of source quality control analysis of aggregates.
            c) Include the flow from Figure 1 of ASTM C 1778 indicating test results sequence.
            d) Field performance history alone shall not be submitted to document acceptable aggregate performance.
            e) Size and exposure condition of the Work in Table 2 of ASTM C 1778: dry.
            f) Structure class for use in Table 3 of ASTM C1778: Class SC3.

G. Maximum total water-soluble chloride ion content for concrete mix including all ingredients measured as weight percent of cement in accordance with ASTM C1218:
1. Prestressed concrete: 0.06.
2. All other concrete: 0.10.

H. Non-shrink Grout:
   1. Manufacturers and Products: Subject to compliance with the contract Documents, the following are acceptable:
      a. Master Builders Solutions, Masterflow, 713.
      b. Euclid Chemical Company, NS Grout.
      c. Sika, Sika Grout 212.
      d. Or equal.
   2. Description:
      a. This provision requires non-shrink, non-metallic grout. Unless otherwise shown or indicated in the Contract Documents, references to "non-shrink grout" refer to non-shrink, non-metallic grout required by this provision.
   3. Performance Criteria:
      a. Non-shrink grout shall produce a positive but controlled expansion.
      b. Mass expansion shall not be created by gas liberation or by other means.
      c. Minimum 28-day Compressive Strength: 7,000 PSI.
   4. Material:
      a. Provide material that is non-shrink, non-metallic, non-corrosive, and non-staining.
      b. Comply with ASTM C1107, Grade B.
      c. Premixed with water only. Add water in accordance with manufacturer's written instructions.

I. Epoxy Grout:
   1. Manufacturers and Products: Subject to compliance with the Contract Documents, the following are acceptable:
      a. Master Builders Solutions, Masterflow 648.
      b. Five Star Products, DP Five Start Epoxy Grout.
      c. Euclid Chemical Company, E3 Flowable.
      d. Sika, Sikadur 42, Grout Pak.
      e. Or equal.
      f. One manufacturer shall furnish both aggregate and adhesive.
   2. Description:
      a. Three-component epoxy resin system, comprised of two liquid epoxy components and one inert aggregate filler component.
      b. Indication of locations where epoxy grout is required are indicated in the grout schedule in Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing.
      c. Furnish each component in separate package for mixing at the Site.
   3. Performance Criteria:
      a. Minimum 28-day Compressive Strength: 13,000 psi.
   4. Materials:
      a. Aggregate shall be compatible with adhesive.

2.2 MIXES

A. Mixes - General:
   1. Provide concrete capable of: (a) being placed without segregation of aggregate from other components, and (b) developing all properties necessary and required.
   2. Provide ready-mix concrete in accordance with ASTM C94/C94M.
   3. Batching and other tolerances shall be in accordance with ACI 117.
   4. All concrete shall be normal weight concrete, unless otherwise required by the Contract Documents. Normal weight concrete shall weigh approximately 145 to 150 pounds per cubic foot (without reinforcing steel), measured 28 days after placing.

B. Concrete Mixes:
   1. Mix design requirements are indicated in this Section's Table 03 31 30-A, below.

C. Air Entrainment:
   1. Provide air entrainment in concrete providing total air content, expressed as percent by volume, in accordance with this Section's Table 03 31 30-A, below.

2. Adjust dosage rate as necessary to compensate for shrinkage reducing admixtures and concrete placing method.

D. Slump:
   1. Slump – General:
      a. Measure slump at point of discharge of wet concrete into final location.
      b. Compensate for slump loss due to placing method.
      c. Concrete with slump less than minimum required may be used provided such concrete can be properly placed and consolidated.
      d. Slump of Concrete to be Placed by Pumping:
         1) Provide water or water-reducing admixture at ready-mix plant for concrete to be placed by pumping, to allow for slump loss due to pumping.
         2) Provide additional water sufficient only so that slump of concrete at discharge end of pump hose does not exceed: (a) maximum allowable slump indicated, and (b) maximum specified water-to-cement ratio.
      e. Slump Adjustment at the Site:
         1) Slump may be adjusted at the Site by providing water reducers.
         2) Dosing shall be performed by experienced quality control technician employed by concrete Supplier. Concrete mixing thereafter shall be directed by the same technician.
      f. Slump tolerances shall comply with ACI 117.
   2. Concrete for Walls and Columns:
      a. 8 inches maximum; 4 inches minimum.
      b. Slump shall be obtained by use of mid-range or high-range water reducer complying with ASTM C494.
   3. All Other Members:
      a. Concrete using water reducer in accordance with ASTM C494: 8 inches maximum; 4 inches minimum.
      b. Concrete without water reducer in accordance with ASTM C494: 5 inches maximum, one inch minimum.

E. Proportioning:
   1. Proportioning - General:
      a. Proportion components of concrete to provide mixture that can be placed: (a) into corners and angles of forms, and around reinforcing, by placing and consolidation methods employed, (b) without component materials becoming segregated, and (c) without excessive, free water to collecting on concrete surface or other surfaces.
      b. Proportion component elements of concrete to provide proper concrete Work, including concrete durability, strength, and other necessary and required properties.
   2. Normal Weight Concrete:
      a. Normal weight concrete target cementitious materials contents and maximum water to-cementitious ratios shall be in accordance with this Section's Table 03 31 30-A, below.
      b. Target cementitious materials contents indicated in the Contract Documents are intended to provide crack-free, durable, finished concrete Work, rather than concrete Work of excessive strength.
   3. SCM:
      a. SCM – General:
         1) Based on results of AAR testing by Supplier (performed in accordance with ASTM C1778) and alkali content of cement, SCM content (in accordance with this Section) may be adjusted in lieu of the indicated percentages to reduce risk associated with AAR.
         2) Use only one type of SCM in a given mix unless expressly required or approved by Contracting Officer.
         3) Water-to-cementitious (i.e, total of SCM plus cement) ratio shall not exceed required maximum water-to-cement ratio indicated in this Section.
      b. Fly Ash:

1) For cast-in-place concrete only, maximum of 25 percent by weight of Portland cement content, per cubic yard, may be fly ash, at rate of one pound fly ash for one pound cement.
2) For the chlorine handling tank only, a minimum of 15 percent by weight of Portland cement content, per cubit yard, may be fly ash, at a rate of one pound fly ash for one pound cement.
3) Do not use fly ash in concrete required in Section 03 41 33 - Precast and Prestressed Concrete, and.

4. Water-Reducing, Water-Retarding, and Water-Accelerating Admixtures:
   a. Provide in accordance with admixture manufacturer's written instructions.
   b. Add to mix at ready-mix plant.
   c. Use hydration stabilizer admixture, or AAR-inhibiting admixture, in concrete, as necessary and required, for placing and workability.
      1) Water reducers are required to maintain required maximum water-to-cement ratios.
5. High Range Water Reducers (Superplasticizers):
   a. Superplasticizers are required in:
      1) Concrete to be pumped, except slabs-on-grade and mats.
      2) Concrete for water-bearing structures.
      3) Other concrete Work at Contractor's option.
   b. Maximum concrete slump, before addition of admixture, shall be three inches. Maximum slump after addition of superplasticizer admixture shall be eight inches.
   c. Comply with Section 03 31 31 - Concrete Mixing, Placing, Jointing, and Curing, relative to superplasticizers.
6. Macro Synthetic Fibers:
   a. Uniformly disperse synthetic fibers into concrete mixtures. Provide synthetic fibers in mixer at ready-mix plant.
   b. Required Locations: Provide macro synthetic fibers in the following concrete Work:
      1) Water bearing concrete structures.
      2) Concrete so shown or indicated on the Drawings.
   c. Required Dosage:
      1) Determined by Contractor and concrete Supplier as necessary to comply with concrete's required minimum average residual strength.
      2) Provide in accordance with ASTM C1399 and ASTM C1609.
      3) Under no circumstances shall dosage of macro synthetic fibers be less than:
         a) Four pounds per cubic yard when used in concrete slabs on metal decking, in accordance with SDI 31.
         b) Three pounds per cubic yard for all other locations where such fibers are required or used.
7. Normal Weight Concrete Mix Proportioning:
   a. Method 1:
      1) Use Method 1 when combination of concrete component materials and mixes will be evaluated and selected via trial-and-error.
      2) Provide mixes with suitable proportions and properties in accordance with ACI 211.1, using not less than three different water-to-cementitious ratios providing a range of concrete compressive strengths, including required average compressive strength.
      3) Trial mixes shall have slump within 0.75 inches of maximum allowed in the Contract Documents. For air-entrained concrete, air content of trial batches shall be within 0.5 percent of air entrainment required by the Contract Documents.
      4) For each water-to-cementitious ratio:
         a) Provide not less than three trial compressive strength tests for concrete test age required, and cure in accordance with ASTM C192.
         b) Cylinder Size: In accordance with ASTM C31.
         c) Test for compressive strength at 28 days, in accordance with ASTM C39.

(1) Quantity of cylinders shall comply with one of the following trial strength test:
(a) 6-inch diameter cylinders: Two.
(b) 4-inch diameter cylinders: Three.

5) From results of such required tests, plot curve showing relationship between water-to-cementitious ratio and compressive strength.
6) Based on required curve, select water-to-cementitious ratio for the Work, that will provide concrete of required average compressive strength.
7) Provide cementitious content and mixture proportions so maximum water cement ratio is not exceeded when slump is equal to maximum allowed in the Contract Documents.
8) Required average compressive strength is indicated below in this Section.

b. Method 2:
1) In lieu of trial mixes required by Method 1, field test results from prior projects, for concrete made using identical or substantively identical concrete component materials and proportioning, may be used by concrete supplier in determining proposed mix proportions, provided the test results are within a year of project start date.
2) Use of proposed concrete mix proportions based on field test results from prior projects are subject to approval by Contracting Officer. Contracting Officer's decision will be based on information in such Submittals and demonstrated ability, of such concrete successfully provided on such prior projects, to provide required average compressive strength.
3) Requirements for Submittals of Concrete Test Results from Prior Projects:
a) Submittals of field test results from prior projects shall clearly indicate all materials, proportions, and conditions, and clearly indicate where such matters are similar to those required for the concrete Work on the Project.
b) Changes in the materials, proportions, and conditions within submitted test results from prior projects shall have been not more restricted than those for the subject, proposed concrete mix.
c) Field test reports from prior projects shall be in accordance with ACI 350].
4) Concrete proportions for the concrete Work may be determined from test results of prior projects via interpolation (by Contractor and concrete Supplier) between compressive strengths and proportions of two or more test results from prior projects, each in accordance with requirements of the Contract Documents for this Project.

8. Required average compressive strength shall exceed required 28-day compressive strength by the extent determined in accordance with ACI 350, Chapter 5 using the standard deviation of concrete ready-mix plant proposed for the Work as described in ACI 350, Chapter 5.

F. Flowable Fill or Controlled Low Strength Material (CLSM):
1. CLSM and Flowable fill are interchangeable.
2. Provide mixture of cement, SCM, fine sand, water, and air, with consistency allowing flow under a very low pressure (low head).
3. Approximate quantities of each component per cubic yard of mixed material:
a. Cement (Type I or Type II): 50 pounds.
b. SCM: 200 pounds.
c. Fine Sand: 2,700 pounds.
d. Water (approximate): 420 pounds.
e. Air Content (approximate): 10 percent.
4. Adjust actual quantities to provide yield of one cubic yard with materials used.
5. Approximate compressive strength shall be 85 to 175 psi.
6. Sand Gradation: Fine sand shall be evenly graded material with not less than 95 percent passing No. 4 sieve and not more than five percent passing No. 200 sieve.

G. Allowable Shrinkage:
   1. Provide in accordance with Table 03 31 30-A of this Section, tested in accordance with ASTM C157 at 28 days.
   2. Continue testing for 64 weeks in accordance with ASTM C157 and submit results to Contracting Officer as Informational Submittals.
   3. Perform for concrete Work for all water bearing or basement structures unless expressly indicated otherwise in the Contract Documents.

TABLE 03 31 30-A							
Type of Concrete	28-day Compressive Strength	Max. W/C Ratio	Target Total Cement (pounds)	SCM	ASTM C33 Size No.	Air Content (%)	Allowable Shrinkage Limit
Normal weight concrete fill utility encasement concrete	4500 PSI	0.50	517	Note 1	57	4.5 to 7.5	NA
Normal weight precast concrete	5000 PSI	0.42	611		57	4.5 to 7.5	NA
Normal weight all other concrete	4500 PSI	0.45	564	Note 1	57	4.5 to 7.5	0.048 percent

Table 03 31 30-A Notes:

1. If fly ash is proposed for use, the weight of fly ash plus weight of Portland cement shall be used to comply with total target cement content.
2. Unless otherwise indicated, larger aggregate (No. 467) is required for concrete slabs or foundations on grade; optional elsewhere
3. Red dye shall be used in buried utility encasements for duct banks.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. Field Testing and Inspections:
   1. Code-Required Tests and Special Inspections:
      a. Section 01 40 00 - Quality Requirememts, indicates testing scope for code-required testing and special inspections by testing entity retained by Contracting Officer or entity for whom Government is responsible.
      b. Section 03 05 05 - Concrete Testing and Inspection, indicates required testing for concrete Work.
   2. Contractor-Performed Field Testing and Inspections:
      a. Where concrete testing and inspection is required by the Contract Documents and is not part of the code-required tests and special inspections by Contracting Officer or other entity for whom Government is responsible, such tests and inspections shall be by Contractor.
      b. Perform concrete testing and inspections in accordance with Section 03 05 05 - Concrete Testing and Inspection.
      c. Aggregates and Other Stockpiled Materials: To ensure stockpiles at the concrete mixing location are not contaminated and otherwise comply with Contract requirements, perform tests on such materials at the concrete ready-mix plant.
      d. Perform strength test on all concrete to which water or superplasticizer, above the amount stated in concrete mix design Submittal approved by Contracting Officer, has been added.
         1) Perform sampling after water or superplasticizer has been added and additional mixing has been performed.

END OF SECTION

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SECTION 03 31 31
CONCRETE MIXING, PLACING, JOINTING, AND CURING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Mixing, placing, jointing, and curing of concrete construction.

B. Related Requirements: Include but are not necessarily limited to:
   1. Section 03 05 05 - Concrete Testing and Inspection.
   2. Section 03 11 13 - Formwork.
   3. Section 03 21 00 - Reinforcement.
   4. Section 03 31 30 - Concrete, Materials and Proportioning.
   5. Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.
   6. Section 07 92 00 - Joint Sealants.

1.2 REFERENCES

A. Terminology:
   1. Terminology: Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this Section have the meanings indicated below:
      a. Unless obviously meant or intended otherwise, certain words and terms used in this Section have meanings indicated in ACI CT-13.
      b. "Water-bearing concrete" means concrete surface to be in contact (whether continuously or intermittently) with water, process liquid, or slurries during intended operation of the facility, including, but not limited to, concrete tanks, channels, wet wells, distribution chambers, and secondary containment structures.

B. Reference Standards: Standards referenced in this Section include, but are not necessarily limited to, the following:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
      d. 304.2R, Placing Concrete by Pumping Methods.
      e. 305R, Guide to Hot Weather Concreting.
      f. 305.1, Specification for Hot Weather Concreting.
      g. 306R, Guide to Cold Weather Concreting.
      h. 306.1, Standard Specification for Cold Weather Concreting.
      i. 308.1, Specification for Curing Concrete.
      j. 309R, Guide for Consolidation of Concrete.
      k. 318, Building Code Requirements for Structural Concrete and Commentary.
      l. 350, Code Requirements for Environmental Engineering Concrete Structures.
      m. 360R, Guide to Design of Slabs-on-Ground.
   2. ASTM International (ASTM):
      a. C94/C94M, Standard Specification for Ready-Mixed Concrete.
      b. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      c. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
      d. D994, Standard Specification for Preformed Expansion Joint Filler for Concrete (Bituminous Type).
      e. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.

f. D1751, Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types).

3. National Ready Mixed Concrete Association (NRMCA):
   a. Checklist for Certification of Ready Mixed Concrete Production Facilities.
4. United States Army Corps of Engineers (USACE):
   a. CRD-C572, Specifications for Polyvinylchloride Waterstop.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordinate concrete placement Work with other Work, and work of other contractors (if any), that must be installed prior to placement of concrete.
   2. Inform other contractors, if any, affected by the concrete Work of intended date(s) of placement of concrete. Provide sufficient advance notice to allow other contractors to perform their work that is to be completed prior to placing of concrete.

B. Pre-Installation Conference:
   1. A meeting to review the detailed requirements of the Contractor's proposed concrete design mixes, to determine the procedures for producing proper concrete construction, and to clarify the roles of the parties involved shall be held no later than 30 days after Notice to Proceed.
      a. Schedule the meeting to occur no later than five days in advance of the first scheduled date of concrete placement.
   2. All parties involved in the concrete work shall attend the conference, including: Required Participants:
      a. Contractor's Representative
      b. Testing laboratory representative/inspectors.
      c. Concrete subcontractor.
      d. Reinforcing steel installer.
      e. Reinforcing steel detailer.
      f. Concrete supplier.
      g. Admixture manufacturer's representative.
      h. Contracting Officer.
      i. Contracting Officer's representative.
      j. Building Code Official.
   3. The conference shall be held at a mutually agreed upon time and location.
   4. Participants shall be prepared to discuss the topics indicated below, and shall be empowered by their employer to make binding decisions concerning the conference topics:
      a. Designation of responsible personnel.
      b. Schedule for concrete Work and subsequent Work.
      c. Status of other construction requiring coordination with subject concrete Work.
      d. Status of required Submittals for concrete Work.
      e. Contractor's concrete pre-placement plan checklist.
      f. Mock-ups as a quality standard.
      g. Subbase preparation and status (as applicable).
      h. Formwork.
      i. Reinforcing.
      j. Jointing, waterstops (as applicable), and related Work.
      k. Sampling and testing for quality control and compliance with building codes and other Laws and Regulations.
         1) Contractor responsibility for coordinating with testing entity and special inspectors.
         2) Storage and protection of Samples.
         3) Additional test cylinders to be made for concrete deliveries in which water exceeding the water/cement ratio of approved mix design was added at the Site.
         4) Additional test cylinders to be made for concrete structural elements Contractor intends to subject to live loading prior to 28 days after placement of concrete.
         5) Duties and authority of testing and inspection agency.

l. Logistics for concrete delivery (Contractor's responsibility) and placing, including:
    1) Travel time between ready-mix plant and Site, maximum time concrete to be in delivery vehicles, and exceptions to limits.
    2) Review of approved concrete mix(es), including limits of water addition and person authorized to add water, if water has been withheld at the plant.
    3) Traffic flow and delivery vehicle cleanout (Contractor's responsibility).
m. Concrete placing and consolidation means, methods, procedures, techniques, and sequences, and related safety and protection measures (Contractor's responsibility).
n. Concrete finishing.
o. Temperature, weather, and atmosphere during placing and curing (Contractor's responsibility).
p. Curing procedures (Contractor's responsibility).
q. Removal of formwork and patching (Contractor's responsibility).
r. Criteria for approval and rejection of work.
s. Other, related, subsequent Work.
t. Other necessary topics.

5. Discussion, whether at the pre-installation conference or otherwise, of Contractor's means, methods, procedures, techniques, and sequences of construction, and associated safety and protection measures, in no way changes or mitigates Contractor's sole responsibility for such matters.
6. Record of Conference: Within two days following the pre-installation conference, Contractor shall prepare and distribute to all participants of pre-installation conference, and others as appropriate, a reasonably complete record of topics discussed, identified problems, decisions made, and other matters pertinent to the subject concrete Work.
7. Should conference reveal matters that will not be suitably addressed by the scheduled date for the subject concrete placement, after taking steps to address the matter(s) in question, reconvene the conference. If necessary, reschedule concrete placement without change in the Contract Times and Contract Price.

1.4 DEFINITIONS

A. Words and terms used in this Specification Section are defined in the ACI CT-13.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. Scaled (minimum 1/8 inch per foot) drawings showing proposed locations of construction joints, control joints, expansion joints (as applicable) and joint profile dimensions for each joint type.
        b. Drawing indicating location, size and type of prefabricated waterstop joints.
    2. Product Data including:
        a. Manufacturers and types:
            1) Joint fillers.
            2) Curing agents.
            3) Construction joint bonding adhesive.
            4) Prefabricated waterstops.
        b. Acknowledgement that products submitted meet requirements of standards referenced.
    3. Monitoring Procedures:

B. Informational Submittals: Submit the following:
    1. Delivery Tickets:
        a. Copies of concrete delivery tickets.
    2. Supplier Instructions:
        a. Procedure for adding high-range water reducer at the Site.
    3. Instructions for handling and installing products approved by Contracting Officer's Representative. Supplier Site Visit Reports:

a. Report of each visit to the Site by Supplier, summarizing purpose of visit, activities while onsite, problems encountered, advice given to Contractor or Subcontractor, and actions taken.

4. Special Procedure Submittals:
   a. Description of proposed curing methods.
5. Qualifications:
   a. Ready-mix plant certification, in accordance with this Section's "Quality Assurance" Article.
   b. Waterstops: Certificate of training from waterstop manufacturer for individuals performing installation of waterstops and field welds and splices of waterstops.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Concrete Delivery:
   1. Prepare a delivery ticket for each load of ready mixed concrete.
   2. Truck operator shall hand ticket to Contractor at the time of delivery.
   3. Ticket to show:
      a. Mix identification.
      b. Quantity delivered.
      c. Quantity of material in each batch.
      d. Outdoor temperature in the shade at location of concrete placement.
      e. Time at which cement was added.
      f. Time of delivery.
      g. Time of discharge.
      h. Quantity of water that may be added at the site without exceeding the specified water-cement ratio.
      i. Quantity of any water added at the Site.

1.7 PROJECT CONDITIONS

A. Adjust concrete mix design when material characteristics, job conditions, weather, strength test results or other circumstances warrant.
   1. Do not use revised concrete mixes until submitted to and approved by Contracting Officer.

1.8 SEQUENCING AND SCHEDULING

A. Do not begin concrete production until proposed concrete mix design has been approved by the Contracting Officer.
   1. Approval of concrete mix design does not relieve Contractor of responsibility to provide concrete that meets the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 PRODUCTS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements.
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the manufacturers listed in this article are acceptable.

C. Neoprene Expansion Joint Fillers:
   1. Acceptable manufacturers:
      a. Permaglaze.
      b. Or equal.

2. Materials:
    a. Closed cell neoprene.
    b. ASTM D1056, Type 2, Class A or C.
    c. Grade: Compression deflection as required to limit deflection to 25 percent of joint thickness under pressure from concrete pour height.

D. Asphalt Expansion Joint Fillers:
1. Acceptable manufacturers:
    a. W.R Meadows.
    b. Or equal.
2. Materials: ASTM D994.

E. Fiber Expansion Joint Fillers:
1. Materials: ASTM D1751.

F. Evaporation Retarder:
1. Waterborne, monomolecular film forming, manufactured for application to fresh concrete.
2. Manufacturer and Products:
    a. Euclid Chemical Company, Eucobar
    b. Or equal.

G. Curing Materials shall comply with one or more of the following:
1. Absorbent Covers.
2. Moisture Retaining Covers.
3. Dissipating curing compound:
    a. Fugitive dye, waterborne, membrane-forming.
    b. ASTM C309, Type 1D, Class A or B, shall be composed of hydrocarbon resins, and dissipating agents that begin to break down upon exposure to UV light, and traffic, approximately four to six weeks after applications, providing a film that is removable with standard degreasing agents, and mechanized scrubbing actions to not impair the later addition and performance of applied finishes.
    c. Products and Manufacturers:
        1)
        2) Euclid Chemical Company; Kurez DR VOX.
        3) Or equal.
4. Clear, water-borne, membrane-forming curing and sealing compound:
    a. ASTM C1315, Type 1, Class A.
    b. Moisture loss shall be not more than 0.40 kilograms per square meter when applied at 300 square feet per gallon.
    c. Manufacturer's certification is required.
    d. Subject to Project requirements, provide one of the following products:
        1) Solvent-based:
            a) Euclid Chemical Company; Super Diamond Clear, Luster Seal 300 (exterior), Super Rez-Seal (interior).
            b) Or equal.
        2) Water-based:
            a) Euclid Chemical Company; Super Diamond Clear VOX.
            b) Or equal.

H. Non-shrink grout and epoxy grout: Comply with Section 03 31 30 - Concrete Materials and Proportioning.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installing the Work constitutes Contractor’s approval of underlying work, substrates, and field conditions prevailing at the time of the Work.

3.2 PREPARATION

A. Preparation – General:
   1. Materials and construction shall comply with the tolerances as specified in ACI 117.
   2. Complete formwork.
      a. Perform formwork in accordance with Section 03 11 13 - Formwork.
   3. Remove earth, snow, ice, water, foreign matter, and other extraneous materials from areas that will receive concrete.
   4. Secure reinforcement in place.
      a. Provide reinforcing in accordance with Section 03 21 00 - Reinforcement.
   5. Provide expansion joint material, anchors and other embedded items.
   6. Prior to placing concrete, obtain Contracting Officer's concurrence that associated formwork and reinforcing appear to be in accordance with the Contract Documents. However, in no event will Contracting Officer's observations, comments, or concurrence that any part of the Work appears to be in accordance with the Contract Documents modify or reduce Contractor's sole responsibility for providing Work in accordance with the Contract Documents.
   7. Do not place concrete during rain, sleet, snow, or other adverse ambient or environmental conditions unless adequate protection is provided by Contractor and such placement is acceptable to Contracting Officer's.
      a. Provide sufficient quantity of competent, experienced workers with due regard for effects of concrete temperature and atmospheric conditions on rate of hardening of concrete as required to obtain good surfaces and avoid unplanned cold joints.
      b. Do not allow precipitation or storm water runoff to increase mixing water nor to damage surface finish.
   8. Remove hardened concrete and foreign materials from inner surfaces of conveying equipment and formwork.
   9. Provide slabs and beams of minimum indicated required depth when sloping structural foundation base slabs and elevated slabs to drains.
      a. For floor slabs on grade, slope top of subgrade to provide slab of required uniform thickness.

B. Preparation of Subgrade for Slabs On Ground:
   1. Subgrade shall be wetted without standing water immediately prior to placing concrete.
   2. Obtain approval of subgrade compaction density prior to placing slabs on ground.

C. Edge Forms and Screeds:
   1. Set accurately to produce designated elevations and contours of finished surface.
   2. Sufficiently strong to support vibrating screeds or roller pipe screeds, if required.
   3. Use strike off templates, or acceptable vibrating type screeds, to align concrete surfaces to contours of screed strips.

3.3 CONCRETE MIXING

A. Concrete Mixing - General:
   1. Provide concrete materials from one ready-mix batch plant qualified in accordance with this Section's "Quality Assurance" Article.
   2. Batch, mix, and transport in accordance with ASTM C94/C94M.

B. Control of Admixtures:
   1. Control at ready-mix plant:
      a. Admixtures shall be introduced at the ready-mix plant in accordance with manufacturer's recommendations.
      b. Charge admixtures into mixer as solutions.
         1) Measure by means of an appropriate mechanical dispensing device.
         2) Liquid considered a part of mixing water.
         3) Admixtures that cannot be added in solution may be weighed or measured by volume if so recommended by manufacturer.

c. Add separately, when two or more admixtures are used in concrete, to avoid possible interaction that might interfere with efficiency of either admixture, or adversely affect concrete.
d. Complete performing addition of retarding admixtures within one minute after addition of water to cement has been completed, or prior to beginning of last three quarters of required mixing, whichever occurs first.

2. Control of Admixtures at the Site:
   a. Additional quantities of admixtures (with the exception of retarders) may be added at the Site provided:
      1) Addition of admixtures shall be under the supervision of the ready-mix plant's quality control representative.
      2) Addition of each admixture shall be documented on the delivery ticket.
      3) Provide additional mixing in accordance with ASTM C94.

C. Tempering and Control of Mixing Water:
1. Mix concrete only in quantities for immediate use.
2. Discard concrete which has set.
3. Discharge concrete from ready-mix delivery vehicles within time limit stated in ASTM C94.
4. Addition of water at the Site:
   a. Comply with Section 03 31 30 - Concrete Materials and Proportioning, for specified water cement ratio and slump.
   b. Do not exceed maximum specified water cement ratio or slump.
   c. Incorporate water by additional mixing equal to at least half of total mixing required.

3.4 PLACING OF CONCRETE

A. Placing of Concrete - General:
1. Place concrete as a rate such that concrete, which is being integrated with fresh concrete, is "workable".
   a. Provide sufficient, competent, skilled workers for timely delivery of concrete into forms to avoid unintended cold joints and placement consolidation issues.
2. Contractor may choose to submit an equivalent self-consolidating concrete mix to reduce consolidation and placement issues.
3. Tined rakes are prohibited as a means of conveying fiber reinforced concrete.
4. Provide additional equipment to place mass concrete if deemed required to avoid placement issues.
5. Comply with ACI 304R,ACI 304.2R, and ACI 301.
6. Do not begin placing concrete during rain, sleet, snow, or other adverse weather or environmental conditions that may be detrimental to concrete placement.
   a. Protect fresh concrete from ensuing inclement weather and other environmental conditions that may be detrimental to concrete.
7. Time between concrete batching and final placement shall not exceed 90 minutes.
   a. Selection of time limit to end of discharge should consider ambient conditions, types of cementitious materials and admixtures used, placement procedures, and projected transportation time between ready-mix plant and the point of delivery.
   b. If discharge is acceptable after more than 90 minutes have elapsed since batching, verify that air content of air-entrained concrete, slump, and temperature of concrete are as specified.
8. Do not deposit concrete which has partially hardened or has been contaminated by foreign materials.
9. Begin work only when work of other trades affecting concrete is complete.
10. When pumping concrete, do not use excess grout or mortar to lubricate concrete conveyance piping.
11. Do not use excess water for workability or any reason when placing concrete by freefall.
12. Deposit concrete continuously to avoid cold joints.

13. Provide construction joints at locations shown or indicated in the Contract Documents, unless otherwise approved by Contracting Officer via Shop Drawing or Contract modification.
    a. Plan size of crews with due regard for effects of concrete temperature and ambient conditions to avoid unplanned cold joints.
14. Spreaders:
    a. Temporary: Remove as soon as concrete placing renders their function unnecessary.
    b. Embedded:
        1) Obtain approval of Contracting Officer for their use.
        2) Materials: Concrete or metal.
        3) Ends of metal spreaders coated with plastic coating two inches from each end.
15. Do not begin placing of concrete in supported elements until concrete previously placed in supporting members is no longer plastic and has been in place at least a minimum of 2 hours.
16. Deposit concrete as nearly as practicable in its final position to avoid segregation.
    a. Maximum free fall: 4 feet.
    b. Place concrete by means of hopper, “elephant trunk” or tremie pipe extending to within four feet of surface.
17. Perform the following operations before bleeding water has an opportunity to collect on surface:
    a. Spread.
    b. Consolidate.
    c. Straightedge.
    d. Darby or bull float.
    e. Evaporation Retarder.
        1) See manufactures printed instruction for required waiting period prior to finishing or troweling.
18. No water shall be added to the concrete surface to ease finishing operation.
19. Do not discharge water into forms.
20. Consider use of form vibrators for certain placement situations.
21. Deposit concrete on void forms by methods which will not crush or damage void forms in any way.

B. Cold Weather Concrete Placement:
    1. Comply with ACI 306.1.
    2. Do not place concrete on forms or subgrades that are below 32 degrees F or contain frozen material.
    3. Maintain all materials, forms, reinforcement, subgrade and any other items which concrete will come in contact with free of frost, ice or snow at time of concrete placement.
    4. Temperature of concrete when discharged at site: in accordance with ACI 306.1.
    5. Heat subgrade forms, embedments and reinforcement to between 45 and 70 degrees F, when temperature of surrounding air is 40 degrees F or below at time concrete is placed.
        a. Remove frost from subgrade, forms and reinforcement before concrete is placed.
    6. Combine water with aggregate in mixer before cement is added, if water or aggregate is heated above 90 degrees F.
    7. Do not mix cement with water or with mixtures of water and aggregate having a temperature greater than 90 degrees F.
    8. Comply with ACI 306R for specific requirements dealing with elevated steel troweled slabs that will be exposed to freeze-thaw cycles.

C. Hot Weather Concrete Placement:
    1. Comply with ACI 305.1.
    2. Cool ingredients before mixing, or add flake ice or well crushed ice of a size that will melt completely during mixing for all or part of mixing water if high temperature, low slump, flash set, cold joints, or shrinkage cracks are encountered.
    3. Temperature of concrete at point of delivery (i.e. delivery vehicle discharge) when placed:

a. Not to exceed 90 degrees F.
b. Not to exceed:

Section Thickness (Least Dimension, feet)	Maximum Temperature (degrees F)	Concrete Placement Size (Volume, CU YD limit)
Up to 2.0	90	Unlimited
2.0 to 3.0	76	Unlimited
3.0 to 6.0	72	250
Greater than 6.0	72	Review by Contracting Officer's Representative

c. Not so high as to cause:
1) Shrinkage cracks.
2) Difficulty in placement due to loss of slump.
3) Flash set.

4. Temperature of forms and reinforcing when placing concrete:
a. Not to exceed 90 degrees F.
b. May be reduced by spraying with water to cool below 90 degrees F.
1) Leave no standing water to contact concrete being placed.
5. Prevent plastic shrinkage cracking, slab curling, or both due to evaporation.

D. Consolidating:
1. Consolidate in accordance with ACI 309R except as modified herein.
2. Consolidate by vibration so that concrete is thoroughly worked around reinforcement, embedded items and into corners of forms.
a. Ensure no displacement of reinforcing or other embeds from final position.
b. Eliminate:
1) Air or stone pockets.
2) Honeycombing, pitting, or both.
3) Planes of weakness.
3. Use suitable form vibrators located just below top surface of concrete, where internal vibrators cannot be used in areas of congested reinforcing.
a. Size and coordinate external vibrators to specifically match forming system used.
4. Internal vibrators:
a. Minimum frequency of 8000 vibrations per minute.
b. Insert and withdraw at points approximately 1.5 feet apart.
1) Allow sufficient duration at each insertion to consolidate concrete but not sufficient to cause segregation.
c. Use in:
1) Beams and girders of framed slabs.
2) Columns and walls.
3) Vibrating concrete around all waterstops.
d. Size of vibrators shall be in accordance with ACI 309R, Table 5.1.5.
5. Obtain consolidation of slabs with internal vibrators, vibrating screeds, roller pipe screeds, or other appropriate means.
6. Do not use vibrators to transport concrete within forms.
7. When placing self-consolidating concrete, the use of form or pencil vibrators is acceptable, provided such methods do not cause aggregate segregation, or otherwise adversely affect the quality of the Work.
8. Do not excessively vibrate or power screed concrete that contains "traprock" aggregate.
9. Provide sufficient spare vibrators at the Site during all concrete placing operations to ensure continuous vibration.

10. Bring a full surface of mortar against form by vibration supplemented if necessary by spading to work coarse aggregate back from formed surface, where concrete is to have an as-cast finish.
11. Prevent construction equipment and machinery, construction operations, and personnel from introducing vibrations into freshly placed concrete after the concrete has been placed and consolidated.

E. Handle concrete from mixer to place of final deposit by methods which will prevent segregation or loss of ingredients and in a manner which will assure that required quality of concrete is maintained.
   1. Use truck mixers, agitators, and non-agitating units in accordance with ASTM C94.
   2. Temporary horizontal belt conveyors:
      a. Mount at a slope which will not cause segregation or loss of ingredients.
      b. Protect concrete against undue drying or rise in temperature.
      c. Use an arrangement at discharge end to prevent segregation.
      d. Do not allow mortar to adhere to return length of belt.
      e. Discharge conveyor runs into equipment specially designed for spreading concrete.
   3. Temporary metal or metal lined chutes:
      a. Slope not exceeding 1 vertical to 2 horizontal and not less than 1 vertical to 3 horizontal.
      b. Chutes more than 20 feet long and chutes not meeting slope requirements may be used provided they discharge into a hopper before distribution.
      c. Provide end of each chute with a device to prevent segregation.
   4. Temporary pumping or pneumatic conveying equipment:
      a. Designed for concrete application and having adequate pumping capacity.
      b. Control pneumatic placement so segregation is avoided in discharged concrete.
      c. Loss of slump in pumping or pneumatic conveying equipment shall not exceed 1.5 inches.
      d. Do not convey concrete through pipe of aluminum or aluminum alloy.
      e. Provide pumping equipment without Y sections.

3.5 JOINTS AND EMBEDDED ITEMS

A. Construction Joints - General:
   1. Provide joints at locations as shown or indicated on the Drawings or as shown on approved Shop Drawings approved by Contracting Officer or in an appropriate Contract modification.
      a. Where construction joint spacing shown on the Drawings exceeds the joint spacing indicated in Paragraph B. below, submit proposed construction joint location in conformance with this Section.
   2. Unplanned construction joints are unacceptable.
      a. If concrete cannot be completely placed between planned construction joints, then it must be removed.
   3. In general, locate joints near middle of spans of slabs, beams and girders unless a beam intersects a girder at this point, in which case, offset joint in girder a distance equal to twice the width of the beam.
   4. Locate joints in walls and columns at underside of floors, slabs, beams, or girders, and at tops of foundations or floor slabs, unless shown otherwise.
      a. At Contractor's option, beam pockets may be formed into concrete walls.
      b. Size pockets to allow beam reinforcing to be placed as detailed on the Drawings.
   5. Place beams, girders, column capitals and drop panels at same time as slabs.
   6. Place corbels monolithically with their supporting members.
      a. Locate wall vertical construction joints midway between corbels.
      b. Where only a single corbel is located, place it also monolithically with wall and locate wall vertical construction joint a minimum of three feet from face of corbel.
   7. Make joints perpendicular to main reinforcement with all reinforcement continuous across joints.
   8. Provide the following joints unless shown or indicated otherwise on the Drawings:

a. Roughen joints: horizontal construction joints.
b. Keyed joints: vertical construction joints.

9. Roughen construction joints:
   a. Clean the previously hardened concrete interface and remove all laitance.
   b. Intentionally roughen the interface to a full amplitude of 0.25 inch.
10. Keyways:
    a. Construction joint keyways shall have the following dimensions, unless shown or indicated otherwise on the Drawings or as directed by Contracing Officer. .
    b. Keyways in footings, foundations, and base slabs:
       1) Keyway height not less than one-third and not more than one-half the slab thickness.
       2) Keyway depth not less than 1.5 inches.
       3) Keyway in slab center unless shown otherwise on the Drawings.
11. Minimum time before placement of adjoining concrete construction:
    a. All concrete: 60 hours, unless otherwise noted.

B. Construction Joints - Spacing Unless Otherwise Specified:
   1. Structures not intended to contain liquid:
      a. Wall vertical construction joints:
         1) 50 feet maximum on centers.
         2) At wall intersections, four feet minimum from corner.
      b. Base slab, floor, and roof slab construction joints:
         1) Placements to be approximately square and not to exceed 4,000 square feet.
         2) Maximum side dimension of a slab pour shall be 90 feet.

C. Construction Joints - Bonding:
   1. Obtain bond between concrete pours at construction joints by thoroughly cleaning and removing all laitance from construction joints.
   2. Before new concrete is placed, all construction joints shall be coated with cement grout, or dampened, as indicated below:
   3. Roughen construction joints:
      a. Roughen the surface of the concrete to expose the coarse aggregate uniformly with 0.25 inch minimum amplitude.
         1) Remove laitance, loosened particles of aggregate or damaged concrete at the surface.
   4. Keyed construction joints:
      a. Thoroughly clean construction joints and remove all laitance.
      b. Dampen the hardened concrete immediately prior to placing of fresh concrete.

D. Slab On Grade Joints:
   1. Locate construction and control joints in slabs on grade as shown or indicated on the Drawings.
   2. Time cutting properly with set of concrete, if saw cut joints are required or allowed.
      a. Start cutting as soon as concrete has hardened sufficiently to prevent aggregates being dislodged by saw.
      b. Complete before shrinkage stresses become sufficient to produce cracking.

E. Expansion Joints:
   1. Do not allow reinforcement or other embedded metal items bonded to concrete (except smooth dowels bonded on only one side of joint) to extend continuously through an expansion joint.
   2. Use neoprene expansion joint fillers, unless shown or indicated otherwise on the Drawings.
   3. Seal expansion joints as shown or indicated on the Drawings.
      a. Comply with Section 07 92 00 - Joint Sealants.

F. Other Embedded Items:
   1. Place sleeves, inserts, anchors, and embedded items required for adjoining work or for its support, prior to initiating concreting.

2. Do not route electrical conduit, drains, or pipes in concrete slabs, walls, columns, foundations, beams or other structural members unless approved by Contracting Officer's Representative.

G. Placing Embedded Items:
   1. Support against displacement.
   2. Fill voids in sleeves, inserts and anchor slots temporarily with readily removable material to prevent entry of concrete into voids.
   3. Provide adequate means for anchoring waterstop in concrete.
      a. Provide means to prevent waterstops in the forms from being folded over by the concrete as it is placed.

3.6 FINISHING

A. Comply with Section 03 35 00 - Concrete Finishing and Repair of Surface Defects.

B. Coordinate mixing and placing with finishing.

3.7 INSTALLATION OF GROUT

A. Grout Schedule:
   1. Non-shrinking non-metallic grout:
      a. Filling form tie holes.
      b. Under column and beam base plates.
      c. Other uses shown or indicated on the Drawings.
   2. Epoxy grout:
      a. Patching cavities in concrete.
      b. Grouting of dowels and anchor bolts into existing concrete.
      c. Grouting of rotating or oscillating equipment base plates.
      d. As shown or indicated on the Drawings.

B. Grout Installation:
   1. Non-shrink non-metallic grout:
      a. Clean concrete surface to receive grout.
      b. Saturate concrete with water for 24 hours prior to grouting.
      c. Mix in a mechanical mixer.
      d. Use no more water than necessary to produce flowable grout.
      e. Place in accordance with manufacturer's instructions.
      f. Provide under beam, column, and equipment base plates, in joints between precast concrete and cast-in-place slabs, and in other locations shown or indicated on the Drawings.
      g. Completely fill spaces and cavities below the top of base plates.
      h. Provide forms where base plates and bed plates do not confine grout.
      i. Where exposed to view, finish grout edges smooth.
      j. Except where a slope is shown or indicated on the Drawings, finish edges flush at the base plate, bed plate, member or piece of equipment.
      k. Coat exposed edges of grout with cure or seal compound recommended by the grout manufacturer.
   2. Epoxy grout:
      a. Mix and place in accordance with manufacturer's written instructions.
      b. Apply only to clean, dry, sound surface.
      c. Completely fill cavities and spaces around dowels and anchors without voids.
      d. Grout base and bed plates as specified for non-shrinking, non-metallic grout.
      e. Obtain manufacturer's field technical assistance as necessary to ensure proper placement.

3.8 CURING AND PROTECTION

A. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage immediately after placement, and maintain with minimal moisture loss at relatively

constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.

1. Comply with ACI 308.1 except as modified herein.
2. Do not impose loads by foot traffic, wheeled traffic, and other loads until concrete has sufficiently cured to carry imposed loads without adversely affecting the concrete. In no event shall concrete be subject to loading or traffic during initial 48 hours of curing, unless otherwise approved by Contracting Officer.
3. Evaporation Retarder:
    a. Apply evaporation retarder to uniformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 pounds per square foot per hour (one kilogram per square meter per hour) before and during finishing operations.
        1) Apply according to manufacturer's written instructions one or more times after placing, screeding, and bull floating or darbying concrete, but before float finishing.

B. For surfaces of non-water bearing structures, apply one of the following curing procedures immediately after completion of placement and finishing (surfaces not in contact with forms).
    1. Ponding or continuous sprinkling. Avoid eroding the surface of freshly placed concrete.
    2. Application of wet Absorbent Covers:
        a. Minimum lap: 12 inches.
        b. Provide continuous uniform supply of moisture, such as sprinklers or soaker hoses as necessary to keep concrete surface continuously wet.
        c. Monitor Absorbent Covers as required to prevent cover materials or concrete surface from drying out.
    3. Continuous application of steam (not exceeding 150 degrees F) or mist spray.
    4. Application of Moisture Retaining Cover sheet materials.
        a. Place as soon as possible after final finishing and without marring the surface.
        b. Minimum lap: 12 inches.
        c. Seal edges to make water-tight.
        d. Place Moisture Retaining Cover in intimate contact with the concrete surface, without wrinkles and weighted to hold in place.
        e. Hold cover and edges in place as necessary to prevent wind from displacing the cover.
        f. Moisture Retaining Fabric:
            1) Install in accordance with manufacturer’s written recommendations.
            2) Saturate concrete surface and fabric side of cover immediately prior to placing.
        g. Monitor continuously during the curing period:
            1) Repair holes, tears or displaced cover.
            2) Rewet as necessary to keep concrete moist under cover.
    5. Application of other moisture retaining covering acceptable to Contracting Officer..
    6. Water used for curing shall be within 20 degrees F of the concrete temperature.
    7. Application of a curing compound.
        a. Apply curing compound in accordance with manufacturer's written recommendations immediately after any water sheen, which may develop after finishing, has disappeared from concrete surface.
        b. Do not use on surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
        c. Where a vertical surface is cured with a curing compound, the vertical surface shall be covered with a minimum of two coats of the curing compound.
            1) Apply the first coat of curing compound to a vertical surface immediately after form removal.
            2) The vertical concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
            3) Allow the preceding coat to completely dry prior to applying the next coat.
            4) A vertical surface: Any surface steeper than 1 vertical to 4 horizontal.
    8. Surfaces In Contact with Forms:

a. Formed surfaces: Cure formed concrete surfaces utilizing final curing methods per ACI 308.1, including underside of beams, supported slabs, and other similar surfaces,
   1) See Section 03 11 13 - Formwork.
b. Minimize moisture loss from and temperature gain of concrete placed in forms exposed to heating by sun by keeping forms wet and cool until they can be safely removed.
c. Make provisions to keep concrete wall moist while stripping forms and until curing measures are in place.
d. After form removal, cure concrete until end of time prescribed.
e. Use one of the methods listed above.
f. Forms left in place shall not be used as a method of curing in hot weather.
g. The term "hot weather", where used in these Specifications, is defined in ACI 305.1.
h. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete.

C. For Surfaces of Water Bearing Structures:
1. Protect concrete from premature drying, excessively hot or cold temperatures, and mechanical damage immediately after placement, and maintain with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement, hardening, and compressive strength gain.
   a. Follow recommendations of ACI 308.1 except as modified herein.
   b. Use Evaporation Retardant to reduce surface moisture evaporation of slabs during concrete placement. Comply with the manufacturer’s written instructions of use as required to obtain the intended results.
2. Apply one of the following moist curing procedures immediately after completion of placement and finishing, for concrete surfaces not in contact with forms.
   a. Ponding or continuous sprinkling.
   b. Application of absorptive mats or fabric kept continuously wet and in intimate contact with concrete.
   c. Surfaces shall be covered with a double layer of absorptive mats or fabric, wetted before placing, and overlapped at least 6 inches.
   d. Application of sand kept continuously wet.
   e. Continuous application of steam (not exceeding 150 degrees F) or mist spray.
   f. Ponding and sprinkling in conjunction with application of waterproof sheet materials, conforming to ASTM C171 and only with a program as approved by the Engineer that will keep the surface continuously wet.
   g. Ponding and sprinkling in conjunction with application of other moisture retaining covering as approved by the Engineer that will keep the surface continuously wet.
3. After seven days of moist curing, application of a curing compound conforming to ASTM C309 may be substituted for moist curing.
   a. Apply curing compound in accordance with manufacturer's written recommendations immediately after any water sheen which may develop during moist curing has disappeared from concrete surface.
   b. Do not use on surface against which additional concrete or other material is to be bonded unless it is proven that curing compound will not prevent bond.
   c. Where a surface is cured with a curing compound, the surface shall be covered with a minimum of two coats of the curing compound, 30 mils thick each coat.
   d. Apply the first coat of curing compound immediately after form removal or discontinued moist curing and before the surface displays water loss. Apply in one direction only, covering uniformly to a minimum thickness of 30 mils.
   e. The concrete surface at the time of receiving the first coat shall be damp with no free water on the surface.
   f. Allow the preceding coat to completely dry prior to applying the next coat.
   g. Apply second coat in direction perpendicular to the first coat application direction, covering uniformly to a minimum thickness of 30 mils.

h. Curing compounds used for concrete that will be in contact with potable water or water that will be treated to become potable shall be non-toxic, taste and odor-free, and be compliant with NSF/ANSI 61.
i. Alternately, remove curing compound, non-compliant with NSF/ANSI 61, from surfaces of concrete that will be in contact with potable water or water that will be treated to become potable, without damaging the concrete finish.

4. Curing Concrete In Contact with Forms:
   a. Minimize moisture loss of concrete placed in forms by keeping forms wet and cool until they can be safely removed.
   b. Moist cure the top surface of concrete placed in forms as specified.
   c. After form removal, cure concrete until end of time prescribed.
      1) Use one of methods indicated above.
      2) When acceptable to the Engineer, placement of the second pour at joints may occur prior to the end of the curing period.
   d. Forms left in place shall not be used as a method of curing in hot weather.
   e. The term "hot weather", where used in these Specifications, is defined in ACI 305R.
   f. In hot weather, remove forms from vertical surfaces as soon as concrete has gained sufficient strength so that the formwork is no longer required to support the concrete and commence moist curing as specified.

D. Curing Period:
   1. Continue curing for at least seven days for all concrete except Type III, high early strength concrete for which period shall be at least three days.
      a. If one of curing procedures indicated above is used initially, it may be replaced by one of other procedures indicated any time after concrete is two days old, provided concrete is not permitted to become surface dry during transition.

E. Cold Weather:
   1. Comply with of ACI 306.1.
   2. Maintain temperature of concrete in accordance with ACI 306.1 for a minimum of 72 hours after concrete is placed, when outdoor temperature is 40 degrees F, or less.
      a. Maximum temperature rate of decrease: In accordance with ACI 306.1.
   3. Provide temporary heating, covering, insulating, or housing of the concrete Work to maintain required temperature without damage due to concentration of heat.
   4. Do not use combustion heaters unless precautions are taken to prevent exposure of concrete to exhaust gases which contain carbon dioxide.
   5. Interior slabs in areas intended to be heated shall be adequately protected so that frost does not develop in the supporting subgrade.

F. Hot Weather:
   1. Comply with ACI 305.1 and ACI 308.1.
   2. Provide as necessary cooling forms, reinforcement and concrete, windbreaks, shading, fog spraying, sprinkling, ponding, or wet covering with a light colored material.
   3. Provide protective measures as quickly as concrete hardening and finishing operations will allow.
   4. Maximum temperature rate of decrease: In accordance with ACI 305.1.

G. Rate of Temperature Change:
   1. Maintain temperature of air immediately adjacent to concrete as uniform as possible, during and immediately following curing.

H. Protection from Mechanical Damage:
   1. Protect concrete from damage of all types, whether or not mechanically imparted including load stresses, heavy shock, and excessive vibration.
   2. Protect finished concrete surfaces from all types of damage, including damage by construction equipment and machinery, construction means and methods, precipitation, and running water.
   3. Do not load self-supporting structures in such a way as to overstress concrete.

3.9 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Special Inspections in accordance with building code:
      a. Comply with Section 01 40 00 and Statement of Structural Tests and Special Inspections from for special inspection requirements.
      b. Concrete tests required per Specification Section 03 05 05.

END OF SECTION

SECTION 03 35 00
CONCRETE FINISHING AND REPAIR OF SURFACE DEFECTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Concrete finishing and repair of surface defects.
   2. Chemical Sealers.
   3. Polymer Modified Cementitious Coating.
   4. Resurfacing Mortar.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 11 13 - Formwork.
   2. Section 03 31 30 - Concrete, Materials and Proportioning.
   3. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. CT-13, Concrete Terminology.
      b. 117, Specification for Tolerances for Concrete Construction and Materials.
      c. 303R, Guide to Cast-in-Place Architectural Concrete Practice.
      d. 308, Standard Practice for Curing Concrete.
   2. ASTM International (ASTM):
      a. C109, Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or 50-mm Cube Specimens).
      b. C150, Standard Specification for Portland Cement.
      c. C157, Standard Test Method for Length Change of Hardened Hydraulic-Cement Mortar and Concrete.
      d. C309, Standard Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
      e. C666, Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
      f. C779, Standard Test Method for Abrasion Resistance of Horizontal Concrete Surfaces.
      g. C1315, Standard Specification for Liquid Membrane-Forming Compounds Having Special Properties for Curing and Sealing Concrete.
      h. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      i. D4259, Standard Practice for Abrading Concrete.
      j. E1155, Standard Test Method for Determining F(F) Floor Flatness and F(L) Floor Levelness Numbers.
      k. E1486, Standard Test Method for Determining Floor Tolerances Using Waviness, Wheel Path and Levelness Criteria.
   3. International Concrete Repair Institute (ICRI):
      a. 310.2R, Selecting and Specifying Concrete Surface Preparation for Sealers, Coatings, and Polymer Overlays.
   4. National Council Highway Research Program (NCHRP):
      a. 244, Concrete Sealers for the Protection of Bridge Structures.
   5. The Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 13/NACE No. 6, Surface Preparation of Concrete.

B. Qualifications:
   1. Chemical Sealer CS-2:

a. Applicator shall be factory trained and approved, in writing, by the manufacturer to apply the product.
b. Applicator shall have a minimum of five years of experience successfully applying materials specified.

C. Mock-Ups.
1. General:
a. Construct additional mock-ups as required until accepted.
b. Mock-ups constitute minimum standard of quality for actual construction.
c. Maintain mock-up during construction.
d. Remove when directed by Contracting Officer Representative.
2. Construct mock-up for each type of wall finish specified for review and acceptance by Contracting Officer Representative.
a. Minimum 4 x 4 feet area for each different wall finish specified.
b. Mock-ups shall include:
1) Sample of patched tie hole.
2) Sample of all jointery being used in the walls.
c. Include mock-up of wall having polymer modified cementitious coating.
1) Mock-up shall be stepped to show surface preparation, repairs and coating in all stages of application.
3. Construct mock-up floor slab for review and acceptance by Contracting Officer Representative.
a. Minimum 10 x 10 feet.

1.3 DEFINITIONS

A. Vertical Surface Defects:
1. Any void in the face of the concrete deeper than 1/8 inches, such as:
a. Tie holes.
b. Air pockets (bug holes).
c. Honeycombs.
d. Rock holes.
2. Scabbing:
a. Scabbing is defect in which parts of the form face, including release agent, adhere to concrete.
3. Foreign material embedded in face of concrete.
4. Fins 1/16 inches or more in height.

B. Installer or Applicator:
1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
2. Installer and applicator are synonymous.

C. Other words and terms used in this Specification Section are defined in ACI CT-13.

1.4 SUBMITTALS

A. Shop Drawings:
1. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's installation instructions.
2. Certifications:
a. Certification of aggregate gradation.
b. Certification of manufacturer experience qualifications and performance history.
c. Certification of applicator's qualifications.
1) Refer to Qualifications paragraph.
2) Provide manufacturer's written approval of applicators.
3) Provide references substantiating specialty experience.

B. Informational Submittals:

1.5 DELIVERY, STORAGE, AND HANDLING

A. Comply with manufacturer's recommendations and requirements for materials used.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Bonding Agents:
      a. Euclid Chemical Co.
      b. Or equal
   2. Chemical Sealers:
      a. Euclid Chemical Co.
      b. Or equal.
   3. Polymer Modified Cementitious Coating:
      a. Euclid Chemical Co.
      b. Or equal.
   4. Patching Mortar:
      a. Euclid Chemical Co.
      b. Or equal.

C. Submit request for substitution in accordance with Specification Section 01 33 23.

2.2 MATERIALS

A. Chemical Sealer CS-1:
   1. High solids, water-based solution containing acrylic copolymers.
      a. ASTM C1315, Type I, Class A.
      b. Non-yellowing UV resistant.
      c. VOC Content: <200 G/L.
   2. USDA approved as a concrete floor sealer.
   3. Euclid Chemical Super Diamond Clear VOX.

B. Chemical Sealer CS-2:
   1. Water based chemical solution containing a blend of silicate and siliconate polymers designed to seal, harden and dustproof concrete floors.
   2. VOC Content: 0 G/L.
   3. Performance of treated concrete floor:
      a. Coefficient of Friction:
         1) Dry: 0.81.
         2) Wet: 0.72.
      b. Liquid repellency, RILEM Method 11.4:
         1) ≥ 1 mL.
   4. Euclid Chemical Euco Diamond Hard.

C. Chemical Sealer CS-3:
   1. Clear, penetrating, breathable, waterborne silane-siloxane solution.
   2. VOC content: ≤50 G/L.
   3. Odorless.

4. Flash point: >200 degrees F.
5. Water absorption: 85% reduction per NCHRP 244.
6. Chloride penetration: 82% reduction per NCHRP 244.
7. Euclid Chemical Baracade WB 244.

D. Patching Mortar: Trowelable cementitious repair mortar for vertical, overhead, and horizontal repairs.
   1. Portland cement-based, rapid set repair mortar for interior or exterior use.
   2. Compressive Strength, ASTM C109:
      a. Minimum 3000 psi at 7 days.
      b. Minimum 5000 psi at 28 days.
   3. Freeze Thaw Durability, ASTM C666: 96.75% at 300 Cycles.
   4. Shrinkage, ASTM C157: 0.069%.
   5. Euclid Chemical Speed Crete Red Line.

E. Bonding Agents:
   1. For use only on concrete surfaces not receiving liquid water repellent coating:
      a. High solids acrylic latex base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.
         1) Master Builders MasterEmaco A 660.
         2) Euclid Chemical Co. Flex-Con.
         3) Laticrete L&M Everbond.
   2. For use only on concrete surface receiving liquid water repellent:
      a. Non-acrylic base liquid for interior or exterior application as a bonding agent to improve adhesion and mechanical properties of concrete patching mortars.

F. Cement:
   1. ASTM C150, Type II, Portland, or ASTM C595, Type IL-HS Blendfor areas exposed to sewage.
   2. ASTM C150, Type I Portland or ASTM C595, Type IL elsewhere.

G. Aggregate:
   1. Sand: Maximum size #30 mesh sieve.
   2. For exposed aggregate finish surfaces: Same as surrounding wall.

H. Water: Potable.

I. Polymer modified cementitious coating:
   1. Polymer modified Portland cement based coating for concrete and masonry.
      a. Waterproof.
      b. Resistant to both positive and negative hydrostatic pressure.
      c. Breathable.
   2. Master Builders Solutions MasterSeal 581 or Euclid Chemical Tamoseal.
      a. Color:
         1) Interior surfaces: Standard gray.
         2) Exterior surfaces: Standard gray.
      b. Texture: Fine.

J. Nonshrink Grout: See Specification Section 03 31 30 and Specification Section 03 31 31.

2.3 MIXES

A. Bonding Grout: One part cement to one part aggregate.

B. Patching Mortar:
   1. One part cement to 2-1/2 parts aggregate by damp loose volume.
      a. Substitute white Portland cement for a part of gray Portland cement to produce color matching surrounding concrete.

PART 3 - EXECUTION

3.1 PREPARATION

A. For methods of curing, see Specification Section 03 31 31.

B. Surface Preparation:
   1. Clean surfaces in accordance with ASTM D4258 to remove dust, dirt, form oil, grease, or other contaminants prior to abrasive blasting, chipping, grinding or wire brushing.
   2. Prepare surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
      a. Provide concrete surface profile (CSP) in accordance with ICRI 310.2:
         1) Areas to receive Repair Mortar:
            a) Areas larger than 1 SF or deeper than 1/4 inches Abrasive blast, scarify or needle scale to CSP No. 6-8.
      b. If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
      c. No featheredges will be permitted.
      d. Rinse surface with clean water to remove all dust, dirt, debris, loosened concrete, laitance, and other contaminants.

C. Preparation of Bonding Grout Mixture:
   1. Mix cement and aggregate.
   2. Mix bonding agent and water together in separate container in accordance with manufacturer's instructions.
   3. Add bonding agent/water mixture to cement/aggregate mixture.
   4. Mix to consistency of thick cream.
   5. Bonding agent itself may be used as bonding grout if approved by manufacturer and Contracting Officer Representative.

D. Preparation of Patching Mortar Mixture:
   1. Mix specified patching mortar per manufacturer’s published recommendations.
   2. For repairs exceeding 2 inches in depth, mix with clean, pre-dampened 3/8 inches pea gravel in accordance with the manufacturer’s recommendations.

E. Polymer modified cementitious coating:
   1. Mix in accordance with manufacturer's recommendations using bonding agent acceptable to coating manufacturer.

3.2 INSTALLATION AND APPLICATION

A. Do not repair surface defects or apply wall or floor finishes when temperature is or is expected to be below 50 degrees F.
   1. If necessary, enclose and heat area to between 50 and 70 degrees F during repair of surface defects and curing of patching material.
      a. Use only clean fuel, indirect fired heating apparatus.
      b. Exhaust combustion byproducts outside of work area.

B. Chemical Sealer Application:
   1. General:
      a. Immediately prior to Substantial Completion, thoroughly clean floor in accordance with ASTM D4258 and prepare to receive chemical sealer.
         1) Remove previously applied membrane curing compounds.
         2) Remove soil, oils, stains, discoloration, or any other imperfection having a negative impact on the appearance of the finished floor.
      b. Apply product to floor areas indicated on the Drawings.
      c. Apply in accordance with manufacturer's published installation instructions.
   2. Chemical Sealer (CS-1):
      a. Apply two uniform coats at rate recommended by manufacturer.
         1) Apply using manufacturer’s recommended equipment with a fan-tip nozzle.

2) Do not allow material to puddle.
b. Allow first coat to completely dry before applying second coat.
c. Spotted or mottled appearances will not be accepted.

3. Chemical Sealer (CS-2):
   a. Apply two uniform coats at rate recommended by manufacturer.
      1) Scrub the material into the floor using a mechanical scrubber.
         a) Keep the surface wet for not less than 30 minutes.
         b) Continue scrubbing in accordance with manufacturer's application instructions.
         c) After material has thickened, but not more than 60 minutes after application, remove all excess liquid.
      2) Thoroughly rinse with clean water to remove all residue.
         a) Damp mop with clean water to remove any streaks.
         b) Do not allow residue to dry on floor surface.
      3) Do not track material onto untreated surfaces.
   b. After rinsing, allow floor to dry completely and apply second coat following the same procedures.
   c. Final floor finish shall have uniform sheen without streaking, stains or white residue.
4. Chemical Sealer (CS-3):
   a. Apply uniform coats at rate recommended by manufacturer.
      1) Apply with fine, uniform spray or microfiber pad.
   b. Allow floor to dry completely and remove any dried residue using hot water and mild citric acid.
   c. Final floor finish shall be uniform, free of residue, and shall repel water.
   d. Apply additional coat(s) as necessary to achieve water repellent finish.

C. Repairing Surface Defects:
1. This method is to be used on vertical concrete surfaces as indicated in the Concrete Finishes for Vertical Wall Surfaces paragraph of this Specification Section and similar concrete surfaces not otherwise specified to receive another finish or coating.
   a. For surfaces indicated to receive finish or coating other than those specified herein; refer to the applicable Specification Section for surface preparation requirements:
      1) Match concrete and seal per this specification.
2. Fill and repair surface defects and tie-holes using patching mortar mix specified in the MATERIALS Article in PART 2.
   a. Prime exposed reinforcing steel, embeds or other steel surfaces with primer as recommended by patching mortar manufacturer.
   b. Scrub bond coat:
      1) Wet substrate to a saturated surface dry (SSD) condition.
      2) Mix patching mortar to a scrub coat or slurry consistency per manufacturer's published recommendations and apply to entire area.
   c. As an alternate to the scrub bond coat, concrete may be primed with manufacturer's recommended epoxy primer.
   d. Patching Mortar Application:
      1) Mix and apply Patching Mortar per manufacturer's recommendations within the open time of the product scrub coat or any bonding agents.
      2) Finish to level of surrounding concrete surface utilizing techniques recommended by manufacturer.
3. Consolidate patching mortar into place and strike off so as to leave patch slightly higher than surrounding surface.
4. Leave undisturbed until mortar has stiffened before finishing level with surrounding surface.
   a. Do not use steel tools in finishing a patch in a formed wall which will be exposed to view.
5. Cure patching mortar in accordance with ACI 308.

D. Concrete Finishes for Vertical Wall Surfaces:
1. General:

a. Give concrete surfaces finish as specified below after removal of formwork and repair of surface defects.
b. Finish numbers not listed are "Not Used".

2. Finish #1 - As cast rough form finish:
   a. Selected forming materials are not required.
   b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
   c. Repair the following surface defects using patching mortar specified in PART 2:
      1) Tie holes.
      2) Honeycombs deeper than 1/4 inches.
      3) Air pockets deeper than 1/4 inches.
      4) Rock holes deeper than 1/4 inches.
   d. Chip or rub off fins exceeding 1/4 inches in height.
   e. Provide at unexposed surfaces such as:
      1) Foundations.
      2) Below-grade walls not to be waterproofed.
      3) Concealed surface of concrete back-up wythe in cavity wall construction.
3. Finish #2 - As cast form finish:
   a. Form facing material shall produce a smooth, hard, uniform texture.
      1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
   b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
      1) Chip or rub off fins exceeding 1/8 inches in height.
      2) Abrasive blast surfaces in accordance with ASTM D4259 and SSPC SP 13/NACE No. 6 to completely open defects down to sound concrete and remove laitance.
         a) Provide ICRI 310.2 Concrete Surface Profile (CSP) No. 3, minimum across the entire surface.
            (1) For contiguous repair areas larger than 1 SF or deeper than 1/4 inches Abrasive blast, scarify or needle scale to CSP No. 6-8.
         b) If additional chipping or wire brushing is necessary, make edges perpendicular to surface or slightly undercut.
         c) No feather edges will be permitted.
      3) Rinse surface with clean water and allow surface water to evaporate prior to repairing surface defects.
      4) Repair the following surface defects using patching mortar specified in PART 2:
         a) Tie holes.
         b) Honeycombs deeper than 1/4 inches or larger than 1/4 inches diameter.
         c) Air pockets deeper than 1/4 inches or larger than 1/4 inches diameter.
         d) Rock holes deeper than 1/4 inches or larger than 1/4 inches diameter.
         e) Scabbing.
      5) Brush blast repaired areas to match adjacent surface texture.
   c. Provide this finish for:
      1) Interior walls of pipe galleries , pump rooms , or tipping floors.
      2) Underside of horizontal elements adjacent to the finished surface.
      3) Exposed surfaces not specified to receive another finish.
4. Finish #4 - Polymer modified cementitious coating:
   a. Form facing material shall produce a smooth, hard, uniform texture.
      1) Use forms specified for surfaces exposed to view in accordance with Specification Section 03 11 13.
      2) Comply with ACI 303R for formwork accuracy and form joint handling to prevent grout leakage.
   b. Prepare surface in accordance with the PREPARATION Article in PART 3 of this Specification Section.
      1) Chip or rub off fins exceeding 1/8 inches in height.
      2) Abrasive blast and repair surface defects in accordance with Concrete Finish #2.

c. Apply decorative coating to entire surface.
    1) As a mixing liquid for the coating, use bonding agent and water mixture as recommended by coating manufacturer.
    2) Apply two (2) coats at 2 pounds per square yard per coat.
        a) During application of first coat, complete fill all voids, depressions or other surface imperfections.
d. When second coat is set, float to a uniform texture with a sponge float.
e. Provide this finish on all exposed to view:
    1) Exterior building surfaces not otherwise indicated to receive an Architectural Abrasive Blast Finish.
    2) Interior walls, columns and similar vertical surfaces where indicated on Room Finish Schedule on the Drawings.
    3) Underside of horizontal elements adjacent to the finished surface.
f. Construct mock-up per the Mock-Ups paragraph in the QUALITY ASSURANCE Article in PART 1 of this Specification Section.

E. Related Unformed Surfaces (Except Slabs):
1. Strike smooth and level tops of walls or buttresses, horizontal offsets, and similar unformed surfaces occurring adjacent to formed surfaces after concrete is placed.
2. Float surface to a texture consistent with that of formed surfaces.
    a. If more than one finish occurs immediately adjacent to unformed surface, provide surface with most stringent formed surface requirement.
3. Continue treatment uniformly across unformed surfaces.

F. Concrete Finishes for Horizontal Slab Surfaces:
1. General:
    a. Tamp concrete to force coarse aggregate down from surface.
    b. Screed with straightedge, eliminate high and low places, bring surface to required finish elevations; slope uniformly to drains.
    c. Dusting of surface with dry cement or sand during finishing processes not permitted.
2. Unspecified slab finish:
    a. When type of finish is not indicated, use following finishes as applicable:
        1) Surfaces intended to receive bonded applied cementitious applications: Scratched finish.
        2) Surfaces intended to receive roofingor waterproofing membranes: Floated finish.
        3) Floors : Troweled finish.
        4) Garage floors and ramps: Broom or belt finish.
        5) Exterior slabs, sidewalks, platforms, steps and landings, and ramps, not covered by other finish materials: Broom or belt finish.
        6) All slabs to receive a floated finish before final finishing.
3. Scratched slab finish: After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, roughen surface with stiff brushes or rakes before final set.
4. Floated finish:
    a. After concrete has been placed, consolidated, struck off, and leveled to a Class B tolerance, do no further work until ready for floating.
    b. Begin floating when water sheen has disappeared and surface has stiffened sufficiently to permit operations.
        1) Use wood or cork float.
    c. During or after first floating, check planeness of entire surface with a 10 feet straightedge applied at not less than two different angles.
5. Cut down all high spots and fill all low spots to produce a surface with Class B tolerance throughout.
    a. Refloat slab immediately to a uniform texture.
6. Troweled finish:
    a. Float finish surface to true, even plane.
    b. Power trowel, and finally hand trowel.

c. First troweling after power troweling shall produce a smooth surface which is relatively free of defects, but which may still show some trowel marks.
d. Perform additional trowelings by hand after surface has hardened sufficiently.
e. Final trowel when a ringing sound is produced as trowel is moved over surface.
f. Thoroughly consolidate surface by hand troweling.
g. Finish in accordance with the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.
1) Leave finished surface essentially free of trowel marks, uniform in texture and appearance.
h. On surfaces intended to support floor coverings, remove any defects that would show through floor covering.

7. Broom or belt finish: Immediately after concrete has received a float finish as specified, give it a transverse scored texture by drawing a broom or burlap belt across surface.
8. Underside of concrete slab finish:
a. Match finish as specified for adjacent vertical surfaces.
b. If more than one finish occurs immediately adjacent to underside of slab surface, provide surface with most stringent formed surface requirement.

3.3 FIELD QUALITY CONTROL

A. Tolerances:
1. Finished floor slabs:
a. Provide Floor Flatness (F_F) and Floor Levelness (F_L) in accordance with ACI 117.
1) Measure in accordance with ASTM E1155.
b. Slabs not indicated to be sloped:
1) F_F: Equal or greater than 35.
2) F_L: Equal or greater than 25.
c. Slabs indicated to be sloped or curved:
1) Measure in accordance with ASTM E1486.
2) Provide slopes or curves as indicated on the Drawings.
d. Slabs indicated to receive polished concrete floor:
1) F_F: Equal or greater than 45.
2) F_L: Equal or greater than 35.
3) Refer to Room Finish Schedule on Drawings.
2. Horizontal surfaces other than finished floor slabs, including but not limited to, top of footings, top of walls, concrete fill in tankage, channels and similar applications:
a. Gap between a 10 feet straightedge placed anywhere and the finished surface shall not exceed:
1) Class A tolerance: 1/4 inches.
2) Class B tolerance: 3/8 inches.
3) Class C tolerance: 1/2 inches.
b. Accumulated deviation from intended true plane of finished surface shall not exceed 1/2 inches.

B. Unacceptable finishes shall be replaced or, if approved in writing by Contracting Officer Representative, may be corrected provided strength and appearance are not adversely affected.
1. High spots to be removed by grinding and/or low spots filled with a patching compound or other remedial measures to match adjacent surfaces.

C. Provide services of manufacturer's technical representative:
1. A certified manufacturer's representative experienced in the use of the products used shall be present on a full-time basis to observe and oversee all operations associated with the installation.
2. Contractor, along with manufacturer, shall be fully responsible for the proper application, including all means and methods incidental thereto necessary for a sound, secure and complete installation.
3. Manufacturer's representative shall be present for installation of:
a. Dry-shake Hardener.

b. Heavy-duty Metallic Aggregate Topping.

3.4 PROTECTION

A. All horizontal slab surfaces receiving chemical sealer shall be kept free of traffic and loads for minimum of 72 hours following installation of sealer.

END OF SECTION

SECTION 03 41 33
PRECAST AND PRESTRESSED CONCRETE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast and prestressed concrete.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 05 05 - Testing.
   2. Section 01 35 73 – Delegated Design Procedures

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.
   2. American Concrete Institute (ACI):
      a. 211.2, Standard Practice for Selecting Proportions for Structural Lightweight Concrete.
      b. 318, Building Code Requirements for Structural Concrete.
      c. 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
      c. A416, Standard Specification for Steel Strand, Uncoated Seven-Wire for Prestressed Concrete.
      d. A496, Standard Specification for Steel Wire, Deformed, for Concrete Reinforcement.
      e. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
      f. C33, Standard Specification for Concrete Aggregates.
      g. C150, Standard Specification for Portland Cement.
      h. C330, Standard Specification for Lightweight Aggregates for Structural Concrete.
      i. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
      j. E329, Standard Specification for Agencies Engaged in Construction Inspection and/or Testing.
   4. American Welding Society (AWS):
      a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
      b. A5.5/A5.5M, Specification for Low-Alloy Steel Electrodes for Shielded Metal Arc Welding.
      c. A5.4/A5.4M, Specification for Stainless Steel Electrodes for Shielded Metal Arc Welding.
      d. D1.1, Structural Welding Code - Steel.
      e. D1.4, Structural Welding Code - Reinforcing Steel.
      f. D1.6, Structural Welding Code – Stainless Steel.
   5. Occupational Safety and Health Administration (OSHA).
   6. Precast/Prestressed Concrete Institute (PCI):
      a. MNL 116, Manual for Quality Control for Plants and Production of Precast and Prestressed Concrete Products.
      b. MNL 120, Design Handbook - Precast and Prestressed Concrete.

B. Qualifications:
   1. Provide precast and prestressed concrete units produced by an active member of PCI.

2. Plant to be certified by the Precast/Prestressed Concrete Institute, Plant Certification Program, as applicable:
    a. Certification Code C1: Precast Concrete Products.
    b. Certification Code C2: Precast Hollow Core and Repetitive Products.
    c. Certification Code C3: Prestressed Straight Strand Structural Members.
    d. Certification Code C4: Prestressed Deflected Strand Structural Members.
    e. Plant shall have been certified within past year from bid date.
3. Plant shall be certified by IAS and shall be acceptable to the Building Code Official to assure compliance with approved fabricator Special Inspection requirements in accordance with the building code.
    a. Plants that are not certified by IAS or not acceptable to the Building Code Official may be acceptable to work on the Project, provided:
        1) Plant meets all remaining qualifications.
        2) Contractor reimburses the Government the cost of Special Inspection services.
4. Provide units manufactured by plant which has regularly and continuously engaged in manufacture of units of same type as those required for a minimum of three years.
5. Assure manufacturer's testing facilities meet requirements of ASTM E329.
6. Welding operators and processes to be qualified in accordance with:
    a. AWS D1.1 for welding steel shapes and plates.
    b. AWS D1.4 for welding reinforcing bars.
    c. AWS D1.6 for stainless steel shapes and plates.
7. Welding operators to have passed qualification tests for type of welding required during the previous 12 months prior to commencement of welding.
8. Engineer for all precast or prestressed members: Professional Engineer licensed in the State of Arizona.
    a. Engineer to have minimum five years of experience in design of precast and prestressed members with scope similar to this Project.
9. Precast erector:
    a. Minimum five years of experience with projects of similar size and complexity.

1.3 DEFINITIONS

A. Slabs: May refer to hollow core slabs or solid flat slabs, prestressed or non-prestressed.

1.4 SUBMITTALS

A. Shop Drawings:
    1. Product technical data including:
        a. Acknowledgement that products submitted meet requirements of standards referenced.
        b. Manufacturer's installation instructions.
        c. Sizes, types and manufacturer of bearing pads.
        d. Hardware to be utilized to support suspended appurtenances.
    2. Shop Drawings and erection plans for precast units, their connections and supports showing:
        a. Member size and location.
        b. Size, configuration, location and quantity of reinforcing bars and prestressing strands.
        c. Initial prestress forces.
        d. Size and location of openings verified by Contractor.
        e. Size, number, and locations of embedded metal items and connections.
        f. Required concrete strengths.
        g. Identification of each unit using same standard marking numbers as used to mark actual units.
    3. Calculations for members and connections designed by fabricator.
        a. Calculations to be sealed by a professional Structural Engineer registered in the State of Arizona.
        b. Perform calculations using the dead load of the members plus the superimposed uniform and concentrated loads shown on the Drawings and indicated in this Specification Section.

c. Design wet well structure for the surcharge loading from the retaining wall footings as applicable.
d. Indicate the following:
1) Design for maximum moment, maximum shear and maximum torsion.
2) Final top and bottom flexural stresses resulting from the stresses due to maximum moment and prestress force.
3) Ultimate moment capacity.
4) Final top and bottom flexural stresses, ultimate moment capacity, and ultimate shear capacity, if affected, for members with reduced cross sections due to openings or penetrations.
5) When required on Drawings, a check for no tension in top and bottom of members due to prestress force and member dead load plus superimposed loads indicated on Drawings and in this Specification Section.
6) Column design for maximum axial load and maximum moment.

4. Submit test results, when so required on Drawings, showing that embedded connection items will adequately support the indicated loads.
a. Connection items to have an ultimate load capacity of at least two times the required indicated load.
5. Concrete mix design(s) including submittal information defined in Specification Section 03 31 30.
6. Fabricator's quality control documentation for special inspections as required by the building code.
7. Copies of source quality control tests.
8. Certification of manufacturer's testing facility qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Headed studs and deformed bar anchors:
a. Nelson Stud Welding Div., TRW, Inc.
b. Or Equal

C. Submit requests for substitution in accordance with Specification Section 01 33 23.

2.2 MATERIALS

A. Embedded Steel Plates and Shapes:
1. ASTM A36.

B. Stainless Steel Bars and Shapes:
1. ASTM A276, Passivated, Grade 316

C. Cement:
1. Comply with ASTM C150, Type I or III; or ASTM C595, Type IL-HS
2. Type II cement to be used in the following precast units:
a. Precast weir troughs.

D. Aggregates for Normal Weight Concrete:

1. ASTM C33 with coarse aggregate meeting the gradation for Size 67 as stated in ASTM C33.
2. Provide aggregates approved for bridge construction by the State Highway Department in the state where the precast units are fabricated or in the state where the Project is located.
3. All fine aggregate to be natural not manufactured.

E. Aggregates for Lightweight Concrete:
1. ASTM C330 with 3/4 inches maximum size coarse aggregate.
2. All fine aggregate to be natural not manufactured.

F. Water:
1. Potable, clean.
2. Free of oils, acids, and organic matter.

G. Maximum total chloride ion content contributed from all ingredients of concrete including water, aggregates, cement and admixtures measured as a weight percent of cement to not exceed 0.06 for prestressed concrete and 0.10 for all other precast concrete.

H. Prestressing Strands:
1. Either 250K or 270K high tensile strength uncoated seven wire strand.
2. Manufacture and test strands in accordance with ASTM A416.

I. Reinforcing Steel and Welded Wire Reinforcement: See Specification Section 03 21 00.

J. Headed Studs:
1. ASTM A108.
2. Minimum yield strength: 50,000 psi.
3. Minimum tensile strength: 60,000 psi.

K. Deformed Bar Anchors:
1. ASTM A496 or ASTM A1064.
2. Minimum tensile strength: 80,000 psi.
3. Minimum yield strength: 70,000 psi.

L. Electrodes:
1. E70 series conforming to AWS A5.1/A5.1M or AWS A5.5/A5.5M for welding steel shapes and plates.
2. E90 series conforming to AWS A5.5/A5.5M for welding rebar.
3. E316L series conforming to AWS A5.4/A5.4M for stainless steel electrodes.

M. Concrete sand cement grout in keyways between slabs.
1. See Specification Section 03 31 30.

2.3 DESIGN

A. General Design Requirements:
1. Design units and connections in strict accordance with ACI 318, ACI 350 and the PCI MNL 120.
2. Design units for spans, dead load of members, dead and live loads indicated on the Drawings with concentrated loads placed in their actual locations.
   a. Verify weights and locations of concentrated loads.
3. Design units taking into account reduced cross section at openings and penetrations.
4. Provide all reinforcing in units as indicated.
   a. Where not indicated, design and provide all reinforcing and prestressing strands subject to approval of the Contracting Officer's Representative.
5. Due to presence of corrosive atmosphere, design prestressed members where indicated on Drawings for no tension in top and bottom of members resulting from loads indicated on Drawings and in this Specification Section.
6. Design connections to allow rotation and/or movement as appropriate to avoid damage to connections, supporting members, joint sealants and other building components.

B. Specific Design Requirements:
   1. Refer to Drawings for loadings and hoist supports.

2.4 MIXES

A. See Specification Section 03 31 30.

B. Do not begin fabrication of units until concrete mix design(s) have been approved by the Contracting Officer.

2.5 FABRICATION

A. Do not fabricate units until Shop Drawings have been approved by the Contracting Officer and returned to Contractor and support locations have been field verified by Contractor.

B. Manufacture, quality, dimensional and erection tolerances of all units to be in accordance with both PCI MNL 116 and PCI MNL 120.

C. Cast all members in smooth rigid forms which will provide straight, true members of uniform thickness and uniform color and finish.

D. Use sand cement grout mixture to fill all air pockets and voids, and to repair chipped edges.

E. Finish all repairs smooth and to match adjacent surface texture and color.

F. Where units are to receive concrete topping, provide units having heavy broom finish on top surface for bond.
   1. Provide roughness of top surface to provide bond with topping and design for horizontal shear at topping and unit interface in accordance with requirements of ACI 318 and ACI 350 Horizontal Shear Strength paragraph.
   2. Make all other surfaces smooth.

G. Incorporate embedded plates, angles, and flange welding strips into members at time of manufacture.
   1. Provide embedded items as shown on the Drawings unless prior approval is received from Contracting Officer to do otherwise.
   2. Provide flange welding strips on all flanged edges of all double tee units as indicated on Drawings.
   3. Space strips as shown on Drawings.
   4. Cast lifting handles into units at or near support points.
      a. Remove lifting handles after units are erected.

H. Cast openings larger than 6 inches SQ or 6 inches diameter in units at time of manufacture.
   1. Make smaller openings by neat cutting or neat drilling by trades requiring them.
   2. Coordinate sizes and locations of all openings before fabrication of units.

I. Make provisions for support of suspended ceilings, lighting fixtures, ducts, piping, conduits and other suspended work.
   1. When drilled expansion bolts or powder-driven fasteners are approved for use, coordinate prestress strand location with prestress concrete member supplier so that drilled expansion bolts or powder-driven fasteners do not hit or are drilled or driven into prestress strands.
   2. Install powder-driven fasteners by means of a low velocity powder-actuated tool complying with requirements of OSHA.
      a. Assure that the load to be supported by each in place drilled expansion bolt or powder-driven fastener does not exceed the maximum allowable load recommended by the bolt or fastener manufacturer for the concrete strength encountered and for the type, size and embedment length of expansion bolt or driven fastener installed.

J. Automatically weld headed studs and deformed bar anchors to members to provide full penetration weld between studs, bar anchors and members they are attached to.

K. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4 or AWS D1.6 for stainless steel shapes and plates.

L. Minimum concrete compressive strength at time of strand release: 3500 psi.

M. Mark each unit as indicated on the erection plans.
   1. Place mark on non-exposed-to-view surface.

N. Coat or finish ends of exposed prestressing strands to prevent rusting.

O. Fabricate the following types of precast and prestressed units (all units to be made with normal weight concrete unless noted otherwise on Drawings):
   1. Precast concrete beams as shown on Drawings:
      a. Reinforce as indicated.
         1) If reinforcement is not indicated, design and provide reinforcement as required to support maximum torsion, shear, moment and axial loads.
      b. See the Specific Design Requirements paragraph in the DESIGN Article in PART 2 of this Specification Section
      c. Provide beam and column connections as indicated on Drawings and as required to support all loads subject to Contracting Officer's approval.

2.6 SOURCE QUALITY CONTROL

A. During production of precast concrete units, conduct strength tests of concrete placed in units as required in Specification Section 03 05 05 for concrete placed during fabrication.
   1. Results of strength tests to be sent immediately to the Contractor and Contracting Officer.
   2. Test reports to indicate units they represent.

B. When approved by Contracting Officer, strength tests may be made by precast manufacturer after he has submitted certification that his testing facilities meet the requirements of ASTM E329.

C. Conduct tests on precast concrete using the following procedures:
   1. If the precast manufacturer's quality control program requires more frequent or more stringent testing requirements, the manufacturer's quality control program will take precedence over the specific type of test.
      a. Precast manufacturer to employ services of an independent testing laboratory to perform concrete testing for manufacturer's production procedures (not listed below) and quality control program.
   2. If the precast fabrication plant is not certified by IAS and acceptable to the Building Code Official, Government will employ and pay for precast concrete production special inspection.
      a. Coordinate with Owner's special inspector.
         1) Provide minimum 7 calendar days notice prior to the start of fabrication.
         2) Provide minimum 24 hours notice prior to fabrication of any precast members.
   3. If precast fabrication plant is certified by IAS and acceptable to the Building Code Official, perform concrete tests as specified in Section 03 05 05. Frequency of tests: Per PCI MNL-116 or PCI MNL-117 as applicable.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify acceptability and location of supports to receive units.
   1. Check bearing surfaces to determine that they are level and uniform.

B. Verify compressive strengths of concrete and masonry supports.
   1. Do not start erection of units until supports have reached their 28 day required compressive strengths.

3.2 ERECTION

A. Sequence erection to provide a balance of loads across beams and columns.

B. Give consideration to possible lack of stability or capacity of partially completed frame or structure.

C. Contractor to be responsible for guying, shoring, and bracing of frame, walls and individual members as necessary to resist forces due to wind, erection, or any other source that may occur before structure is completed.

D. Use only erection equipment adequate for placing units at lines and elevations indicated on Drawings.
   1. Do not damage units or existing construction during erection.
   2. Erect units using lifting handles cast into the units.

E. Place each leg of all double tees on a 3/8 inches thick bearing pad held 1 inch back from edge of support.
   1. Pad dimensions equal to length of bearing -1 inches x bearing width +2 inches.

F. Place slabs on continuous 1/4 inches thick bearing pad so that width equals bearing length -1 inches.

G. Provide a 1/2 inches thick bearing pad on the top of all precast concrete columns.

H. Pad to cover entire top surface of column except hold pad back 1 inch from face of column all around.

I. Weir Trough:
   1. Anchor weir troughs to supports as indicated on Drawings.
   2. Provide continuous 3/8 inches thick bearing pad under troughs at support.
   3. Hold back pads 1 inch from edge of support.

J. After erection, verify that there is no direct contact between bottom of units and supporting members.
   1. Where direct contact occurs, install additional layers of bearing material to raise units off supports.

K. Weld steel shapes and plates per AWS D1.1 and reinforcing steel per AWS D1.4, and stainless steel shapes and plates per AWS D1.6.

L. Fill all keyways between slabs with concrete sand cement grout.
   1. See Specification Section 03 31 30.

M. After all precast units are erected and all precast unit connections have been made, coat all exposed surfaces of the connections.

   1. Provide biogenic protective coating inside precast concrete.

3.3 FIELD QUALITY CONTROL

A. Testing and Special Inspections: See Section 01 40 00 and Statement of Special Inspections.

B. Causes for rejection of units include, but are not necessarily limited to the following:
   1. Cracked units.
   2. Chipped, broken, or spalled edges.
   3. Units not within allowable casting tolerances.
   4. Voids or air pockets which, in opinion of Contracting Officer's Representative, are too numerous or too large.
   5. Non-uniform finish or appearance.
   6. Low concrete strength.
   7. Improperly placed embedded items and/or openings.
   8. Exposed wire mesh, reinforcing or prestressing strands.
   9. Misaligned pipe penetration sleeves.

END OF SECTION

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SECTION 05 50 00
METAL FABRICATIONS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Custom fabricated metal items and certain manufactured units not otherwise indicated to be supplied under work of other Specification Sections.
      a. Bollards.
      b. Abrasive Stair Nosings.
      c. Steel Grating
      d. Heavy-Duty Castings, Trench Covers, and Accessories
      e. Access Cover
      f. Loose Lintels.
      g. Exterior Equipment Screens.
   2. Delegated design systems and components, including but not limited to:
      a. Metal Stairs.
      b. Aluminum Grating.
      c.
      d. Landings.
      e. Ladders.
      f. Landing and Ladder gates.
      g. Steel checkered plate.
      h. Aluminum checkered plate.
      i. Modular framing system.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 33 23 – Submittal Procedures.
   2. Section 01 35 73 – Delegated Design Procedures.
   3. Section 03 15 19 - Anchorage to Concrete.
   4. Section 03 31 30 - Concrete, Materials and Proportioning.
   5. Section 03 31 31 – Concrete Mixing, Placing, Jointing, and Curing.

1.2 REFERENCES

A. Definitions
   1. Fasteners: As defined in ASTM F1789.
   2. Galvanizing: Hot-dip galvanizing per ASTM A123/A123M or ASTM A153/A153M with minimum coating of 2.0 oz of zinc per square foot of metal (average of specimens) unless noted otherwise or dictated by standard.
   3. Hardware: As defined in ASTM A153/A153M.
   4. Installer or Applicator:
      a. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
      b. Installer and applicator are synonymous.
   5. PQR: Procedure Qualification Record
   6. MIC: Microbiologically induced corrosion.

B. Referenced Standards: Standards referenced in this section include, but are not necessarily limited to, the following:
   1. Aluminum Association (AA):
      a. ADM 1, Aluminum Design Manual.
   2. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB, Standard Specifications for Highway Bridges.

3. American Institute of Steel Construction (AISC):
    a. 325, Manual of Steel Construction.
    b. 360, Specifications for Structural Steel Buildings (referred to herein as AISC Specification).
4. The American Ladder Institute (ALI):
    a. A14.3, Ladders - Fixed - Safety Requirements.
5. American Society of Civil Engineers (ASCE):
    a. 7, Minimum Design Loads for Buildings and Other Structures.
6. ASTM International (ASTM):
    a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling.
    b. A36, Standard Specification for Carbon Structural Steel.
    c. A47, Standard Specification for Ferritic Malleable Iron Castings.
    d. A48, Standard Specification for Gray Iron Castings.
    e. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
    f. A108, Standard Specification for Steel Bar, Carbon and Alloy, Cold Finished.
    g. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
    h. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
    i. A197, Standard Specification for Cupola Malleable Iron.
    j. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
    k. A276, Standard Specification for Stainless Steel Bars and Shapes.
    l. A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
    m. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
    n. A380/A380M, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems.
    o. A500, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
    p. A501, Standard Specification for Hot-Formed Welded and Seamless Carbon Steel Structural Tubing.
    q. A536, Standard Specification for Ductile Iron Castings.
    r. A554, Standard Specification for Welded Stainless Steel Mechanical Tubing.
    s. A572, Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
    t. A563, Standard Specification for Carbon and Alloy Steel Nuts.
    u. A666, Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
    v. A668, Standard Specification for Steel Forgings, Carbon and Alloy, for General Industrial Use.
    w. A780, Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
    x. A786, Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
    y. A992, Standard Specification for Steel for Structural Shapes.
    z. A1064, Standard Specification for Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete.
    aa. A1011, 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.
    bb. B26, Standard Specification for Aluminum-Alloy Sand Castings.

cc. B209, Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
dd. B221, Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
ee. B308, Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
ff. B429, Standard Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
gg. B632, Standard Specification for Aluminum-Alloy Rolled Tread Plate.

hh. F436, Standard Specification for Hardened Steel Washers Inch and Metric Dimensions.
ii. F467, Standard Specification for Nonferrous Nuts for General Use.
jj. F468, Standard Specification for Nonferrous Bolts, Hex Cap Screws, and Studs for General Use.
kk. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
ll. F835, Standard Specification for Alloy Steel Socket Button and Flat Countersunk Head Cap Screws.
mm. F879, Standard Specification for Stainless Steel Socket Button and Flat Countersunk Head Cap Screws.
nn. F1789, Standard Terminology for F16 Mechanical Fasteners.
oo. F3125, Standard Specification for High Strength Structural Bolts, Steel and Alloy Steel, Heat Treated, 120 ksi (830 MPa) and 150 ksi (1040 MPa) Minimum Tensile Strength, Inch and Metric Dimensions.

7. American Welding Society (AWS):
   a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
   b. D1.1, Structural Welding Code - Steel.
   c. D1.2, Structural Welding Code - Aluminum.
   d. D1.6/D1.6M, Structural Welding Code - Stainless Steel.
8. National Association of Architectural Metal Manufacturers (NAAMM):
   a. AMP 510, Metal Stairs Manual.
   b. AMP 555, Code of Standard Practice for the Architectural Metal Industry (Including Miscellaneous Iron).
   c. MBG 531, Metal Bar Grating Manual.
9. NACE International (NACE).
10. Nickel Development Institute (NiDI):
    a. Publication 11 007, Guidelines for the Welded Fabrication of Nickel-Containing Stainless Steels for Corrosion Resistant Services.
11. Occupational Safety and Health Administration (OSHA):
    a. 29 CFR 1910, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Fabrication and/or layout drawings and details:
         1) Submit drawings for all fabrications and assemblies.
            a) Include erection drawings, plans, sections, details and connection details.
         2) Identify materials of construction, shop coatings and third party accessories.
   2. Product technical data (for fabrications not delegated design) including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Provide Manufacturer’s data and information on all products specified.
      c. Manufacturer's installation instructions.
      d. Provide manufacturer's standard allowable load tables for the following:
         1) Grating and checkered plate.
         2) Castings, trench covers and accessories.
         3) Modular framing systems.

3. Delegated Design Professional's "Instruments of Service" Submittals:
    a. Design drawings sealed and signed by delegated design professional, including:
        1) Design drawings deemed appropriate and necessary by delegated design professional.
        2) Show or indicate necessary details establishing the method of fastening throughout system and attachments to supporting primary structure including anchorage to concrete as required.
        3) Coordinate drawings and details with delegated design professional's calculations required in this Section.
        4) At option of Contractor or fabricator, design drawings may be combined with the Shop Drawings required in this Section, although delegated design professional's seal and signature is required on the Shop Drawings in the event of a combined Submittal.
    b. Design drawings and specifications shall sealed and signed by delegated design professional licensed in the State of Arizona.
    c. Certification of compliance in accordance with Contract Documents, including:
        1) List of design loads and load combinations used to design structural systems and components.
        2) List of loads transmitted to the supporting structural elements.
        3) Compliance with project performance and design criteria specified in the Contract Documents.
        4) Expressly indicate where structural element reaction forces to designed supporting elements, verify reaction forces indicated on Contract Documents, or existing construction differ from reaction forces indicated in the Contract Documents.

B. Color Samples:
    1. Refer to "Specification Section 01 33 23 – Submittal Procedures, Section 2.4 Color Submittals" for submission procedures and requirements of Color Samples.

C. Informational Submittals:
    1. Certifications
        a. NACE certification of surface preparation.
        b. NACE certification of paint application.
    2. Supplier's Instructions:
        a. Fabricator's instructions for handling, storing, and installing structural elements furnished.
        b. Galvanizing repair paint manufacturer's installation instructions.
    3. Qualifications Statements:
        a. NACE inspector qualifications.
        b. Delegated design professional.
        c. Fabricator, when requested by Contracting Officer Representative, including:
            1) Qualifications and experience.
            2) Qualifications of welders to be employed in fabricating the structural elements for the Project.
            3) Qualifications of welders to be employed during erection of the structural elements for the Project.
        d. Installer, when requested by Contracting Officer Representative, including fabricator's approval of installer.
    4. Delegated design Shop Drawings approved by delegated design professional:
        a. Detailed structural elements erection drawings, shop details, erection detail.
        b. Indicate member type, location, spacing, size, and gauge of members; method of attachment to supporting members; and necessary erection details.
        c. Show and indicate supplemental bracing, strapping, splices, bridging, accessories, and details necessary for proper installation.

d. Structural element Placement Diagram: Diagram showing and indicating assumed location of each structural element and references the corresponding structural element design drawing.

5. Delegated design product data approved by delegated design professional:
   a. Fabricator's published product data for each type of structural element and accessory required.
   b. Expressly indicate compliance with applicable reference standards. If not addressed in fabricator's published information, submit as special certification addressing compliance with reference standards indicated in this Section.
   c. Published product data for galvanizing repair paint.
6. Delegated design calculations in accordance with Contract Documents:
   a. Complete set of design calculations, indicating:
      1) Basis of design, including a list of codes and standards used for design.
      2) List of design loads and load combinations.
      3) Design moments, shear forces, and axial compression/tension forces.
      4) Design of connections, including splices, if required.
      5) Bridging and bracing design, including attachments to trusses and anchorage to supporting structural elements, if required.
      6) Special requirements, if any.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Applicable construction codes including building code, are indicated in Section 01 42 00 - References.

B. Qualifications:
   1. Qualify welding procedures and welding operators in accordance with AWS.
      a. All welders shall be qualified in all positions that will be utilized during welding. Welders shall utilize qualified PQR for testing.
      b.
   2. Fabricator shall have minimum of 10 years of experience in fabrication of metal items specified.
   3. Engineer for contractor-designed systems and components: Professional structural engineer licensed in the State of Arizona
   4. NACE certified inspector shall have minimum of two years of experience performing inspections as indicated.
      a. Have a current Level III coating inspector certification.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and handle fabrications to avoid damage.

B. Store above ground on skids or other supports to keep items free of dirt and other foreign debris and to protect against corrosion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified salient characteristics.

2. Abrasive stair nosings (embedded in exterior concrete stairs):
   a. Babcock Davis - "BSTCA-C3W".
   b. Or Equal.
3. Abrasive stair nosings (embedded in interior steel pan concrete stairs):
   a. Balco - "DXH-330"
   b. Or Equal.
4. Headed studs and deformed bar anchors:
   a. Nelson Stud Welding Div., TRW Inc.
   b. Stud Welding Products, Inc.
5. Mechanical anchor bolts:
   a. See Section 03 15 19.
6. Epoxy adhesive anchor bolts:
   a. See Section 03 15 19.
7. Concrete screw anchors:
   a. See Section 03 15 19.
8. Castings, trench covers and accessories:
   a. Neenah Foundry Co.
   b. Deeter Foundry Co.
   c. Barry Craft Construction Casting Co.
   d. McKinley Iron Works.
9. Aluminum ladders:
   a. O'Keeffe's Inc. – Model 501.
   b. Or Equal.
10. Ladder safety extension posts:
    a. Bilco - "LadderUp" safety post.
    b. Or Equal.
11. Ladder safety system:
    a. Miller Equipment - "Saf-T-Climb" system.
    b. Or Equal.
12. Steel pan concrete stairs:
    a. Steel Shop / Factory Fabricated.
    b. Or Equal.
13. Aluminum Stop Plates (Volume 7):
    a. RW Gate Company – Model RW4000-A.
    b. Or Approved Equal.
14. Exterior Equipment Screens:
    a. PalmSHIELD
    b. Or Equal.
15. Galvanizing repair paint:
    a. Aervoe Industries, Inc.
    b. ZRC Products.
16. Modular framing system:
    a. Unistrut Building Systems.
    b. B-Line Systems.
    c. Kindorf.
    d. Superstrut.

2.2 MATERIALS

A. Steel:
   1. Structural:
      a. W-shapes and WT-shapes: ASTM A992, Grade 50.
      b. All other plates and rolled sections: ASTM A36.
   2. Pipe: ASTM A53, Types E or S, Grade B or ASTM A501.
   3. Structural tubing:
      a. ASTM A500, Grade B (46 ksi minimum yield).

4. Bolts, high strength:
    a. ASTM F3125, Grade A325.
5. Nuts, high strength:
    a. ASTM A563.
6. Washers (hardened):
    a. ASTM F436.
    b. Provide two (2) washers with all bolts.
7. Bolts and nuts (unfinished):
    a. ASTM A307, Grade A.
8. Welding electrodes: AWS D1.1, E70 Series.
9. Steel forgings: ASTM A668.

B. Aluminum:
1. Alloy 6061-T6 or Alloy 6061-T6, 32,000 psi tensile yield strength minimum.
    a. ASTM B221 and ASTM B308 for shapes including beams, channels, angles, tees and zees.
    b. Stop plates, ASTM B308/308M (Volume 7).
    c. Weir plates, baffles and deflector plates, ASTM B209.
2. Alloy 6063-T5 or T6, 15,000 psi tensile yield strength minimum.
    a. ASTM B221 and ASTM B429 for bars, rods, wires, pipes and tubes.
3. ASTM B26 for castings.
4. ASTM F468, alloy 2024 T4 for bolts.
5. ASTM F467, alloy 2024 T4 for nuts.
6. Electrodes for welding aluminum: AWS D1.2, filler alloy 4043 or 5356.
7. Sheet: Alloy 5005-H3 to comply with ASTM B209.

C. Washers: Same material and alloy as found in accompanying bolts and nuts.

D. Embedded Anchor Bolts:
1. See Specification Section 03 15 19.

E. Mechanical Anchor Bolts and Adhesive Anchor Bolts:
1. See Specification Section 03 15 19.

F. Headed Studs: ASTM A108 with a minimum yield strength of 50,000 psi and a minimum tensile strength of 60,000 psi.

G. Deformed Bar Anchors: ASTM A1064 with a minimum yield strength of 70,000 psi and a minimum tensile strength of 80,000 psi.

H. Iron and Steel Hardware: Galvanized in accordance with ASTM A153/A153M when required to be galvanized.

I. Galvanizing Repair Paint:
1. High zinc dust content paint for regalvanizing welds and abrasions.
2. ASTM A780.
3. Zinc content: Minimum 92% in dry film.
4. ZRC "ZRC Cold Galvanizing" or Aervoe " Crown Cold Galvanize Coating 93% Zine Rich."

J. Dissimilar Materials Protection: Isolate dissimilar metals with neoprene or coatings as required by manufactuer.

2.3 MANUFACTURED UNITS

A. Ladders:
1. General:
    a. All ladders of a particular material shall have consistent construction and material shapes and sizes unless noted otherwise on the Drawings.
    b. Design ladder in accordance with OSHA Standards, ANSI A14.3, ASCE 7 and the building code.

c. Ladders shall be designed to support a minimum concentrated live load of 300 pounds at any point to produce the maximum stress in the member being designed.
    1) Apply additional 300 pound loads for each section of ladder exceeding 10 feet.
d. Maximum allowable stresses per AA ADM 1.
e. Maximum lateral deflection: Side rail span/240 when lateral load of 100 pounds is applied at any location.

2. Material:
    a. Aluminum.
        1) Finish: Mill.
3. Brackets:
    a. Angle or bent plate brackets welded to side rails:
        1) 3/16-inch thick extruded aluminum bracket on each side of ladder.
            a) "Z" shaped brackets shall be minimum 9-inches high to fasten to wall and back side of rails with fasteners/bolts per manufacturer.
        2) Provide punched holes per manufacturers standards for bolts or anchors.
        3) Minimum distance from centerline of rung to wall or any obstruction: 7-inches.
        4) Maximum spacing: 4 feet on center.
    b. Floor supported ladders shall have 3/16-inch thick aluminum angles 4-inch by 1-3/8-inch legs by 2-inch wide fastened to inside face of rails and to floors.
        1) Provide one on each side of ladder rails.
        2) Provide wall brackets on floor supported units if vertical run is over 4 feet.
4. Ladder safety extension post:
    a. Telescoping tubular aluminum section that automatically locks into place when fully extended.
    b. Non-ferrous corrosion-resistant spring and hardware.
    c. Factory assembled with all hardware necessary for mounting to ladder.
5. Ladder safety system:
    a. Extruded aluminum safety rail.
        1) Safety rail shall extend from within 3-feet of base of ladder to top of ladder side rails.
        2) Provide rung clamps at not more than 4-feet on center.
        3) Provide dismount extensions as appropriate for application.
    b. Aluminum shuttle.
        1) Provide (2) shuttles per ladder.
    c. Full body harness with adjustable leg straps, backpad, and front dee ring.
        1) Provide (2) harnesses per ladder.
    d. Provide all components required for a complete OSHA compliant ladder safety system.

B. Bollards:
1. 8 inches diameter extra strength steel pipe, ASTM A53.
    a. Galvanized.
    b. Paint bollards Federal Standard Color Brown #10080 after installation.

C. Stairs Aluminum Framed:
1. Refer to "Specification Section 01 35 73 – Delegated Design Procedures" for the complete design of stair systems.
2. Fabricated as indicated.
    a. Aluminum, 6061-T6 Alloy
3. Treads: Aluminum bar grating treads
4. Risers:
    a. Grating treads:
        1) Solid plate welded to trailing edge of tread or landing.
        2) Minimum 3/16 inch by 4 inch high.
5. Landings:
    a. Grating as specified.
    b. Provide integral corrugated non-slip nosing at edge acting as stair tread/nosing.

6. Design live load for landing platform and supporting structure:
    a. 100 pounds per square feet, uniform load.
    b. 300 pounds concentrated load on 4-inches square area.
    c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
    d. Maximum deflection: 1/300 of span under a superimposed live load of 100 pounds per square feet.
    e. Reference project requirements.
7. Design, fabricate, and install in compliance with NAAMM and applicable codes.
    a. NAAMM AMP 510:
        1) Exterior at site structures and equipment: Industrial Class.
        2) Interior or exterior at buildings: Service Class
    b. ICC A117.1.
8. Nosings:
    a. Abrasive nosings as specified.
    b. Coordinate riser height to compensate for thickness of nosing.
9. Handrails and guardrails: Comply with OSHA requirements.

D. Steel Checkered Plate:
1. Provide galvanized checkered plate and edge supports.
2. Conform to ASTM A786.
    a. Diamond pattern: No.3 (large) or No.4 (medium).
    b. Use one pattern throughout Project.
    c. Material: 36 ksi minimum yield strength.
3. For removeable plate panels:
    a. Weight limit not to exceed 50 lbs.
4. Design live load (unless noted otherwise on Drawings):
    a. 100 psf, uniform load.
    b. 300 pounds concentrated load on 4 inches square area.
    c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
    d. Maximum deflection: 1/300 of span under a superimposed live load of 50 psf.
5. Reinforce as necessary with steel angles welded to underside of checkered plate.
6. Plate sections:
    a. Maximum 3 feet wide.
    b. Minimum 1/4 inches thick.
    c. Maximum 100 pounds per section if required to be removable.
7. Provide joints at center of all openings unless shown otherwise.
    a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
8. Unless shown otherwise, frame for opening with steel checkered plate cover:
    a. Steel support angles:
        1) 3 by 2 by 1/4 inches minimum size with long leg vertical.
        2) 5/8 inches diameter adhesive anchor bolts spaced at maximum of 24 inches on-center along each side with not less than two anchor bolts per side.
    b. Steel concrete insert seats:
        1) 2 by 2 by 1/4 inches minimum size.
        2) Auto-welded studs or strap anchors, ASTM A108 at 18 inches on-center with not less than two studs or anchors per side.
    c. Drill and tap frame to receive 3/8 inches diameter fasteners at not more than 24 inches on-center with not less than two fasteners per side.
        1) Fasteners: Flat countersunk cap screws, ASTM F835.
            a) Galvanized, ASTM A153/A153M.

E. Aluminum Checkered Plate:
1. Conform to ASTM B632.

a. Diamond pattern: Use one pattern throughout Project.
b. Material: Type 6061-T6 or 6005-T6.

2. Design live load:
   a. 100 psf, uniform load.
   b. 300 pounds concentrated load on 4 inches square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 50 psf.
3. Reinforce as necessary with aluminum angles.
4. Plate sections:
   a. Maximum 3 feet wide.
   b. Minimum 1/4 inches thick.
   c. Maximum 100 pounds per section if required to be removable.
   d. Provide (2) flush lifting handles for each removable section.
5. Provide joints at center of all openings unless shown otherwise.
   a. Reinforce joints and openings with additional angles to provide required load carrying capacity.
6. Unless shown otherwise, frame for openings with aluminum checkered plate cover:
   a. Aluminum support angles:
      1) 3 by 2 by 1/4 inches minimum size with long leg vertical.
      2) 5/8 inches diameter adhesive anchor bolts spaced at maximum of 24 inches on-center along each side with not less than two anchor bolts per side.
   b. Aluminum concrete insert seats:
      1) 2 by 2 by 1/4 inches minimum size.
      2) Auto-welded studs or strap anchors at 18 inches on-center with not less than two studs or anchored per side.
   c. Drill and tap frame to receive 3/8 inches diameter fasteners at not more than 24 inches on-center with not less than two fasteners per side.
      1) Fasteners: Stainless steel flat countersunk cap screws: ASTM F879.

F. Aluminum Grating:
1. NAAMM MBG 531.
2. Minimum depth: 1-1/2 inches.
3. Minimum rectangular bearing bar size:
   a. 3/16 inches thick.
   b. Maximum 1-3/16 inches on-center spacing.
4. Minimum I-bar flange width: 1/4 inches.
5. For removeable panels:
   a. Weight of panel not to exceed 50 lbs.
6. Design live load, unless noted otherwise on Drawings:
   a. 100 psf, uniform load.
   b. 300 pounds concentrated load on 4 inches square area.
   c. All components to be adequate for the uniform load or the concentrated load, whichever requires the stronger component.
   d. Maximum deflection: 1/300 of span under a superimposed live load of 50 psf.
7. Cross bars:
   a. Welded, swaged or pressure locked to bearing bars.
   b. Maximum 4 inches on-center spacing.
8. Top edges of bars: Grooved or serrated.
9. Removable grating sections: Not wider than 3 feet and not more than 100 pounds.
   a. Provide (2) flush lifting handles for each section designated as removable.
10. Standard mill finish.
11. Ends and perimeter edges: Banded.
12. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 inches high toe plate.
13. Provide openings at joints between individual grating sections.

14. Clips and bolts: Stainless steel.
15. Seat angles: Aluminum.
16. At Contractor's option, aluminum plank type grating with skid-resistant surface may be used.
    a. Grating to have a minimum 35% up to a maximum of 45% open area and meet the design loads and deflection specified in this Specification Section.

G. Seat angles: Aluminum or stainless steel Aluminum Stop Plates (Volume 7):
1. Plate:
    a. Shall be reinforced with plates or channel shaped members to restrict deflection to less than ¼-inch at the design head.
    b. Shall be designed to ensure that plates lower into place through gravity with no external downward force necessary.
    c. Each plate shall have a tag, constructed of aluminum, to indicate the manufacturer's name and opening width, if applicable.
2. Frame:
    a. Shall be constructed of aluminum and shall be reinforced to withstand operating conditions.
    b. Shall not contain any rubber or plastic seals or seats.
3. Anchorage:
    a. Anchor bolts shall be 316 stainless steel, fully threaded and shall have a minimum diameter of ½-inch.
    b. Anchor bolts shall be of the epoxy type.
4. Finish:
    a. All aluminum shall be mill finish.
    b. Aluminum in contact with concrete shall be field coated with a heavy coat of bitumastic pain field applied by the Contractor.
5. Stop Plate Schedule:

STOP PLATE ID #	HEIGHT	WIDTH	OPENING	OPENING INVERT	OPENING HEIGHT	OPENING WIDTH	SHEET
SP-1	3'-3"	1'-0"	YES	8319.40	1'-0"	8"	072 D101
SP-2	3'-3"	1'-0"	YES	8319.40	1'-0"	8"	072 D101
SP-3	1'-0"	1'-0"	NO	N/A	N/A	N/A	073 D305
SP-4	1'-0"	1'-0"	NO	N/A	N/A	N/A	073 D305
SP-5	4'-1"	2'-0"	NO	N/A	N/A	N/A	073 D322

H. Steel Grating:
1. NAAMM MBG 531.
2. Bearing bars:
    a. Rectangular 1-1/2 by 3/16 inches unless otherwise noted on Drawings.
    b. Maximum 1-3/16 inches on-center spacing.
3. Cross bars:
    a. Welded, swagged or pressure locked to bearing bars.
    b. Maximum 4 inches on-center spacing.
4. Top edges of bars: Serrated or grooved.
5. Removable grating sections: Not wider than 3 feet and not more than 50 pounds.
6. Finish:
    a. Galvanized.
    b. Clips and bolts: Galvanized.
    c. Seat angles: Galvanized steel.

7. Ends and perimeter edges: Banded.
8. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 inches high toe plate.
9. Provide joints at openings between individual grating sections.

I. Heavy-Duty Castings, Trench Covers, and Accessories:
1. Prefabricated, cast iron ASTM A48.
2. Design load: AASHTO HS-20 wheel loading for indicated span.
3. Machine horizontal mating surfaces.

J. Access Cover:
1. Tank type manhole frame and solid lid: ASTM A48 or ASTM A536, cast iron.
2. Unless shown otherwise, design of cover shall be such that top of frame extends several inches above slab to prevent surface water from entering tank.
3. Equip lid with four stainless steel screws to secure lid to frame.

K. Loose Lintels:
1. Steel, ASTM A36 or ASTM A572 Grade 50, sizes as indicated on Drawings.
2. Hot-dip galvanized per ASTM A123/A123M.

L. Modular Framing System:
1. Materials:
   a. Steel: ASTM A1011, carbon steel, Grade 33.
      1) Hot-dipped galvanized, ASTM A123 or ASTM A153.
   b. Aluminum: ASTM B221 or ASTM B209.
   c. Stainless steel: ASTM A666.
2. Channels and inserts:
   a. Steel or stainless steel: Minimum 12 GA.
   b. Aluminum: Minimum 0.080 inches.
   c. Channels to have one side with a continuous slot with in-turned lips.
      1) Width: 1-5/8 inches.
      2) Depth and configuration as necessary for loading conditions.
3. Fittings: Same material as system major components.
4. Fasteners:
   a. Nuts: Toothed groves in top of nuts to engage the in-turned lips of channel.
   b. Bolts: Hex-head cap screws.
   c. Same material as system major components.
5. End caps:
   a. At each exposed end of each piece mounted on walls, or guardrails, or suspended from framing 7 feet or less above the floor or platform.
      a) Plastic for all exposed ends 7 feet or more above floor or platform.
      b) Plastic or metallic for all other exposed ends.
6. Schedule:
   a. Interior wet areas: Stainless steel.
      1) Including the following rooms or areas:
         a) Headworks Building
         b) Secondary Treatment Process Area
   b. Interior corrosive areas: Stainless steel.
      1) Including the following rooms or area:
         a) Headworks Building.
   c. Exterior areas: Stainless steel.
   d. All other areas not listed above: Hot-dipped galvanized steel.
7. Provide dissimilar materials protection..
8. Repair all cut ends or otherwise damaged areas of galvanized steel in accordance with ASTM A780.

2.4 FABRICATION

A. Verify field conditions and dimensions prior to fabrication.

B. Form materials to shapes indicated with straight lines, true angles, and smooth curves.
   1. Grind smooth all rough welds and sharp edges.
      a. Round all corners to approximately 1/32 - 1/16 inches nominal radius.

C. Provide drilled or punched holes with smooth edges.
   1. Punch or drill for field connections and for attachment of work by other trades.

D. Weld Shop Connections:
   1. Stainless steel connections subject to corrosive environments or immersion service will be subject to the following enhanced visual and welding requirements:
      a. Fabricator
         1) Fabricator shall have QC program and procedures in place to avoid cross contamination with carbon steel products and material.
      b. Weld Procedures
         1) Weld procedures shall be qualified for all positions that will be welded, qualified by testing in accordance with applicable welding code AWS D1.6 requirements.
         2) Procedure Qualification Record (PQR) shall document all essential variables to perform consistent quality welds. PQR shall include maximum heat input per pass and shall be tested for CVN properties, macro hardness, and macro/micro hardness testing.
   2. Welds shall be continuous fillet type unless indicated otherwise.
   3. Full penetration butt weld at bends in stair stringers and ladder side rails.
   4. Weld structural steel in accordance with AWS D1.1 using Series E70 electrodes conforming to AWS A5.1/A5.1M.
   5. Weld aluminum in accordance with AWS D1.2.
   6. Weld stainless steel in accordance with AWS D1.6.
   7. All headed studs to be welded using automatically timed stud welding equipment.
   8. Grind smooth welds that will be exposed.

E. Make provisions to prevent carbon steel/free iron contamination of stainless steel surfaces (i.e., contact between carbon steel or iron and stainless steel component). Do not use cutting/grinding/drilling tools, wire brushes, or wire wheels on stainless steel that have been previously used on carbon steel or iron. Do not support or hang stainless steel weldments or fixtures with carbon steel cables or dunnage.

F. Passivate stainless steel items and stainless steel welds after they have been ground smooth, in accordance with ASTM A380/A380M.

G. Passivation Requirements:
   1. For components/assemblies to be used only in dry air service environments:
      a. No post-fabrication passivation treatments are required for external corrosion control.

H. Conceal fastenings where practicable.

I. Fabricate work in shop in as large assemblies as is practicable.

J. Tolerances:
   1. Rolling:
      a. ASTM A6.
      b. When material received from the mill does not satisfy ASTM A6 tolerances for camber, profile, flatness, or sweep, the Contractor is permitted to perform corrective work by the use of controlled heating and mechanical straightening, subject to the limitations of the AISC Specification.
   2. Fabrication tolerance:
      a. Member length:
         1) Both ends finished for contact bearing: 1/32 inches.

2) Framed members:
a) 30 feet or less: 1/16 inches.
b) Over 30 feet: 1/8 inches.

b. Member straightness:
1) Compression members: 1/1000 of axial length between points laterally supported.
2) Non-compression members: ASTM A6 tolerance for wide flange shapes.

c. Specified member camber (except compression members):
1) 50 feet or less: -0/+1/2 inches.
2) Over 50 feet: -0/+1/2 inches (+1/8 inches per 10 feet over 50 feet).
3) Members received from mill with 75% of specified camber require no further cambering.
4) Beams/trusses without specified camber shall be fabricated so after erection, camber is upward.
5) Camber shall be measured in fabrication shop in unstressed condition.

d. At bolted splices, depth deviation shall be taken up by filler plates.
1) At welded joints, adjust weld profile to conform to variation in depth.
2) Slope weld surface per AWS requirements.

e. Finished members shall be free from twists, bends and open joints.
1) Sharp kinks, bends and deviation from above tolerances are cause for rejection of material.

K. Fabricate grating, checkered plate, stairs, ladders and accessories using aluminum unless shown otherwise on Drawings.
1. Finish:
a. Mill, unless noted otherwise.
b. Coat surfaces in contact with dissimilar materials.
1) See Specification Section 09 96 00.

L. Fabricate grating in accordance with NAAMM MBG 531.
1. Maximum tolerance for difference in depth between grating depth and seat or support angle depth: 1/8 inches.
2. Distance between edge of grating and face of embedded seat angle or face of wall or other structural member: 1/4 inches.
a. Tolerance: NAAMM MBG 531.
3. Removable sections: Not wider than 3 feet and not heavier than 100 pounds.
4. Ends and perimeter edges: Banded, with alternate bearing bars welded to band.
a. Provide full depth banding unless noted otherwise.
b. Banding at trenches and sumps to be 1/4 inches less than grating depth to allow for drainage.
5. Openings through grating: Reinforced to provide required load carrying capacity and banded with 4 inches high toe plate.
6. Provide joints at openings between individual grating sections.
7. Fabricate grating so that bearing bars and cross bars in adjacent sections are aligned.

M. Fabricate checkered plate and miscellaneous metals in accordance with NAAMM AMP 555.
1. Workmanship: Class 2 unless noted otherwise.

2.5 SOURCE QUALITY CONTROL

A. Surface Preparation:
1. All miscellaneous metal fabrication item surfaces shall be observed and approved, prior to application of shop-applied coatings, by a NACE Certified Coatings Specialist (CIP-3) with at least 4 years of experience in similar inspections.
a. Inspection shall be performed to determine depth of blast profile and cleanliness of surface.
b. Fabricator shall reblast and or re-clean surfaces as required until acceptable.

B. Shop Applied Coating Application:

1. After surface has been accepted in writing by NACE certified coatings inspector, fabricator may proceed with application of coatings.
2. Application of coatings shall be observed and certified by NACE certified coatings inspector.

C. Shop Inspection and Testing:
1. Contractor will employ and pay for the services of a qualified independent testing agency to inspect and test all structural steel work for compliance with Contract Documents.
2. Contractor responsible for testing to qualify shop and field welders and as needed for Contractor's own quality control to ensure compliance with Contract Documents.
3. Independent testing agency shall have a minimum of five years performing similar work and shall be subject to Government's approval.

D. Responsibilities of Testing Agency:
1. Inspect shop and field welding in accordance with AWS Code including the following non-destructive testing:
   a. Visually inspect all welds.
   b. In addition to visual inspection, test 50% of full penetration welds and 20% of fillet welds with liquid dye penetrant or mag particle.
   c. Test 20% of liquid dye penetrant tested full penetration welds with ultrasonic or radiographic testing.
   d. For all surfaces intended to be immersed or intended to be water tight:
      1) 100% of all fillet welds shall be PT tested to ensure water-tight surfaces are free of surface defects that would create areas for MIC.
      2) 100% of all completed SS welds and material shall be passivated in accordance with ASTM A380/A380M.
2. Inspect high-strength bolting in accordance with the RCSC Specification for Structural Joints Using High-Strength Bolts, Section 9.
   a. Verify direct tension indicator gaps, if applicable.
3. Inspect structural steel which has been erected.
4. Inspect stud welding in accordance with AWS Code.
5. Prepare and submit inspection and test reports to Contracting Officer Representative.
   a. Assist Contracting Officer Representative to determine corrective measures necessary for defective work.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide items to be built into other construction in time to allow their installation.
1. If such items are not provided in time for installation, cut in and install.

B. Prior to installation, inspect and verify condition of substrate.

C. Correct surface defects or conditions which may interfere with or prevent a satisfactory installation.
1. Field welding aluminum is not permitted unless approved in writing by Contracting Officer Representative.

3.2 INSTALLATION

A. Set metal work level, true to line, plumb.
1. Shim and grout as necessary.

B. Contractor is solely responsible for safety.
1. Construction means and methods and sequencing of work is the prerogative of the Contractor.

2. Take into consideration that full structural capacity of many structural members is not realized until structural assembly is complete; e.g., until slabs, decks, and diagonal bracing or rigid connections are installed.
3. Partially complete structural members shall not be loaded without an investigation by the Contractor.
4. Until all elements of the permanent structure and lateral bracing system are complete, temporary bracing for the partially complete structure will be required.

C. Adequate temporary bracing to provide safety, stability and to resist all loads to which the partially complete structure may be subjected, including construction activities and operation of equipment is the responsibility of the Contractor.
1. Plumb, align, and set structural steel members to specified tolerances.
2. Use temporary guys, braces, shoring, connections, etc., necessary to maintain the structural framing plumb and in proper alignment until permanent connections are made, the succeeding work is in place, and temporary work is no longer necessary.
3. Use temporary guys, bracing, shoring, and other work to prevent injury or damage to adjacent work or construction from stresses due to erection procedures and operation of erection equipment, construction loads, and wind.
4. Contractor shall be responsible for the design of the temporary bracing system and must consider the sequence and schedule of placement of such elements and effects of loads imposed on the structural steel members by partially or completely installed work, including work of all other trades.
    a. If not obvious from experience or from the Drawings, confer with the Contracting Officer Representative to identify those structural steel elements that must be complete before the temporary bracing system is removed.
5. Remove and dispose of all temporary work and facilities off-site.

D. Examine work-in-place on which specified work is in any way dependent to ensure that conditions are satisfactory for the installation of the work.
1. Report defects in work-in-place which may influence satisfactory completion of the work.
2. Absence of such notification will be construed as acceptance of work-in-place.

E. Field Measurement:
1. Take field measurements as necessary to verify or supplement dimensions indicated on the Drawings.
2. Contractor responsible for the accurate fit of the work.

F. Check the elevations of all finished footings or foundations and the location and alignment of all anchor bolts before starting erection.
1. Use surveyor's level.
2. Notify Contracting Officer Representative of any errors or deviations found by such checking.

G. Framing member location tolerances after erection shall not exceed the frame tolerances listed in the FIELD QUALITY CONTROL Article in PART 3 of this Specification Section.

H. Erect plumb and level; introduce temporary bracing required to support erection loads.

I. Use light drifting necessary to draw holes together.
1. Drifting to match unfair holes is not allowed.

J. Welding:
1. Comply with AWS D1.1, AWS D1.2, and AWS D1.6 (as applicable for the material welded) and requirements of this Section’s “Fabrications” Article in “Part 2 - Products”.
2. When joining two sections of steel of different ASTM designations, welding techniques shall be in accordance with a qualified AWS D1.1 procedure.
3. 100% of all completed stainless steel welds and material shall be passivated in accordance with ASTM A380/A380M.

K. Shore existing members when unbolting of common connections is required.

1. Use new bolts for rebolting connections.

L. Clean stored material of all foreign matter accumulated prior to the completion of erection.

M. Bolt Field Connections: Where practicable, conceal fastenings.

N. Field Welding:
   1. Follow AWS procedures.
   2. Grind welds smooth where field welding is required.
   3. 100% of all completed stainless steel welds and material shall be passivated in accordance with ASTM A380/A380M.

O. Field cutting grating or checkered plate to correct fabrication errors is not acceptable.
   1. Replace entire section.

P. Remove all burrs and radius all sharp edges and corners of miscellaneous plates, angles, framing system elements, etc.

Q. Unless noted or specified otherwise:
   1. Connect steel members to steel members with 3/4 inches diameter ASTM F3125, Grade A325 high strength bolts.
   2. Connect aluminum to aluminum with 3/4 inches diameter stainless bolts.
   3. Connect aluminum to structural steel using 3/4 inches diameter stainless steel bolts.
      a. Provide dissimilar metals protection.
   4. Connect aluminum and steel members to concrete and masonry using stainless steel mechanical anchor bolts or adhesive anchor bolts unless shown otherwise.
      a. Provide dissimilar materials protection.
   5. Provide washers for all bolted connections.
   6. Where exposed, bolts shall extend a maximum of 3/4 inches and a minimum of 1/2 inches above the top of installed nut.
      a. If bolts are cut off to required maximum height, threads must be dressed to allow nuts to be removed without damage to the bolt or the nuts.

R. Install and tighten ASTM F3125, Grade A325 high-strength bolts in accordance with the AISC 325, Allowable Stress Design (ASD).
   1. Provide hardened washers for all Grade A325 bolts.
      a. Provide the hardened washer under the element (nut or bolt head) turned in tightening.

S. After bolts are tightened, upset threads of ASTM A307 bolts or anchor bolts to prevent nuts from backing off.

T. Secure metal to wood with lag screws of adequate size with appropriate washers.

U. Do not field splice fabricated items unless said items exceed standard shipping length or change of direction requires splicing.
   1. Provide full penetration welded splices where continuity is required.

V. Provide each fabricated item complete with attachment devices as indicated or required to install.

W. Anchor such that work will not be distorted nor fasteners overstressed from expansion and contraction.

X. Set beam and column base plates accurately on nonshrink grout as indicated on Drawings.
   1. See Division 03 Specification Sections for non-shrink grout and anchorage.
   2. Set and anchor each base plate to proper line and elevation.
      a. Use metal wedges, shims, or setting nuts for leveling and plumbing columns and beams.
         1) Wedges, shims and setting nuts to be of same metal as base plate they support.
         2) Tighten nuts on anchor bolts.
      b. Fill space between bearing surface and bottom of base plate with nonshrink grout.

1) Fill space until voids are completely filled and base plates are fully bedded on wedges, shims, and grout.

c. Do not remove wedges or shims.
   1) Where they protrude, cut off flush with edge of base plate.

d. Fill sleeves around anchor bolts solid with non-shrink grout.

Y. Tie anchor bolts in position to embedded reinforcing steel using wire.
   1. Tack welding prohibited.
      a. Coat projecting bolt threads and nuts with heavy coat of clean grease.
   2. Anchor bolt location tolerance:
      a. Per Section 03 15 19.

Z. Install bollards as detailed on Drawings.
   1. Fill pipe with concrete and round off at top.

AA. Provide abrasive stair nosings in each tread and landing of all concrete stairs and at each concrete stair landing having metal stair structure attaching to the concrete landing.
   1. Center stair nosings in stair width.

BB. Accurately locate and place frames for openings before casting into floor slab so top of plate is flush with surface of finished floor.
   1. Keep screw holes clean and ready to receive screws.

CC. Attach grating to end and intermediate supports with grating saddle clips and bolts.
   1. Maximum spacing: 2 feet on-center with minimum of two per side.
   2. Attach individual units of aluminum grating together with clips at 2 feet on-center maximum with a minimum of two clips per side.

DD. Coat aluminum surfaces in contact with dissimilar materials with cathodic coating.

EE. Repair damaged galvanized surfaces in accordance with ASTM A780.
   1. Prepare damaged surfaces by abrasive blasting or power sanding.
   2. Apply galvanizing repair paint to minimum 6 mils DFT in accordance with manufacturer's instructions.

FF. Anchor ladder to concrete structure with minimum 3/4-inch stainless steel anchor bolts with minimum 6-inches embedment.

GG. Install ladder safety extension post in accordance with manufacturer's instructions.
   1. Mount device opposite the climbing side.
   2. Provide ladder safety extension device for all ladders unless noted otherwise.

HH. Mount ladder fall protection system with rail offset from ladder side rail approximately 3-inches.

II. Install factory pre-fabricated stairs in location indicated in the Contract Documents and approved submittals.

JJ. Install loose lintels as shown on drawings.

KK. Install Exterior Equipment Screen in accordance with the manufacturer’s written instructions:
   1. Minimum requirements - posts to be anchored to concrete slab with 10-inch x 10-inch x 3/4-inch aluminum base plates welded to bottom of posts and anchored with four (4) 3/4-inch epoxy anchors into concrete slab.

3.3 FIELD QUALITY CONTROL

A. Tolerances (unless otherwise noted on the Drawings):
   1. Frame placement, after assembly and before welding or tightening.
      a. Deviation from plumb, level and alignment: 1 in 500, maximum.
      b. Displacement of centerlines of columns: 1/2-inches maximum, each side of centerline location shown on Drawings.

3.4 CLEANING

A. After fabrication, erection, installation, or application, clean all miscellaneous metal fabrication surfaces of all dirt, weld slag and other foreign matter.

B. Provide surface acceptable to receive field applied paint coatings.

END OF SECTION

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SECTION 06 10 00
ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Rough Carpentry.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 15 19 – Anchorage to Concrete
   2. Section 07 92 00 - Joint Sealants.
   3. Section 09 22 16 – Non-Structural Metal Framing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. D1761, Standard Test Methods for Mechanical Fasteners in Wood and Wood-Based Materials.
      c. D2898, Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing.
      d. D4442, Standard Test Methods for Direct Moisture Content Measurement of Wood and Wood-Base Materials.
      e. D4444, Standard Test Method for Laboratory Standardization and Calibration of Hand-Held Moisture Meters.
      f. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. American Wood Protection Association (AWPA):
      a. E1-72, Laboratory Methods for Evaluating the Termite Resistance of Wood-based Materials: Choice and No-choice Tests.
      b. T1 Processing and Treatment Standard.
   3. Environmental Protection Agency (EPA).
   4. National Institute of Standards and Technology (NIST):
      a. PS 1, Quantitative NMR (Benzoic Acid).
      b. PS 20, American Softwood Lumber Standard.
   5. Underwriters Laboratories, Inc. (UL):
      a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.

B. Qualifications:
   1. Wood Treatment Plant: AWPA M3.
   2. Treated Wood Inspection: AWPA M2.

C. Miscellaneous:
   1. Factory marking:
      a. Lumber:
         1) Identify type, grade, moisture content, inspection service, producing mill, and other qualities specified.
         2) Marking may be omitted, as allowed by the building code, if certificate of inspection is provided for each shipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions for all products specified.

1.4 DELIVERY AND STORAGE

A. Delivery, storage and handling of untreated wood products:
   1. Lumber: As recommended by the grading agency indicated on the grade stamp.

B. Delivery, storage, handling and disposal of treated wood products: AWPA M4.

1.5 WARRANTY

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fire-Retardant Treated Material (FRTM):
      a. Hoover Treated Wood Products, Inc.:
      b. Or Equal.

2.2 MATERIALS

A. General:
   1. Lumber (for framing, blocking, nailers, furring, grounds and similar members):
      a. NIST PS 20.
      b. Species:
         1) Treated material: As indicated in the appropriate AWPA standard.
            a) Provide species of FRTM as necessary to achieve UL rating listed.
      c. Grade:
         1) For nominal sizes up to and including 2 x 4: Standard and better.
         2) For nominal sizes up to 2-inches thick and wider than 4-inches: #2 and better.
   2. Moisture content:
      a. Kiln-dry, ASTM D4442 and ASTM D4444.
      b. Lumber: 19 percent maximum.

B. Fire-Retardant Treated Material (FRTM):
   1. Maximum moisture content:
      a. Prior to treatment: 25 percent.
      b. Kiln-dry after treatment (KDAT), ASTM D4442 and ASTM D4444:
         1) Lumber: 19 percent (KDAT).
         2) Plywood: 15 percent (KD-15).
   2. Fire-retardant preservative:
      a. Provide protection against decay:
         1) EPA registered for use as a wood preservative.
      b. Shall not bleed-through or adversely affect bond of any finish.
   3. Pressure-treat material in accordance with AWPA U1.
   4. UL Classified:
      a. FR-S, UL 723.
      b. Exterior: No increase in classification when subjected to the Standard Rain Test, ASTM D2898.
      c. Provide UL mark on each piece of FRTM.

5. Maximum flame spread rating: 25, ASTM E84.
6. Wherever practicable, material to be treated shall be manufactured in its final form prior to treatment.

C. Fasteners and Anchors:
1. Nails and screws:
a. Dry, non-corrosive exposure: Hot dipped galvanized meeting ASTM A153 or Type 304 stainless steel.
b. Wet, corrosive, marine, and/or below grade: Type 316 stainless steel.
2. Adhesive anchors, expansion anchors, self-tapping concrete anchors, bolts, nuts, and washers: See Specification Section 03 15 19.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify measurements, dimensions, and shop drawing details before proceeding.

B. Coordinate location of studs, nailers, blocking, grounds and similar supports for attached work.

C. Eliminate sharp projections which would puncture roofing, flashing or underlayment material.

3.2 ERECTION AND INSTALLATION

A. General:
1. Provide fire-retardant treated material for all wood used:
a. Inside building for blocking in walls and exposed backing panels for electrical panels, devices, etc.
b. Exterior building wall sheathing.

B. Attach work securely by anchoring and fastening as indicated or required to support applied loading.
1. Anchor wood to concrete using adhesive or expansion anchors as specified in Specification Section 03 15 19.
a. Separate wood from direct contact to concrete with polyethylene foam gasket strip.
1) Size: 1/4-inches by width of wood member.
2) Owens Corning "SillSealR".
2. Anchor wood to metal using bolts and nuts as specified in Specification Section 03 15 19.
3. Provide flat washers under all bolt heads and nuts.
4. Fasten plywood in accordance with APA recommendations.
5. Use fasteners of size that will not penetrate members where opposite side will be exposed to view or receive finish materials.
6. Install fasteners without splitting of wood; predrill as required.
7. Do not drive threaded friction type fasteners.
8. Tighten bolts and lag screws at installation and retighten as required.

C. Set work to required levels and lines, plumb, true.
1. Shim as required.
2. Cut and fit accurately.

D. Provide wood nailers or blocking where required for attachment of other work and surface applied items.
1. Form to shapes indicated or required.
a. FRTM lumber:
1) Do not rip or mill.
2) Cross-cutting and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.
3) Resurfacing, planing or fabrication of special shapes or profiles shall be done prior to treatment.
b. FRTM plywood:

1) Cross-cutting, ripping and drilling are allowable in accordance with manufacturer's recommendations and UL requirements.

c. Light sanding of FRTM as permitted by UL to remove raised grain or prepare for finishing is allowable.

d. Field treat cuts and holes in preservative treated material in accordance with AWPA M4 and manufacturer's published recommendations.

E. When wood has been exposed to moisture allow to completely dry out prior to covering with additional wood or another material.

F. Correct or replace wood which shows bowing, warping or twisting to provide a straight, plumb and level substrate for applications of other materials.

END OF SECTION

SECTION 07 21 00
BUILDING INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Building insulation.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 31 31 - Concrete Mixing, Placing, Jointing and Curing
   2. Section 07 92 00 - Joint Sealants.
   3. Section 09 29 00 - Gypsum Board.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      b. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      c. C578, Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.
      d. D1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
      e. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      f. E96/E96M, Standard Test Methods for Water Vapor Transmission of Materials.
   2. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations on sealants, tapes and mastics.

1.4 SITE CONDITIONS

A. For purposes of this Specification Section, design frost line for this Project is 36 inches below grade.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rigid polyisocyanurate foam board insulation:

a. Hunter Panels – Xci CG panels.
b. Or Equal.

2. Vapor retarder:
a. Reef Industries, Inc – Griffolyn TX-1200FR
b. Or Equal.

2.2 MATERIALS

A. General:
1. Foam plastic insulation used in buildings and structures shall comply with the requirements of the building code.
a. Surface burning characteristics: ASTM E84.
b. Flame spread index: Maximum 75.
c. Smoke developed: Maximum 450.

B. Rigid Polyisocyanurate Foam Board Insulation with coated glass facers on both sides:
1. ASTM C1289, Type 2, Class 2, Grade 3.
2. Compressive Strength: ASTM D1621, Grade 3, Minimum 25 psi.
3. CFC and HCFC free.
4. Ozone depletion potential: 0.
5. Thickness shall be 2.5 inches (R-15.3) unless noted otherwise on Drawings.
6. Fire resistance: ASTM E84.
a. Flame spread: Less than 75.
b. Smoke developed: Less than 450.
7. Provide insulation designed for intended use.

C. Sealant and Mastic (for setting polystyrene and/or polyisocyanurate insulation board): Manufacturer's recommended standard.

D. Vapor Retarder:
1. Fire rated, reinforced, 3 ply, Class 1 material.
2. Perm rating: ASTM E96, Not exceeding 0.036 grains/HR-FT^2-IN-Hg.
3. Puncture Strength: ASTM D-4833, 48 foot pounds.
4. Flame Spread: ASTM E-84, not less than 5.
5. Smoke Developed: ASTM E-84, not less than 45.

E. Vapor Retarder Tape: As recommended by vapor retarder manufacturer.

F. Sound Control and Fire Safing Insulation:
1. Mineral wool batts.
a. ASTM C665, Type I.
b. UL listed when used in fire rated construction.
2. Density: Minimum 2.4 pounds per cubic foot.
3. Sound Reduction, ASTM C423.
a. Minimum NRC for 3 inches thick material: 1.05.
4. Thickness: As noted on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
1. Insulate full thickness over surfaces to be insulated.
2. Fit tightly around obstructions, fill voids.
3. Cover all penetrations (electrical junction boxes, switch boxes, piping, conduits, etc.) with insulation, taking care not to compromise the workings of the device.
4. Fit butted joints of batt or blanket insulations tightly together.
5. Apply single or double layer to achieve total thickness.

a. If double layer is provided, stagger all joints minimum 12 inches.

6. Do not use broken or torn pieces of insulation.
7. Install so that completed installation is vapor tight.
   a. Seal all joints.
   b. Seal to abutting materials to maintain vapor retarder integrity.
   c. Provide manufacturer's recommended vapor retarder tape for use with faced batt insulation or separate vapor retarder.
      1) If vapor retarder tape fails to adhere to any surface, apply sprayed-on adhesive as recommended by tape manufacturer to promote adhesion.
   d. Provide manufacturer's recommended solvent-free sealant compatible with insulation board for rigid board insulation.
      1) Tape is not acceptable for use with rigid board insulation.

C. Rigid Board Insulation in Cavity Walls:
   1. Do not proceed with installation until subsequent work which conceals insulation is ready to be performed.
   2. Set each piece of insulation flush with the abutting piece to eliminate ledges in the face of the insulation.
   3. Install mastic on face of concrete or masonry back-up in accordance with mastic and insulation manufacturer's recommendation.
   4. Press courses of insulation between wall ties (horizontal reinforcing) with edges butted tightly both ways.
   5. Set units firmly into mastic.
   6. Seal all horizontal and vertical joints with sealant recommended by insulation manufacturer.
   7. Do not use damaged insulation.

3.2 FIELD QUALITY CONTROL

A. Repair or replace damaged insulation and/or vapor retarder as directed by Contracting Officer Representative.

END OF SECTION

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SECTION 07 84 00
FIRESTOPPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Firestopping of joints in fire resistance-rated construction, including through-wall penetrations, and membrane penetrations.
   2. Firestopping assemblies.

B. Related Requirements: Include but are not necessarily limited to the following:
   1. Section 01 35 73 – Delegated Design Procedures.
   2. Section 01 40 00 - Quality Requirements.
   3. Section 01 67 00 - Product Requirements.
   4. Section 01 73 20 - Openings and Penetrations in Construction.
   5. Section 01 77 00 - Closeout Procedures.

1.2 REFERENCES

A. Terminology:
   1. Terminology indicated below are not defined terms and are not indicated with initial capital letters, but when used in this section have the meaning indicated below:
      a. “Engineering judgement” means an evaluation of the anticipated performance of a firestopping materials or assembly that has not been fire tested (including but not limited to firestopping materials or systems that do not have a UL listing). Engineering judgements shall be governed by the International Firestop Council (IFC) Guidelines referenced in this Section and are based on the performance of listed firestopping materials and assemblies and generally accepted engineering principles. As indicated in the IFC guidelines, engineering judgements are issued by a firestopping product manufacturer’s technical engineering employee. Relative to this term, engineering judgements are not issued by and are not the responsibility of Contracting Officer Representative.
      b. “Firestopping” means material or combination of materials used to retain integrity of fire-rated construction by maintaining an effective barrier against the spread of flame, smoke, and hot gases through penetrations in fire rated wall and floor assemblies. The word “firestop” has the same meaning as “firestopping”.
      c. “Smoke stopping” means material or combination of materials used to retain integrity of smoke-rated construction by maintaining an effective barrier against the spread of smoke, and hot gases through penetrations in smoke-rated partitions and barrier assemblies. The word “smoke stop” has the same meaning as “smoke stopping”.

B. Reference Standards: Standards referenced in this section include, but are not necessarily limited to, the following:
   1. ASTM International (ASTM):
      a. E814, Standard Method of Fire Tests of Through Penetration Fire Stops.
      b. E1399, Standard Test Method for Cyclic Movement and Measuring the Minimum and Maximum Joint Widths of Architectural Joint Systems.
      c. E1966, Standard Test Method for Fire Resistive Joint Systems.
      d. E2307,
   2. Firestop Contractors International Association's (FCIA):
      a. Firestop Manual of Practice (MOP).
   3. FM Global (FM):
      a. MF 4991, Approval Standard for Firestop Contractors.
      b. FM Approvals Guide (online product directory).

4. International Building Code (IBC):
    a. 2018 Edition.
5. International Firestop Council (IFC):
    a. Recommended IFC Guidelines for Evaluating Firestop Systems in Engineering Judgments (EJs), referred to herein as IFC Recommended Guidelines.
    b. Firestop Inspection Pocket Guide.
6. Underwriters Laboratories (UL):
    a. 263, Fire Tests of Building Construction and Materials.
    b. 1479, Fire Tests of Through Penetration Fire Stops.
    c. 2079, Standard for Tests for Fire Resistance of Building Joint Systems.
7. UL Solutions Product iQ (Online Product Directory):
    a. Through Penetration Firestop Systems (XHEZ).
    b. Joint Systems (XHBN).
    c. Fill, Void, or Cavity Materials (XHHW).
    d. Firestop Devices (XHJI).
    e. Forming Materials (XHKU).
    f. Wall Opening Protective Materials (CLIV).
    g. Fire Resistance Ratings (BXRH).

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
    1. Coordinate the Work required by this Section with other construction that must be performed prior to or concurrent with the Work of this Section.
    2. Materials and assemblies furnished as part of the Work of this Section shall be furnished by a single manufacturer. Supplier shall ensure compatibility of all materials and assemblies furnished under this Section and compatibility with other materials with which the Work of this Section will come into contact.

B. Sequencing and Scheduling:
    1. Perform installation of firestopping and smoke stopping after completing installation of penetrating items and prior to covering or concealing of openings.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
    1. For required firestopping applications for which no qualified previously tested materials or system is commercially available through Supplier, submit to authority having jurisdiction an engineering judgment derived from similar qualified tested system designs or other tests for approval by the authority having jurisdiction prior to installation. Upon Contracting Officer Representative's request, submit to Contracting Officer Representative copy of such engineering judgements and approval by the authority having jurisdiction.
    2. Engineering judgment documents shall comply with requirements of International Firestop Council.
    3. Identification Labels for Firestop Assemblies and Penetrations:
        a. Follow guidelines set in Chapter 7 of the International Building Code (IBC 2018 Edition).

B. Qualifications:
    1. Delegated Design Professional's "Instruments of Service" Submittals:
        a. Design drawings sealed and signed by delegated design professional, including:
        b. Design drawings deemed appropriate and necessary by delegated design professional.
        c. Show or indicate necessary details establishing the method of fastening throughout system and attachments to supporting primary structure.
        d. At option of Contractor or fabricator, design drawings may be combined with the Shop Drawings required in this Section, although delegated design professional's seal and signature is required on the Shop Drawings in the event of a combined Submittal.

e. Design drawings and specifications shall be sealed and signed by delegated design professional licensed in the State of Arizona.

2. Design Professional:
   a. Where Contractor proposes providing firestopping materials or assemblies that have not been fire tested (including but not limited to, firestopping materials or systems that do not have a UL listing), Supplier shall prepare engineering judgement, submit to, and obtain approval or acceptance by authority having jurisdiction. Such engineering judgement shall be prepared by, or under the direct, personal, supervision and control of design professional registered and licensed in the same jurisdiction as the Site, appropriate for the type of firestopping required.
   b. Design professional shall be qualified and experienced in accordance with Section 01 73 40 - Execution, and shall possess or be covered by current, valid professional liability insurance in accordance with the Contract Documents. Required limits of professional liability insurance coverage shall not have been previously eroded by prior claims under the policy.
   c. Submit evidence of design professional's compliance with Contract requirements regarding licensure, registration, and insurance.
   d. Engineering judgements shall bear design professional's seal, signature, and date.
3. Installer:
   a. Entity that selects and installs firestopping materials and assemblies shall be an organization regularly engaged in and experienced in firestopping construction of the types and complexities similar to that required for the Work. Such entity shall be appropriately experienced in the type of Work required and shall possess current, valid, licensure and qualifications, in accordance with Laws and Regulations (where applicable) for the type of firestopping required.
   b. Entities that select and install firestopping materials and assemblies shall possess one or more of the following as current, valid accreditations:
      1) Firestop Contractors International Association (FCIA) Levels 1 – 4.
   c. In addition, entity selecting and installing firestopping materials and systems shall possess one or more of the following as current, valid certifications:
      1) Approved Firestop Contractor in accordance with FM4991.
      2) Qualified Firestop Contractor by UL Solutions
   d. Should Contractor propose as entity selecting and installing firestopping an organization with alternative qualifications, accreditation, or certification submit for Contracting Officer Representative's approval appropriate substitution request in accordance with the Contract Documents.
   e. Submit to Contracting Officer Representative documentation demonstrating installer's compliance with qualifications requirements of this provision.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Firestopping schedule (table) indicating the following:
         1) Numerical designation for each penetration.
         2) Type of construction penetrated, such as wall, floor, shaft, head of wall, or other appropriate designation.
         3) F and T ratings for each penetration.
         4) For each penetration, indicate appropriate designation by UL, FM, Intertek, or other applicable rating organization.
         5) Product name and manufacturer for each product used at each penetration.
      b. Plan-view drawings indicating the location of fire-rated and smoke-rated construction and the location of each penetration with serialized numerical designator for each penetration aligning with the Firestopping Schedule.
      c. Firestopping detail drawings for each type of firestopping assembly proposed.
      d. Installation detailed drawings for each type of Work element.

2. Product Data:
    a. Manufacturer's listed firestopping product "design number".
    b. For each item required under this Section, submit manufacturer's published product information, including data sheet (as applicable), clearly indicating materials, limitations, optional features that will be furnished and those options or features that will not be furnished.
    c. Manufacturer's specifications:

B. Informational Submittals: Submit the following:
1. Engineering Judgements:
    a. When UL or third-party listing is not available, provide a written engineering judgment in accordance with IFC Recommended Guidelines and requirements of this Section. Submit to Contracting Officer Representative copy of engineering judgement, sealed, signed, and dated by Supplier's design professional, together with documentation of approval or acceptance by authority having jurisdiction.
2. Supplier Instructions:
    a. Serial numbers of items furnished.
    b. Instructions for handling, installing, and startup.
3. Field Quality Control Submittals:
    a. Results of tests, inspections, and other quality control activities required by the Contract Documents and performed at the Site.
4. Suppliers Site Visit Reports:
    a. Report of each visit to the Site by Supplier, summarizing purpose of visit, activities while onsite, problems encountered, advice given to Contractor or Subcontractor, and actions taken.
5. Qualifications Statements:
    a. Entity selecting and installing firestopping, in accordance with this Section's "Quality Assurance" Article.
    b. Design professional responsible charge of preparing engineering judgements, if any.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
    a. Written statement that all fire-rated penetrations were sealed using products in accordance with UL or FM requirements for required rating.
    b. Documentation of listed materials and systems installed and engineering judgments.
    c. Indicate appropriate revisions for firestopping on record Drawings required in accordance with Section 01 77 00 – Closeout Procedures.
    d. Firestopping Schedule (table), submitted as part of the Shop Drawings, revised to show and indicate as-constructed conditions.
    e. Photographs:
        1) Photograph of each penetration through fire resistance-rated construction showing pre-firestopping and Substantial Completion conditions.
        2) Photographs shall be in accordance with Section 01 32 33 - Photo Documentation. Such photographs are not part of quantities of still photographs required in Section 01 32 33 – Photo Documentation.
        3) Pre-firestopping and Substantial Completion condition photographs shall be taken in a manner to ensure similar photograph orientation to allow for photographic comparison.
    f. Building code sections relevant to firestop systems.

1.6 DELIVERY, STORAGE AND HANDLING

A. Delivery and Acceptance Requirements:
1. In addition to requirements of Section 01 67 00 - Product Requirements, properly label packaging of firestopping and smoke stopping materials and assemblies with associated UL label where applicable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Through Penetration Firestop Systems:
      a. Hilti.
      b. Owens Corning
      c. Or Equal.
   2. Forming Materials:
      a. Rockwool - Roxul.
      b. Or Equal.

2.2 MATERIALS

A. Materials - General:
   1. Installer of the Work under this Section shall select specific materials and systems appropriate for each specific firestopping and smoke stopping application required, in accordance with the Contract Documents and Laws and Regulations.
   2. Provide firestopping materials and assemblies in accordance with ASTM E814, ASTM E1399, ASTM E2307, UL 1479 and UL 2079, as applicable.
   3. Provide tested firestopping materials and assemblies that provide a fire rating equal to that of the construction being penetrated.
   4. Firestopping materials and assemblies shall comply with Laws and Regulations, including applicable building code.
   5. Previous Testing Required: Furnish only materials and assemblies where identical items were previously tested, under controlled conditions for specific fire-rated construction conditions conforming to construction assembly type, penetrating item type, annular space requirements, and fire resistance rating involved for each separate item. Such testing shall be in accordance with the following as applicable:
      a. Openings and Penetrations: UL 1479 or ASTM E814.
      b. Building Joint Systems: ASTM E1966 and ASTM E1399, or UL 2079.
      c. Perimeter Fire Barrier Systems: ASTM E2307.
   6. Where firestopping is not exposed to view, provide materials and assemblies of manufacturer's standard color.

B. Forming Materials:
   1. Comply with ANSI/UL 263.
   2. UL listed.
   3. Product category BZJZ, Batts and Blankets.

C. Firestop Sealant:
   1. UL-listed.
   2. Provide as required by the item's associated UL-listed design.

D. Firestop collars:
   1. UL-Listed.
   2. Provide as required by the item's associated UL-listed design.

E. Backer rod and compressible filler: UL listed, product category XHHW, Fill, Void or Cavity Materials.

F. Identification Labels:
   1. Comply with IBC Chapter 7 (2018 Edition).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Verify existing conditions and substrates before starting the Work of this Section. Remedy unsatisfactory conditions before proceeding.

B. Installing the Work constitutes Contractor's approval of underlying work, substrates, and field conditions prevailing at the time of the Work.

3.2 INSTALLATION

A. Installation - General:
   1. Provide the Work of this Section in accordance with the Contract Documents, Laws and Regulations (including applicable building code), and material, system manufacturer's written installation instructions, and UL listing requirements to provide required fire-resistance rating. When UL listing is not available, install in accordance with approved written engineering judgment. When any such requirements conflict, obtain written interpretation or clarification from Contracting Officer Representative before proceeding further.
   2. Provide firestopping materials and systems in accordance with ASTM E814, ASTM E1399, ASTM E2307, UL 1479 and UL 2079, as applicable.
   3. Where firestopping will be exposed to view, provide materials and systems of colors matching adjacent construction. Alternatively, if approved by manufacturer of materials and systems and following inspection and approval by authority having jurisdiction, field-paint materials and systems to match color of adjacent construction. Such field-painting shall be in accordance with Section 09 91 00 - Architectural Painting.
   4. Do not install firestopping or smoke stopping materials or assemblies when the ambient temperature of the installation location does not comply with manufacturer's written installation instructions for duration of installation and curing.
   5. During installation, provide masking and drop cloths to prevent firestopping materials from contaminating or marring adjacent surfaces.

B. Openings and Penetrations:
   1. Provide firestopping materials and assemblies for each opening, through-penetration, and membrane penetration in fire-resistant rated construction.
   2. Provide Flame (F), Thermal (T) rated assemblies as necessary to comply with Laws and Regulations (including applicable building code).
   3. Comply with Section 01 73 20 - Openings and Penetrations in Construction.

C. Identification
   1. Install firestopping labelling permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be readily visible.
   2. Provide identification in accordance with FCIA MOP.

END OF SECTION

SECTION 07 92 00
JOINT SEALANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Sealing all joints which will permit penetration of dust, air or moisture.

1.2 SCOPE

A. Work required under this Section includes all labor, materials, tools and equipment necessary to complete all work relative to the provision and installation of all exterior and interior sealants where the words caulk, caulking, or sealant are shown on the drawings and at additional locations as required by the specifications. Included are all joint fillers, backer rods and gaskets. Work within this section shall be completely coordinated with work of other trades.

B. Although such work may not be specifically shown or specified, provide and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

C. The material and installation shall conform to the applicable local building code requirements, and all authorities having jurisdiction.

D. Notwithstanding reference to any manufactured or produced item or material in this specification that contains asbestos, materials or items that contain asbestos are not acceptable. In the event that any of the materials or items specified herein contain asbestos, the Contracting Officer Representative shall be promptly notified in writing and the Contracting Officer Representative will select a suitable substitute material or item which shall be furnished at no additional cost to the Government.

1.3 RELATED WORK

A. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 33 23 – Submittal Procedures.
   2. Section 07 84 00 - Firestopping.

1.4 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Concrete Institute (ACI):
      a. 302.1R, Guide for Concrete Floor and Slab Construction.
   2. ASTM International (ASTM):
      a. C920, Standard Specification for Elastomeric Joint Sealants.
      b. C1311, Standard Specification for Solvent Release Sealants.
      c. C1521, Standard Practice for Evaluating Adhesion of Installed Weatherproofing Sealant Joints.

B. Qualifications: Sealant applicator shall have minimum five year’s experience using products specified on projects with similar scope.

C. Mock-Ups:
   1. Before sealant work is started, a mock-up of each type of joint shall be sealed where directed by the Contracting Officer Representative .
      a. The approved mock-ups shall show the workmanship, bond, and color of sealant materials as specified or selected for the work and shall be the minimum standard of quality on the entire project.

b. Each sample shall cure for a minimum of seven days at which time the sealant manufacturer's authorized factory representative shall perform adhesion tests on each sample joint.
   1) Perform adhesion tests per ASTM C1521.
   2) If mock-up is not acceptable or if adhesion test fails, provide additional mock-up and adhesion testing as required until acceptable to Contracting Officer Representative .

1.5 DEFINITIONS

A. Corrosive Areas Include:

B. Defective: Failure of watertightness or airtightness.

C. Finish sealant: Sealant material per this specification applied over face of compressible sealant or expanding foam sealant specified, to provide a finished, colored sealant joint.

D. Installer or Applicator:
   1. Installer or applicator is the person installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

E. "Seal," "sealing" and "sealant": Joint sealant work.

1.6 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Manufacturer's recommendations for joint cleaner, primer, backer rod, tooling and bond breaker.
   2. Certification from sealant manufacturer stating product being used is recommended for and is best suited for joint in which it is being applied.
   3. Certification of applicator qualification.

B. Samples:
   1. Refer to “Specification Section 01 33 23 – Submittal Procedures, Section 2.4 Color Submittals” for submission procedures and requirements of Color Samples.
   2. Actual bead samples of sealants are required. Printed color charts are not acceptable.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver material in manufacturer's original unopened containers with labels intact: Labels shall indicate contents and expiration date on material.

1.8 PROJECT CONDITIONS

A. Schedule installation of sealant work after completion of penetrating item installation but prior to covering or concealing of openings.

B. Verify existing conditions and substrates before starting work. Correct unsatisfactory conditions before proceeding.

C. Do not proceed with the installation of sealant materials when the ambient temperature is outside the manufacturer’s recommended limitations for installation and curing times as printed on the product label and product data sheet.

D. During installation provide masking and drop cloths to prevent sealant materials from contaminating any adjacent surfaces.

E. Perimeter of, and all penetrations through, walls separating unclassified rooms and rooms classified per NFPA 820, shall be gas-tight to meet the definition of “Physically Separated”.

F. For purposes of this Specification Section, the entire building/spaces of the following buildings will be considered as corrosive environments:

G. Notwithstanding reference to any manufactured or produced item or material in this specification that contains asbestos, materials or items that contain asbestos are not acceptable.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Polyurea joint filler:
      a. Master Builders Solutions "MasterSeal CR100 control joint filler".
      b. Or Equal.
   2. Polyurethane sealants:
      a. Master Builders Solutions "MasterSeal NP-1, NP-II, SL-1 SL-2".
      b. Or Equal.
   3. Backer rod, compressible filler, primer, joint cleaners, bond breaker:
      a. As recommended by sealant manufacturer.
   4. Fire-Resistant Sealant:
      a. See Specification Section 07 84 00 – Firestopping.

2.2 MATERIALS

A. Sealants - General:
   1. Provide colors matching materials being sealed.
   2. Where compound is not exposed to view in finished work, provide manufacturer's color which has best performance.
   3. Non-sagging sealant for vertical and overhead horizontal joints.
   4. Sealants for horizontal joints: Self-leveling pedestrian/traffic grade.
   5. Joint cleaner, primer, bond breaker: As recommended by sealant manufacturer.
   6. Bond Breaker Tape: Polyethylene tape or other plastic tape as recommended by sealant manufacturer, to be applied to sealant - contact surfaces where bond to substrate or joint filler must be avoided for proper performance of sealant. Provide self - adhesive tape where applicable.
   7. Sealant backer rod and/or compressible filler:
      a. Closed cell polyethylene, polyethylene jacketed polyurethane foam, or other flexible, nonabsorbent, non-bituminous material recommended by sealant manufacturer to:
         1) Control joint depth.
         2) Break bond of sealant at bottom of joint.
         3) Provide proper shape of sealant bead.
         4) Serve as expansion joint filler.
   8. Masking Tape: Non - staining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

B. Polyurea Joint Filler:
   1. Two component, semi-rigid material for filling formed or saw-cut control joints in interior concrete slabs.

2. Comply with ACI 302.1R performance recommendations regarding control and construction joints.
3. Color: Gray.

C. Polyurethane Sealant:
1. One or two components.
2. Paintable.
3. Meet ASTM C920 Type S or Type M, Grade NS or P, Class 25, Use NT, T, M, A and O.

D. Additional materials for stock.
1. Provide stock/ surplus materials for each product used at each individual location. Minimum (2) large tubes or 1 gallon for pourable material.

PART 3 - EXECUTION

3.1 PREPARATION

A. Before use of any sealant, investigate its compatibility with joint surfaces, fillers and other materials in joint system.

B. Use only compatible materials.

C. Where required by manufacturer, prime joint surfaces.
1. Limit application to surfaces to receive sealant.
2. Mask off adjacent surfaces.

D. Provide joint depth for joints receiving polyurea joint filler in accordance with manufacturer's recommendations.

3.2 INSTALLATION

A. Employ only proven installation techniques, which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, with complete "wetting" of joint bond surfaces equally on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

B. Install products in accordance with manufacturer's instructions and UL requirements.

C. Clean all joints.

D. Make all joints water and airtight.

E. At changes in direction of joints, joint intersections and where sealant joints interface with other construction, install continuous sealant as necessary to ensure a weather-tight seal.

F. Make depth of sealing compounds, except expanding foam and polyurea sealant, not more than one-half width of joint, but in no case less than 1/4 inches nor more than 1/2 inches unless recommended otherwise by the manufacturer.

G. Provide correctly sized backer rod, compressible filler or compressible sealant in all joints to depth recommended by manufacturer:
1. Take care to not puncture backer rod and compressible filler.
2. Provide joint backer rod as recommended by the manufacturer for polyurea joint filler.

H. Apply bond breaker where required.

I. Tool sealants using sufficient pressure to fill all voids.

J. Upon completion, leave sealant with smooth, even, neat finish.

K. Where piping, conduit, ductwork, etc., penetrate wall, seal each side of wall opening.

L. Install compressible sealant to position at indicated depth.
   1. Size so that width of material is twice joint width.
   2. Take care to avoid contamination of sides of joint.
   3. Protect side walls of joint (to depth of finish sealant).
   4. Install with adhesive faces in contact with joint sides.
   5. Install finish sealant where indicated.

M. Install expanding foam sealant to minimum 4-inches depth or thickness of wall being penetrated if less than 4-inches or as indicated on Drawings.
   1. Provide adequate backing material as necessary.
   2. Hold material back from exposed face of wall as necessary to allow for installation of backer rod and finish sealant.
      a. Allow expanding foam sealant to completely cure prior to installing backer rod and finish sealant.
   3. Trim off excess material flush with surface of the wall if not providing finished sealant.

N. Spillage: Do not allow sealants or compounds to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces. Clean adjoining surfaces by whatever means may be necessary to eliminate evidence of spillage.

O. Do not overheat hot - applied sealants.

P. Recess exposed edges of gaskets and joint fillers slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from joints.

Q. Bond ends of gaskets together with adhesive or "weld" by other means as recommended by manufacturer to ensure continuous watertight and airtight performance. Miter - cut and bond ends at corners unless molded corner units are provided.

R. For sealants applied to joints which occur in conjunction with waterproofing, install sealant prior to application of waterproofing.

S. Masking Tape:
   1. Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 SEALANT WORK

A. General:
   1. Work includes but is not limited to: Sealing all joints which will permit penetration of dust, air, or moisture.
   2. Refer to SCHEDULE for materials to be used.
   3. See Specification Section 07 84 00 for firestopping.

B. Concrete joints:
   1. Flooring joints.
   2. Joints between paving or sidewalks and building.

C. Openings:
   1. Perimeters of door and window frames, louvers, grilles, etc.
   2. Door thresholds shall be set in a full bed of sealant.

D. Penetrations of walls, floors and decks.

E. Other joints where sealant, expanding foam sealant or compressible sealant is indicated.

3.4 FIELD QUALITY CONTROL

A. Adhesion Testing:
   1. Perform adhesion tests in accordance with ASTM C1521 per the following criteria:
      a. Water bearing structures: One test per every 1000 linear foot of joint sealed.

b. Exterior precast concrete wall panels: One test per every 2000 linear foot of joint sealed.
c. Chemical containment areas: One test per every 1000 linear foot of joint sealed.
d. Building expansion joints: One test per every 500 linear feet of joint sealed.
e. All other type of joints except butt glazing joints: One test per every 3000 linear feet of joint sealed.
f. Manufacturer's authorized factory representative shall recommend, in writing, remedial measures for all failing tests.

3.5 CURE AND PROTECTION

A. Cure sealants and caulking compounds in compliance with manufacturer's instructions and recommendations, to obtain high early bond strength, internal cohesive strength and surface durability. Advise Contractor of procedures required for cure and protection of joint sealers during construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at time of acceptance.

3.6 SCHEDULE

A. Furnish sealant as indicated for the following areas:
1. Exterior areas unless scheduled otherwise:
a. Above grade: Polyurethane.
b. Below grade: Polyurethane.
2. Exterior joints at door and window frames:
a. Two Component Polyurethane.
3. Exterior horizontal joints at perimeter of building where abutting pavements, walks, etc:
a. One Component Moisture Curing Modified Polyurethane Sealant.
4. Interior areas: Polyurethane
5. Exterior wall penetrations: Expanding urethane foam, with finish sealant.
a. Finish sealant: Polyurethane
6. Under door thresholds:
a. Butyl Rubber and Polyisobutylene Sealant.
7. Use sealant types as specified in other specifications sections.

END OF SECTION

SECTION 08 70 00
FINISH HARDWARE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Finish hardware.
      a. Mechanical door hardware.
      b. Cylinders specified for doors in other sections.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 33 23 - Submittal Procedures.
   2. Section 01 77 00 - Closeout Procedures.
   3. Section 01 78 23 - Operation and Maintenance Data.
   4. Section 05 50 00 - Metal Fabrications.
   5. Section 07 92 00 - Joint Sealants.

1.2 QUALITY ASSURANCE

A. All door hardware shall be provided by a single hardware supplier.

B. Manufacturers Qualifications:
   1. Engage qualified manufacturers with a minimum of 5-years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
   2. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications:
   1. A minimum of 3-years' documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications:
   1. Experienced commercial door hardware distributors with a minimum of 5-years' documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project.
   2. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor and Contracting Officer Representative concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
   1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third-party source will not be accepted.
   2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
   3. Each unit to bear third party permanent label indicating compliance with the referenced testing standards.

F. Keying Conference: Contractor shall conduct a keying conference to incorporate the following criteria into the final keying schedule document:
   1. Function of building, purpose of each area and degree of security required.
   2. Plans for existing and future key system expansion.

3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

1.3 REFERENCED STANDARDS:

A. Americans with Disabilities Act (ADA):
   1. Accessibility Guidelines for Buildings and Facilities (ADAAG).

B. American National Standards Institute/Builders Hardware Manufacturers Association (ANSI/BHMA):
   1. A156.1, Butts and Hinges.
   2. A156.3, Exit Devices.
   3. A156.4, Door Controls -Closers.
   4. A156.13, Mortise Locks.
   5. A156.18, Materials and Finishes.

C. American National Standards Institute/Steel Door Institute (ANSI).
   1. ANSI A117.1, Accessible and Usable Buildings and Facilities.
   2. ANSI/SDI A250.8, Specifications for Standard Steel Doors and Frames (SDI-100).
   3. ANSI UL10C, Positive Pressure Fire Tests of Door Assemblies.
   4. ANSI/UL 305, Panic Hardware.
   5. ANSI/UL 437, Key Locks.
   6. ANSI/UL 1784, Standard for Air Leakage Tests of Door Assemblies and Other Opening Protectives.

D. Door and Hardware Institute (DHI):
   1. TDH-007-20, Installation Guide for Doors and Hardware.

E. International Building Code (ICC/IBC):

F. National Fire Protection Association (NFPA):
   1. NFPA 80, Fire Doors and Windows.
   2. NFPA 101, Life Safety Code.
   3. NFPA 252, Standard Methods of Fire Tests of Door Assemblies.

G. Qualifications:
   1. Installation shall be inspected by a certified Architectural Hardware Consultant (AHC).

1.4 DEFINITIONS

A. AHC: Architectural Hardware Consultant, certified by DHI.

B. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

C. All weather: Capable of operation from -50 to +120 degrees F.

D. Active Leaf: Right-hand leaf when facing door from keyed side unless noted otherwise on Drawings.

1.5 SUBMITTALS

A. Product Data:
   1. Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

B. Door Hardware Schedule:
   1. Prepared by or under the supervision of supplier, detailing, fabrication and assembly of door hardware, as well as procedures and diagrams.

2. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
3. Format:
    a. Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
4. Organization:
    a. Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening.
    b. Organize door hardware sets in same order as in the Door Hardware Sets at the end of this specification section.
5. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
6. Content: Include the following information:
    a. Type, style, function, size, label, hand, and finish of each door hardware item.
    b. Manufacturer of each item.
    c. Fastenings and other pertinent information.
    d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    e. Explanation of abbreviations, symbols, and codes contained in schedule.
    f. Mounting locations for door hardware.
    g. Door and frame sizes and materials.
    h. Warranty information for each product.
7. Submittal Sequence:
    a. Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule.
    b. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.

C. Shop Drawings:
1. Details of electrified access control hardware indicating the following:
    a. Wiring Diagrams:
        1) Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access control system electrified hardware.
        2) Differentiate between manufacturer-installed and field-installed wiring. Include the following:
        3) Elevation diagram of each unique access-controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
        4) Complete (risers, point-to-point) access control system block wiring diagrams.
        5) Wiring instructions for each electronic component scheduled herein.
    b. Electrical Coordination:
        1) Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.

D. Keying Schedule:
1. After a keying meeting with the Contracting Officer Representative has taken place prepare a separate keying schedule detailing final instructions.
2. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Contracting Officer Representative must approve submitted keying schedule prior to ordering permanent cylinders/cores.

E. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
2. Warranty information for all hardware devices having extended warranties.

F. Certifications:
1. Certification from AHC stating all door hardware has been provided per approved Shop Drawings, has been installed in accordance with manufacturer's recommended installation instructions and all doors have been inspected and tested and found to be in proper working order.
2. Door assemblies required to swing in the direction of egress have been inspected and tested in accordance with NFPA 101.
3. All door hardware has been reviewed by AHC and verified to be compatible with doors and frames.

G. No submittals will be reviewed until Contracting Officer Representative has received AHC certification

H. Closeout Submittals:
1. Operating and Maintenance Manuals:
a. Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in 01 78 23 Operation and Maintenance Data.
2. Project Record Documents:
a. Provide record documentation of record documents for door hardware sets in digital format (.pdf, .docx, .xlsx, .csv) and as required in Section 01 77 00 Closeout Procedures.

1.6 DELIVERY, STORAGE AND HANDLING

A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

B. Tag each item or package separately with identification related to the final Door Hardware Schedule and include basic installation instructions with each item or package.

C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Government via registered mail or overnight package service. Instructions for delivery to the Government shall be established at the "Keying Conference".

1.7 COORDINATION

A. Templates: Obtain and distribute to the party’s involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.

B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.8 WARRANTY

A. Warranty Period:
1. Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Government. Failures include, but are not limited to, the following:
a. Structural failures including excessive deflection, cracking, or breakage.
b. Faulty operation of the hardware.

c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
d. Electrical component defects and failures within the systems operation.

B. Warranty Period: Unless otherwise indicated, warranty shall be one year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified products.
2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Butt Hinges:
a. Basis-of-Design: McKinney Manufacturing Co. - TA/T4A Series, 5-knuckle.
b. Or Equal.
2. Cylinders and Keying:
a. Basis-of-Design: dormakaba BEST – to Match Existing Key System.
3. Exit Devices:
a. Basis-of-Design: Sargent Manufacturing - 80 Series.
b. Or Equal.
4. Surface Door Closers:
a. Basis-of-Design: Norton Rixson – 2800ST Series.
b. Or Equal.
5. Weatherstripping, Rain Guards, Sweeps and Thresholds:
a. Basis-of-Design: Pemko.
b. Or Equal.
6. Silencers:
a. Basis-of-Design: Rockwood – 608.
b. Or Equal.
7. Key Control:
a. Basis-of-Design: Lund Equipment.
b. Or Equal.
8. Submit request for substitution in accordance with Specification Section 01 33 23.

2.2 MATERIALS

A. Hardware shall not have any visible manufacturer names on exposed materials, except cylinders, when the door is in a closed position.

B. BUTT HINGES
1. Hinges: ANSI/BHMA A156.1 butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
2. Quantity: Provide the following hinge quantity:
a. Two Hinges: For doors with heights up to 60-inches.
b. Three Hinges: For doors with heights 61 to 90-inches.
c. Four Hinges: For doors with heights 91 to 120-inches.
d. For doors with heights more than 120-inches, provide 4 hinges, plus 1 hinge for every 30-inches of door height greater than 120-inches.

3. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
    a. Widths up to 3-feet-0-inches: 4-1/2-inches standard or heavy weight as specified.
4. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
    a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
    b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
5. Hinge Options: Comply with the following:
    a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for all out-swinging lockable doors.

C. CYLINDERS AND KEYING
1. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
2. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
    a. Threaded mortise cylinders with rings and cams to suit hardware application.
    b. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
    c. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
    d. Tubular deadlocks and other auxiliary locks.
    e. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
3. Keyway: Match the Facility Standard which is a BEST, 7-Pin, “WH” Keyway.
4. Small Format Interchangeable Cores: Provide small format interchangeable cores (SFIC) as specified, core insert, removable by use of a special key; usable with other manufacturers' cylinders. Cores shall match the Facility Standard which is a BEST, 7-Pin, Figure 8 (SFIC).
5. Keying System: Each type of lock and cylinders to be factory keyed.
    a. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
    b. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Contracting Officer Representative.
    c. Existing System: Field verify and key cylinders to match North Rim Facility’s existing system.
6. Key Quantity: Provide the following minimum number of keys:
    a. Change Keys per Cylinder: Two (2)
    b. Master Keys (per Master Key Level/Group): Five (5).
    c. Construction Keys (where required): Ten (10).
    d. Construction Control Keys (where required): Two (2).
    e. Permanent Control Keys (where required): Two (2).
7. Construction Keying: Provide temporary keyed construction cores.
8. Key Registration List (Bitting List):
    a. Provide keying transcript list to Contracting Officer Representative in the proper format for importing into key control software.
    b. Provide transcript list in writing or electronic file as directed by the Contracting Officer Representative.

D. MORTISE LOCKS AND LATCHING DEVICES
1. Mortise Locksets, Grade 1 (Heavy Duty): Provide ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed mortise locksets. Listed manufacturers shall meet all functions and features as specified herein.

E. LOCK AND LATCH STRIKES

1. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
2. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.
3. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
4. Standards: Comply with the following:
5. Strikes for Mortise Locks and Latches: BHMA A156.13.

F. CONVENTIONAL EXIT DEVICES
1. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:
2. Exit devices shall have a five-year warranty.
3. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
6. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
7. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
8. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
11. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed exit devices. Listed manufacturers shall

G. SURFACE DOOR CLOSERS
1. All door closers specified herein shall meet or exceed the following criteria:
2. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
3. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
4. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
5. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
6. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
7. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
8. Door Closers, Surface Mounted (Commercial Duty): ANSI/BHMA 156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, institutional grade door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one

piece cast iron or aluminum alloy body construction, with adjustable backcheck, closing sweep, and latch speed control valves. Provide non-handed units standard.

2.3 FABRICATION

A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers' recognized installation standards for application intended.

2.4 FINISHES

A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.

B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware

C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 INSTALLATION

3.2 EXAMINATION

A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.

B. Notify Contracting Officer Representative of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.3 PREPARATION

A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.

3.4 INSTALLATION

A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
   1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including hanging devices; locking devices; closing devices; and seals.

B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
   1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
   2. DHI TDH-007-20: Installation Guide for Doors and Hardware.
   3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
   4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.

C. Thresholds: Exterior and any interior doors scheduled to have a threshold, shall be installed in full bed of sealant complying with requirements of Specification Section 07 92 00.

3.5 FIELD QUALITY CONTROL

A. Contractor shall produce a final project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
   1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

3.6 ADJUSTING

A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.7 CLEANING AND PROTECTION

A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install all hardware at the latest possible time frame.

B. Clean adjacent surfaces soiled by door hardware installation.

C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of building occupancy.

3.8 DEMONSTRATION

A. Instruct Contracting Officer Representative and maintenance personnel on how to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.9 DOOR HARDWARE SETS

A. The hardware sets represent the design intent. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the Contracting Officer Representative with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
   1. Quantities listed are for each pair of doors, or for each single door.
   2. The supplier is responsible for handing and sizing all products.
   3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
   4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer’s Abbreviations:
   1. MK - McKinney
   2. PE - Pemko
   3. RF - Rixson
   4. SU - Securitron
   5. RO - Rockwood
   6. SA - SARGENT
   7. BE - BEST Locks & Closers
   8. YA - ASSA ABLOY ACCENTRA

9. NO - Norton
10. OT - Other

3.10 SCHEDULES

A. HARDWARE SETS:

Set: 1.0

3	Hinge, Full Mortise, Hvy Wt	T4A3386 NRP	US10BE(SS)	MK
1	Rim Exit Device, Storeroom	43 72 8804 ETL	US10BE	SA
1	I.C. Permanent Core	Facility SFIC Standard	613	BE
1	Surface Closer	PS2800ST	690	NO
1	Kick Plate	K1050 10" x 2" LDW CSK BEV	10BE	RO
1	Door Stop	466-RKW (As required)	Black	RO
1	Gasketing	2891DS		PE
1	Rain Guard	346D (As required)		PE
1	Sweep	315DN		PE
1	Threshold	158D (Or as detailed)		PE

Set: 37.0

Doors: 52-101B, 62-109B, 62-112B, 72-101B, 73-200C, 73-206A, 74-114A

1	All Materials	By Door Manufacturer	OT

Set: 38.0

Door: 72-201A

3	Hinge, Full Mortise, Hvy Wt	T4A3386 NRP	US10BE(SS)	MK
1	Storeroom/Closet Lock	72 8204 LNL	US10BE	SA
1	I.C. Permanent Core	Facility SFIC Standard	613	BE
1	Surface Closer	PS2800HST	690	NO
1	Gasketing	2891DS		PE

END OF SECTION

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SECTION 09 22 16
NON-STRUCTURAL METAL FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Non-Structural Metal Framing in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

1.2 RELATED SPECIFICATION SECTIONS:

A. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 33 23 – Submittal Procedures.
   2. Section 06 10 00 – Rough Carpentry.
   3. Section 07 84 00 – Firestopping.
   4. Section 07 92 00 – Joint Sealants.
   5. Section 09 29 00 – Gypsum Board.

1.3 REFERENCES

A. The American Iron and Steel Institute (AISI):
   1. AISI S220, North American Standard for Cold-Formed Steel Framing – Nonstructural Members.

B. ASTM International (ASTM):
   1. ASTM A641, Standard Specification for Zinc–Coated (Galvanized) Carbon Steel Wire.
   2. ASTM A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
   3. ASTM A1008, Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, Required Hardness, Solution Hardened, and Bake Hardenable.
   4. ASTM C645, Standard Specification for Nonstructural Steel Framing Members.
   5. ASTM C754, Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel Products.
   6. ASTM C840, Standard Specification for Application and Finishing of Gypsum Board.
   7. ASTM E1190, Standard Test Methods for Strength of Power-Actuated Fasteners Installed in Structural Members.
   8. ASTM E1512, Standard Test Methods for Testing Bond Performance of Bonded Anchors.

C. Gypsum Association (GA):
   1. GA-600, Fire Resistance and Sound Control Design Manual Gypsum Systems.

1.4 SUBMITTALS

A. Product Data:
   1. Manufacturer’s specifications for each type of material and accessory.
      a. Where fire resistance classification is indicated, submit copies of nationally recognized testing laboratory listings of products proposed for use.
   2. Where EQ coatings are used, submit copies of nationally recognized testing laboratory results showing conformance with ASTM A653 and AISI S220.
      a. Include data required to show specification compliance.

B. Shop Drawings:
   1. Sizes and spacing of typical framing members and opening framing.
   2. Show locations and sizes of typical framing members, wall framing sections, and opening elevations.

3. Methods of fastening framing members to each other and to supporting systems.
4. Details of vertical deflection connections to structures.
5. Locations and spacing of lateral bracing and structural bracing systems.
6. Accessory products required for complete installation.
7. Bear seal and signature of Registered Professional Engineer licensed in the State of Arizona.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications:
   1. Member of Certified Steel Stud Association (CSSA), Steel Framing Industry Association (SFIA), or Steel Stud Manufacturers Association (SSMA).

A. Code-Compliance Certification of Studs and Tracks:
   1. Provide documentation that framing members are certified according to the product-certification program of the Certified Steel Stud Association and the Steel Framing Industry Association or the Steel Stud Manufacturers Association.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified products.
   2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Non-Structural Metal Framing:
      a. Basis of Design: ClarkDietrich Building Systems.
      b. Or Equal.
   2. Products proposed for use in fire-rated assemblies:
      a. Approved by nationally recognized testing laboratory.
   3. Submit request for substitution in accordance with Specification Section 01 33 23.

2.2 DESIGN CRITERIA

A. Select steel studs in accordance with manufacturer's standard load tables and following design pressures and maximum deflections:

Performance Criteria		
Use Condition [2]	Design Pressure	Maximum Deflection
Wall enclosing stairs, and other vertical shafts	10 psf	L/240
Wall enclosing vestibules and similar spaces subject to intermittent exposure to exterior wind conditions	15 psf	L/240
Walls scheduled with Tile Backer Board, Moisture-Resistant, Impact-Resistant, or Abuse-Resistant Gypsum Wallboard	5 psf	L/360
Walls scheduled to receive Tile, lath and plaster, or veneer plaster. [1]		L/360
Typical Interior Walls/Partitions (those not listed above)	5 psf	L/240

Performance Criteria		
Use Condition [2]	Design Pressure	Maximum Deflection
Interior Ceilings, Soffits and Bulkheads	5 psf	L/360

Footnotes

1. Limit deflection to L/360 where wall cladding on either face is any of the following: Ceramic Tile, Stone Tile, Porcelain Tile and similar brittle finishes which are prone to movement induced cracking.
2. Where elements meet multiple conditions; Use most stringent Deflection and Design Pressure values.

2.3 MATERIALS

A. Metal Studs and Floor Tracks:
   1. C-shaped, roll formed studs and tracks conforming to ASTM C645.
   2. Steel design standard: 33KSI.
   3. Galvanized: G40 or G40EQ conforming to ASTM A653 and AISI S220.
   4. Stud and track depths: As indicated by wall type.
   5. Minimum flange width: 1-1/4-inch.
   6. Minimum thickness: 30 mil (20 GA), except as follows:
      a. Increase member thickness to comply with performance criteria.
   7. In lieu of increased member thickness, design may employ diagonal braces above ceiling to reduce overall span.
      a. Coordinate locations with building services items.
      b. Do not employ studs with member thickness less than allowed by fire resistance rated assemblies.
   8. High strength 50 ksi or 70 ksi studs shall comply with design criteria of equivalent thickness standard 33 ksi studs listed.

B. Z-Furring:
   1. Z-shaped sections attached to structural parent wall.
   2. Galvanized: G40 or certified equivalent.
   3. Sizes: 1, 1-1/2, and 2 inches.
   4. Thickness: 18 mil (25 GA) minimum; Use heavier gauge as dictated by conditions.

C. Support Systems for Gypsum Ceilings:
   1. Stud-Framed Ceiling/Soffit Systems:
      a. C-shaped studs or joists; roll-formed.
      b. Galvanized: G40.
      c. Frame member depth: 3-5/8-inch minimum, unless otherwise indicated.
         1) Use wider stud sections if ceiling span and support requires.
      d. Flange width: 1-1/4-inch minimum.
      e. Stud thickness: 33 mil minimum.
   2. Tie Wire:
      a. ASTM A641, Class 1 zinc coating, soft temper.
      b. Diameter, single strand: 62 mil (14 GA) minimum.
      c. Diameter, double strand: 42 mil (18 GA) minimum.
   3. Wire Hangers:
      a. ASTM A641, Class 1 zinc coating, soft temper.
      b. Diameter: 97 mils (12 GA) minimum.
   4. Other items including suspension wire, tie wire, attachment devices: As specified and indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine supporting structure and conditions under which system will be installed.

B. Correct conditions detrimental to proper installation.

C. Installation constitutes acceptance of responsibility for performance.

3.2 INSTALLATION - GENERAL

A. Layout and install metal framing accurate to dimensions indicated in drawings.

B. Installation Standard: ASTM C754, except comply with framing sizes and spacing indicated.
   1. Gypsum Board Assemblies: Comply with additional requirements in ASTM C840 relative to framing installation.

C. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, wall stops, furnishings, or similar construction.

D. Extend framing full height to structural supports.
   1. Exception: Where partitions are indicated to terminate at, or just above, suspended ceilings.
   2. Continue framing around ducts and similar items which penetrate partitions.

E. Position studs vertically engaging floor track and head of wall deflection track.
   1. Align stud knockouts to facilitate running of wires and conduit.

F. Space studs maximum 16-inches on center.

G. Provide additional studs at corners, partition intersections and terminations of partitions, and at each side of control joints.

H. Positively anchor studs to floor tracks with self-tapping pan head screws, or stud clinching tool per ASTM C754.

I. Anchor fire rated partitions as required by fire resistance design, and firestopping design.

J. Furring Channels:
   1. Attach furring channel systems directly to parent walls.
   2. Install channels at maximum 16-inches on center.
   3. Provide additional framing at openings, cutouts, corners, and control joints.
   4. Space fasteners not more than 24-inches on center, staggered on opposite flanges of furring channels.

3.3 WALL BACKING AND BLOCKING

A. Provide in-wall backing reinforcement where following items are mounted to interior walls and interior face of exterior walls:
   1. Wall-mounted door stops.
   2. Markerboards, tackboards, and chalkboards.
   3. Other wall-mounted items where backing is indicated by details or specification.

B. Metal Wall Backing requirements are described as Accessory Items in Part 2 of this section.

C. Wood Wall Blocking may be used where allowed by Code and Manufacturer of item to be supported. Specified in Section 06 10 00.

D. Coordinate mounting height, location, and coverage with item to be supported.

E. Determine material width according to item to be supported.

F. Provide in-wall metal wall backing material to interior metal stud walls specified herein.

G. Attachment: Minimum (2) #10 sheet metal screws at each stud.

3.4 CEILING FRAMING

A. Install in compliance with manufacturer's recommendations.

B. Provide required items to support and trim out neatly, flush or recessed mechanical and electrical items.

C. Frame openings in ceiling support system to accommodate access panels and similar openings and penetrations.
   1. Completely frame openings with closed channel side of stud facing opening for support of recessed mechanical and electrical items.

END OF SECTION

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SECTION 09 29 00
GYPSUM BOARD

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gypsum board.
   2. Moisture - Resistant gypsum wallboard.
   3. Coated tile backer gypsum board.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 06 10 00 - Rough Carpentry.
   2. Section 07 92 00 - Joint Sealants.
   3. Section 09 22 16 - Non-Structural Metal Framing.
   4. Section 09 91 00 - Architectural Painting.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Specifications Institute (ANSI):
      a. A108.11, Installation of Ceramic Tile.
   2. ASTM International (ASTM):
      a. A653/A653M, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
      b. C11, Standard Terminology Relating to Gypsum and Related Building Materials and Systems.
      c. C36, Standard Specification for Gypsum Wallboard.
      d. C475/C475M, Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
      e. C557, Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
      f. C630, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
      g. C840, Standard Specification for Application and Finishing of Gypsum Board.
      h. C1002, Standard Specification for Steel Self-Piercing Tapping Screws for Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs.
      i. C1047, Standard Specification for Accessories for Gypsum Wallboard and Gypsum Veneer Base.
      j. C1177, Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
      k. C1396/C1396M, Standard Specification for Gypsum Board.
      l. D3273, Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
      m. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   3. Gypsum Association (GA):
      a. GA-214, Recommended Levels of Gypsum Board Finish.
   4. Underwriters Laboratories, Inc. (UL):
      a. Building Materials Directory.
      b. Fire Resistance Directory.
   5. United States Gypsum Company:
      a. Gypsum Construction Handbook.

1.3 DEFINITIONS

A. Gypsum Board Terminology: Refer to ASTM C11 for definitions of terms for gypsum board assemblies.

1.4 QUALITY ASSURANCE

A. Fire - Test - Response Characteristics: For gypsum board assemblies with fire - resistance ratings, provide materials and construction identical to those tested in assembly indicated according to ASTM E119 by an independent testing and inspecting agency acceptable to authorities having jurisdiction.

B. Fire - Resistance - Rated Assemblies: Indicated by design designations from UL's "Fire Resistance Directory." Or GA - 600, "Fire Resistance Design Manual."

1.5 SUBMITTALS

A. Shop Drawings:
   1. Drawings of unusual conditions.
      a. Control joint layout.

B. Product technical data including:
   1. Submit manufacturer’s specifications for each product submitted showing compliance with requirements of standards referenced.
   2. Manufacturer's installation instructions.
   3. Manufacturer's trims, adhesive, joint treatment compound and tape recommendations.

1.6 PRODUCT HANDLING

1. Coordinate delivery with installation to minimize storage periods at the project site. Deliver in manufacturer's unopened containers, bundles or packages, fully identified with manufacturer's name, brand, type, and grade.
2. Store materials inside, under cover and keep them dry and protected against damage from weather, direct sunlight, surface contamination, corrosion, construction traffic and other causes. Neatly stack gypsum boards flat to prevent sagging.
3. Handle gypsum boards to prevent damage to edges, ends and surfaces. Do not bend or otherwise damage metal corner bead and trim.

1.7 JOB CONDITIONS

1. Examine all parts of supporting structure and conditions under which the wallboard is to be installed. Do not proceed with installation until unsatisfactory conditions have been corrected. Coordinate installation with the work of other trades to allow time for the correct installation of their work.
2. Establish and maintain environmental conditions for application and finishing gypsum board to comply with ASTM C840 and with gypsum board manufacturer's written recommendations whichever are more stringent
3. Minimum Room Temperatures: For non - adhesive attachment of gypsum board to framing, maintain not less than 60-degree F. For adhesive attachment and finishing of gypsum board, maintain not less than 60-degree F for 48 hours prior to application and continuously thereafter until drying is complete.
4. Ventilate building spaces to remove water not required for drying joint treatment materials. Avoid drafts during dry, hot weather to prevent materials from drying too rapidly.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Gypsum Board:
      a. Georgia-Pacific Gypsum LLC – Tough Rock Fireguard.
      b. Or Equal.

2.2 MATERIALS

A. General:
   1. Provide UL Listed materials in fire-resistant rated construction.
   2. Furnish in lengths as long as practicable.

B. Gypsum Board (GB):
   1. ASTM C36.
   2. ASTM C1396/C1396M.
   3. Edges: Tapered.
   4. Thickness: Unless noted otherwise.
      a. 5/8-inches, Type X.

2.3 ACCESSORIES

A. Trim:
   1. ASTM C1047.
   2. Galvanized: ASTM A653/A653M G-60, unless noted otherwise.
   3. Interior Trim: Comply with ASTM C 1047.
   4. Shapes:
      a. Corner bead: Metal Corner bead formed from zinc alloy, with flanges knurled and perforated or of fine - mesh expanded metal. Use at outside corners, unless otherwise indicated.
      b. LC - Bead: J - shaped, steel edge trim formed from galvanized steel, complying with type “LC” Bead per Figure 1 of ASTM C840 with exposed long flange which receives joint compound. Use at exposed panel edges.
      c. Expansion (Control) Joint: One - piece, rolled zinc with V - shaped slot 1/4-inch wide by approximately 7/16-inch deep with a removable strip covering slot opening. Use where required.

B. Joint Tape:
   1. ASTM C475/C475M.
   2. Recommended by manufacturer for specified board type and location.

C. Joint Treatment Compound:
   1. ASTM C475/C475M.
   2. Recommended by manufacturer for specified board type and location.
   3. Pre - filling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting - type taping compound.
   4. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting - type taping compound or drying - type, all - purpose compound.
      a. Use setting - type compound for installing paper - faced metal trim accessories.
   5. Fill Coat: For second coat, use setting - type, sandable topping compound or drying - type, all - purpose compound.
   6. Finish Coat: For third coat, use setting - type, sandable topping compound or drying - type, all - purpose compound.

PART 3 - EXECUTION

3.1 EXAMINATION

A. General:

1. Install materials listed in accordance with manufacturer's specifications and recommendations when not in conflict with specific directions included herein.

B. Installation shall be done by experienced craftsmen trained to this type of work. Examine substrates to which drywall construction attaches or abuts, preset hollow metal frames, cast - in - anchors and structural framing, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of drywall construction. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Furnish concrete inserts and other devises indicated to other trades for installation in advance of time needed for coordination and construction.

B. Coordination of concealed construction, supplementary framing and bracing, and blocking:

C. Be aware of all toilet accessories, toilet partitions, special items, cabinet work, case work or any other items which are to attach to and / or hang from partitions.

D. Coordinate the installation of anchors furnished by suppliers of the above mentioned items as well as blocking and backing as specified under Carpentry Section. Provide all necessary double studs, or studs spaced at 1/2 normal spacing to adequately support the weight of all items to be secured to or hung from the partitions.

E. Provide necessary anchors for items mentioned above that are not normally furnished with those items and adequately secure all anchors to two or more studs before applying board.

F. The completed drywall partitions shall be constructed and adequately braced to withstand the weight of all equipment to be hung on the partitions in addition to all loads to be superimposed on that equipment.

G. Install supplementary framing, blocking and bracing at terminations in the work and for support of mixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings and similar construction to comply with details indicated and with recommendations of gypsum board manufacturer, or if non-available, with "Gypsum Construction Handbook" published by United States Gypsum Company.

H. When outdoor temperature is below 60 degrees F., heat shall be maintained in the building continuously and uniformly at not less than 60 degrees F. from one week prior to beginning of installation until the wallboard application and joint treatment is completed.

I. Ventilation, either natural or supplied by fans, circulators, or air conditioning system, shall be provided to remove excess moisture during joint treatment.

3.3 INSTALLATION

A. General:
   1. Verify that metal stud framing has been installed plumb, true, and in accordance with the Contract Documents.
   2. Prior to application of gypsum board, ensure that all blocking, backing and bracing has been installed as necessary for the support of appurtenant items.
   3. Install gypsum board in accordance with ASTM C840.
   4. Install board in fire-rated construction in accordance with UL requirements.
      a. Self-adhesive applied fire rated tape is not acceptable for use on board joints in fire rated walls..
      b. Tape all joints using conventional fire rated joint tape and joint treatment compound.
   5. Erect all board vertically with edges over supporting members.
      a. See Specification Section 09 22 16 non-structural metal framing.
   6. Secure to each support or framing member with screws.
      a. Provide fasteners of sufficient length to penetrate framing members or studs not less than 3/8-inches.
   7. Bring boards into contact, but do not force into place.

8. Fit neatly and carefully.
9. Stagger edge joints on opposite side of a partition so they occur on different framing members.
10. Hold board in firm contact with support while fasteners are being driven.
11. Proceed with attachment from center of board toward ends and edges.
12. Scribe board prior to cutting.
13. Where gypsum board abuts concrete, masonry, metal deck, exterior doors and windows, or other dissimilar material; provide 3/8-inches joint between edge of gypsum board and abutting material.
    a. Provide continuous casing bead trim on edge of board.
    b. Seal joint with sealant and backer rod.
    c. See Specification Section 07 92 00 for sealant.

B. Installation:
1. Set fasteners between 3/8 and 1/2-inches from edges and -inches in from board corner.
    a. Space maximum of 12-inches on center at edges and in field of board.
    b. Space fasteners closer if required by UL.
2. Install fasteners, in gypsum board, so that head rests in a slight dimple without cutting face paper or fracturing core or as recommended by board/panel manufacturer.

C. Control Joints:
1. Install prefabricated control joints to provide following maximum unjointed lengths or areas:
    a. Partitions: 30 feet, maximum straight run, and at both sides of jamb from head of each door, borrow lite, or window opening to top of partition.
        1) Control joints are not required at openings where the partition forms a cross-corridor condition.
        2) At borrow lites, windows or similar conditions, extend control joints at jamb from sill to floor.
2. Seal control joints.
3. Use color to match wall or ceiling color as closely as possible where control or expansion joints occur in fire or sound rated assemblies, install suitable backing material to maintain required rating.
4. Where a partition or ceiling abuts a structural element or dissimilar wall or ceiling, install corner bead, casing bead or other trim as required.

D. Gypsum Board Finishing:
1. Securely attach continuous corner beads to all external corners in accordance with manufacturer's recommendations.
2. Provide the following minimum levels of gypsum board finish in accordance with GA-214.
    a. Areas exposed to view:
        1) Surfaces to receive: Level #4.
    b. Areas not exposed to view:
        1) Fire rated partitions: Level #2 unless a higher grade of finish is required by UL.
        2) Non-fire rated partitions: Level #2.
    c. Provide additional coats of joint compound as required to completely conceal joints, fasteners and accessories.
        1) Joint telegraphing will not be acceptable.
3. Sand each coat to remove excess joint compound.
    a. Avoid roughing paper facing on board.
4. Finish surface shall be smooth and free of tool marks and ridges.
5. Prime gypsum board surfaces in accordance with Specification Section 09 91 00.
    a. After primer has been applied, inspect surfaces and repair and refinish all areas which show defects.
6. Refer to ASTM C840 for additional finishing requirements.

3.4 CLEANING AND PATCHING

A. Clean exposed drywall surfaces free of soil and stain that would affect finish.

B. Repair or remove and replace defective work.

C. Remove all excess materials and debris from the site.

D. Provide final protection and maintain conditions, in a manner suitable to Installer, which ensures gypsum drywall construction being without damage or deterioration at time of Final completion.

END OF SECTION

SECTION 09 91 00
ARCHITECTURAL PAINTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Surface Preparation.
   2. Field application of:
      a. Architectural Coatings.
      b. Stains and varnishes.
      c. Any other coating, thinner, accelerator, inhibitor, etc., specified or required as part of a complete System specified in this Specification Section.
   3. Environmental controls for field application of coatings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 33 23 - Submittal Procedures.
   2. Section 09 29 00 - Gypsum Board.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. D523, Standard Test Method for Specular Gloss.
      b. D4258, Standard Practice for Surface Cleaning Concrete for Coating.
      c. D4259, Standard Practice for Abrading Concrete.
      d. D4261, Standard Practice for Surface Cleaning Concrete Unit Masonry for Coating.
      e. D4262, Standard Test Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
      f. D4263, Standard Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
      g. F1869, Standard Test Method for Measuring Moisture Vapor Emission Rate of Concrete Subfloor Using Anhydrous Calcium Chloride.
      h. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   2. National Fire Protection Association (NFPA):
      a. 101, Life Safety Code.
   3. Steel Door Institute/American National Standards Institute (SDI/ANSI):
      a. A250.10, Test Procedure and Acceptance Criteria For Prime Painted Steel Surfaces for Steel Doors and Frames.
   4. The Society for Protective Coatings (SSPC):
      a. SP 1, Solvent Cleaning.
      b. SP 2, Hand Tool Cleaning.
      c. SP 3, Power Tool Cleaning.
      d. SP 16, Brush-off Blast Cleaning of Non-Ferrous Metals.
   5. The Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 6/NACE No. 3, Commercial Blast Cleaning.
      b. SP 7/NACE No. 4, Brush-off Blast Cleaning.
      c. SP 13/NACE No. 6, Surface Preparation of Concrete.
   6. United States Environmental Protection Agency (EPA).

B. Miscellaneous:
   1. Coating used in all corridors and stairways shall meet requirements of NFPA 101 and ASTM E84.

1.3 DEFINITIONS

A. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

B. Approved Factory Finish: Finish on a product in compliance with the finish specified in the Specification Section where the product is specified.

C. Exposed Exterior Surface:
   1. Exterior surface which is exposed to view.
   2. Exterior surface which is exposed to weather but not necessarily exposed to view.

D. Finished Area:
   1. An area that is listed in or has finish called for on “Room Finish Schedule found on Architectural Finish Schedules” drawing and “Interior Finish Legend found on Architectural Finish Legend and Notes” drawing.
   2. An area that is indicated on Drawings to be painted.

E. Coating:
   1. A film or thin layer applied to a base material called a substrate. A coating may be a metal, alloy, paint, or solid / liquid suspensions on various substrates (metals, plastics, wood, paper, leather, cloth, etc.). They may be applied by electrolysis, vapor deposition, vacuum, or mechanical means such as brushing, spraying, calendaring, and roller coating.
   2. A coating may be applied for aesthetic or protective purposes or both. The term "coating" as used herein includes fillers, primers, sealers, emulsions, oils, alkyds, latex, enamels, stains, varnishes, sealers, epoxies, thinners and other applied coatings, whether used as primer, intermediate, or finish coat. The terms paint and coating are used interchangeably.

F. DFT:
   1. Dry film thickness, the film thickness of the fully cured, dry paint or coating.

G. Mil / mils:
   1. The English measurement for 0.001 in or one / one - thousandth of an inch, equal to 25.4 microns or 0.0254 millimeter.

H. Gloss Range:
   1. Specular gloss measured in accordance with ASTM D523:
      a. Gloss Level – G1 Matte or Flat:
         1) 0 to 5 units at 60 degrees, 10 maximum units at 85 degrees.

I. Paint includes the following:
   1. Architectural paints (AP) include: Acrylic latex or alkyd enamel coatings.
   2. Stains and varnish include alkyd stain and polyurethane varnish.

1.4 SUBMITTALS

A. Product Data:
   1. Provide primers and undercoat paint produced by the same (Single - Source) manufacturer as the finish coats. This submittal shall include the name of the corresponding specified item together with the following detail information of the manufacturer:
      a. Spreading rate.
      b. Dry mil thickness.
      c. Non - volatile percent by weight.
      d. Dust free time.
      e. Recoat time.
      f. Chemistry of product.
      g. Indicate VOC content.

2. Manufacturer's Material Safety Data Sheets: Submit manufacturer's Material Safety Data Sheets for coatings, solvents, and other potentially hazardous materials, as defined in Federal Standard 313.
3. Provide test reports for materials used indicating fire hazard classification as determined by ASTM E 84. Materials shall meet requirements established in NFPA Number 101, Life Safety Code & International Building Code. Generally, all paint used must maintain a Class "A" fire rating on non-combustible substrates.

B. Certifications:
1. Submit Applicator's Qualifications.

C. Shop Drawings:
1. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's surface preparation instructions.
c. Manufacturer's application instructions.

D. Schedule:
1. Provide a complete schedule indicating where each product specified will be used.
a. Identify each building separately in the schedule and what surface each product will be applied on along with the corresponding color.

E. Informational Submittals:
1. Test results.
2. Applicator's daily records:
a. Submit daily records at end of each week in which painting work is performed unless requested otherwise by Contracting Officer Representative.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver in original containers, labeled as follows:
1. Name or type number of material.
2. Manufacturer's name and item stock number.
3. Contents, by volume, of major constituents.
4. Warning labels.
5. VOC content.
6. Application instructions.
7. Color name and number. Corresponding to Schedule of Finishes.

B. Protect from freezing or damage.

C. Store all materials in a single place designated by the General Contractor. Keep storage neat and clean. Make good all damage thereto or to surroundings. Remove rags and waste from building daily. Take precautions to avoid danger of fire. Post "No Smoking" signs in storage areas.

D. Maintain storage for paint materials in conformity with fire codes and authorities having jurisdiction. Protect floor from any spilled materials.

E. Paints and thinners shall be stored in accordance with the manufacturer's written directions, and as a minimum, stored off the ground, under cover, with sufficient ventilation to prevent the buildup of flammable vapors, and at temperatures between 40 to 95 degrees F. Do not store paint, polyurethane, varnish, or wood stain products with materials that have a high capacity to adsorb VOC emissions. Do not store paint, polyurethane, varnish, or wood stain products in occupied spaces.

1.6 COORDINATION OF PAINTING REQUIREMENTS

A. The painting subcontractor shall examine other Sections of the Specifications and shall thoroughly familiarize themselves with all their provisions regarding their painting requirements. Except as otherwise specified, surfaces left unfinished by the requirements of other Sections shall be painted or finished as a requirement of this contract.

B. Prime Coat Coordination: Provide finish coats which are compatible with prime paints used. Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coating system for various substrates. Upon request from other trades, furnish information on characteristics of finish materials proposed for use, to ensure compatible prime coats are used. Provide barrier coats over incompatible primers or remove and reprime as required at no additional cost to Government. Notify Contracting Officer Representative in writing of any anticipated problems using specified coating systems with substrates primed by others.

1.7 PROJECT CONDITIONS

A. Comply, at minimum, with manufacturer recommendations for space ventilation during and after installation. Isolate area of application from rest of building when applying high - emission paints or coatings.
   1. Supply 100 percent outside air 24 hours a day.
   2. Supply airflow at a rate of 6 air changes per hour, when outside temperatures are between 55 degrees F and 85 degrees F and humidity is between 30 percent and 60 percent.
   3. Supply airflow at a rate of 1.5 air changes per hour, when outside air conditions are not within the range stipulated above.
   4. Avoid painting near temporary heaters which might discolor paint.
   5. Vent exhaust gases to exterior environment.
   6. No exhaust gases shall be allowed to vent into the space being painted or any adjacent space.

B. Coatings - Do not apply coating when air or substrate conditions are:
   1. Less than 5 degrees F above dew point;
   2. Below 50 degrees F or above 95 degrees F unless specifically pre - approved in writing by the Owner’s Representative and the product manufacturer. Under no circumstances shall application conditions exceed manufacturer recommendations.

C. Protection During Cleaning:
   1. Personnel engaged in solvent - cleaning of galvanized metal and aluminum, or cleaning concrete, masonry, or portland cement plaster with 5 to 10 percent solution of hydrochloric acid, shall wear the appropriate personal protective equipment to prevent skin and eye contact and fumes inhalation. Ventilate all work areas properly.
   2. Personnel Protection During Coating Applications:
      a. Personnel painting with high-build glaze coating systems shall wear the appropriate personal protective equipment to prevent skin or eye contact or inhalation. Ensure employees use and maintain solvent - resistant, personal protective equipment for the whole body. Emergency eye wash and water supplies shall be available near the work area for emergency flushing of the eyes and body. Coating applications shall be performed only in areas with good ventilation. Smoking will not be permitted in the area where coating is being applied. Wall and room temperature at the time of coating application and curing shall be in accordance with the manufacturer's instructions.

D. Protection During Application of Polyurethane Paints:
   1. Mix and apply polyurethane paints only in specifically designated areas with local exhaust ventilation and other environmental control measures as recommended on the basis of an on-site industrial hygiene survey. Supply and use air respirators in closed areas where adequate ventilation cannot be obtained.

E. Post - Application:
   1. Vacate space for as long as possible after application. Wait a minimum of 48 hours before occupying freshly painted rooms. Maintain one of the following ventilation conditions during the curing period, or for 72 hours after application:

F. Painting Contractor shall apply all materials under adequate illumination. Contractor shall assure adequate illumination exists in all areas where painting operations are in progress.

G. The painting Contractor is responsible for inspecting the work of others prior to the application of any paint or finishing material. If any surface to be finished cannot be put in proper condition for finishing by customary cleaning, sanding and puttying operations, the painting Contractor will immediately notify the General Contractor and the Contracting Officer, in writing, and shall not proceed with this work until conditions have been corrected and are acceptable.

H. Commencing of work in a specific area constitutes acceptance of surfaces, and responsibility for satisfactory work.

I. Painting Contractor shall provide wet paint signs as required.

J. Paint exposed surfaces whether or not colors are designated in "schedules," except where a surface or material is specifically indicated not to be painted or is to remain natural. Where an item or surface is not specifically mentioned, paint the same as similar adjacent materials or surfaces. If color or finish is not designated, the Contractor shall follow the color selection procedures found in Section 01 33 23 – Submittal Procedures, Section 2.4 Color Submittals.

K. Contracting Officer Representative's approval is required PRIOR to application of each coat.

L. The minimum numbers of paint coats are specified in the Paint Schedule found elsewhere in this section. The application of additional coats to provide a total color and sheen uniformity on all surfaces shall be provided at no additional cost to the Government. The painting Contractor shall not be entitled to payment in excess of the amount agreed upon in their contract for any extra work over and above that specified unless authorized in writing by a Change Order.

M. Verify that atmosphere in area where painting is to take place is within paint manufacturer's acceptable temperature, humidity and sun exposure limits.

N. Do not apply coatings in snow, rain, fog or mist.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's request for comparable products when the following conditions are satisfied. If the following conditions are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specified products.
   2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Hollow Metal Doors and Frames:
      a. Basis of Design: Tnemec – Series 135 Chembuild (Primer); and Series 1028/1029 Enduratone (Finish).
      b. Or Equal.
   2. Submit request for substitution in accordance with Specification Section 01 33 23.
   3. Provide products from a single manufacturer to the greatest extent practicable.

2.2 MATERIALS

A. General:
   1. For unspecified materials such as thinner, provide manufacturer's recommended products.
   2. Unless noted otherwise, products listed are manufactured by the manufacturer listed below.
      a. Products of other manufacturers will be considered for use provided that the product:
         1) Is of the same generic formulation.

2) Has comparable application requirements.
3) Meets the same VOC levels or better.
4) Provides the same finish and color options.

3. Coatings shall comply with the VOC limits of EPA.

2.3 PAINT SYSTEMS

A. Schedule:

Substrate	Prime Coat[1]	Intermediate Coat(s)[1]	Finish Coat[1]
Hollow Metal Doors and Frames – Interior	4.0 to 5.0 mil DFT Epoxy Barrier Coat	2.0 to 3.0 mil HDP Acrylic[2]	2.0 to 3.0 mil HDP Acrylic[2]
Gypsum Board scheduled to receive "P"	300 to 400 square feet/GAL Acrylic Primer	300 to 400 square feet/GAL Acrylic Latex [2]	300 to 400 square feet/GAL Acrylic Latex [2]

1. Application rates (SF/GAL) shown are for unthinned materials.
2. Sheen as scheduled or selected.

B. Hollow Metal Doors and Frames:
1. Primer:
a. Modified Polyamidoamine Epoxy with a minimum solids by volume of 84 percent with a total dry film thickness to develop a dry mil thickness of not less than 1.4 mils.
2. Intermediate and Finish Coats - Interior Latex Eggshell:
a. HDP Acrylic Polymer with a minimum solids by volume of 40 percent. Minimum 2 finish coats over a primer with total dry film thickness not less than 4 mils excluding primer and to provide total color and sheen uniformity.

PART 3 - EXECUTION

3.1 ITEMS TO BE PAINTED

A. Exterior surfaces, including but not limited to:
1. Structural and Exterior Steel:
a. Columns, beams and bracing.
b. Field welded connections of factory painted structural steel.
2. Miscellaneous ferrous metal surfaces:
a. Items specifically noted on Drawings to be painted.
3. Miscellaneous galvanized steel surfaces:
a. Items specifically noted on Drawings to be painted.

3.2 ITEMS NOT TO BE PAINTED

A. General: Do not paint items listed in this Article, unless noted otherwise.

B. Items with Approved Factory Finish: These items may require repair of damaged painted areas or painting of welded connections.

C. Electrical equipment.

D. Moving parts of mechanical and electrical units where painting would interfere with the operation of the unit.

E. Code labels, equipment identification or rating plates and similar labels, tagging and identification.

F. Contact surfaces of friction-type structural connections.

G. Stainless steel surfaces.

H. Aluminum Surfaces Except:
   1. Where specifically shown in the Contract Documents.
   2. Where in contact with concrete.
   3. Where in contact with dissimilar metals.

I. Fiberglass Surfaces Except:
   1. Fiberglass piping where specifically noted to be painted.
   2. Piping supports where specifically noted to be painted.

J. Architectural finishes:
   1. Fiberglass fabrications.
   2. Anodized aluminum.
   3. Finish hardware.
   4. Building specialties.
   5. Louvers.

3.3 EXAMINATION

3.4 PREPARATION

A. General:
   1. Prepare surfaces to be painted in accordance with paint manufacturer's instructions and this Specification Section unless noted otherwise in this Specification Section.
      a. Where discrepancy between paint manufacturer's instructions and this Specification Section exists, the more stringent preparation shall be provided unless approved otherwise, in writing, by the Contracting Officer Representative.
   2. Remove all dust, grease, oil, compounds, dirt and other foreign matter which would prevent bonding of paint to surface.
   3. Adhere to manufacturer's recoat time surface preparation requirements.
      a. Surfaces that have exceeded paint manufacturer's published recoat time and/or have exhibited surface chalking shall be prepared prior to additional paint in accordance with manufacturer's published recommendations.

B. Protection:
   1. Protect surrounding surfaces not to be coated.
   2. Remove and protect hardware, accessories, plates, fixtures, finished work, and similar items; or provide ample in-place protection.
   3. Protect code labels, equipment identification or rating plates and similar labels, tagging and identification.

C. Prepare and paint before assembly all surfaces which are inaccessible after assembly.

D. Ferrous Metal:
   1. Complete fabrication, welding or burning before beginning surface preparation.

a. Chip or grind off flux, spatter, slag or other laminations left from welding.
b. Remove mill scale.
c. Grind smooth rough welds and other sharp projections.

2. Solvent clean in accordance with SSPC SP 1 to remove all dust, grease, oil, compounds, dirt and other foreign matter.
3. Exterior exposure:
   a. Commercial blast clean in accordance with SSPC SP 6/NACE No. 3.
4. Interior exposure:
   a. Hand tool cleaning in accordance with SSPC SP 2 and/or power tool cleaning in accordance with SSPC SP 3.

E. Hollow Metal:
1. Solvent clean in accordance with SSPC SP 1 to remove all dust, grease, oil, compounds, dirt and other foreign matter.
2. Lightly sand primed surfaces with fine grit sandpaper as recommended by hollow metal manufacturer.

F. Galvanized Steel and Non-ferrous Metals:
1. Solvent clean to remove all dust, grease, oil, compounds, dirt and other foreign matter.
2. Brush-off blast in accordance with SSPC SP 16 or hand tool cleaning in accordance with SSPC SP 2 to remove surface contaminants.

3.5 APPLICATION

A. General:
1. Thin, mix and apply paints in accordance with manufacturer's installation instructions.
   a. Where discrepancy exists between manufacturer’s instructions and this Specification Section, the more stringent requirement shall apply.
   b. Backroll spray applied paints.
2. Temperature and weather conditions:
   a. Avoid painting surfaces exposed to hot sun.
   b. Do not paint on damp surfaces.
3. Evenly spread to provide full, smooth coverage.
   a. All paint systems are "to cover."
      1) When color or undercoats show through, apply additional coats until paint film is of uniform finish and color.
   b. Finished paint system shall be uniform and without voids, bugholes, holidays, laps, brush marks, roller marks, runs, sags or other imperfections.
4. Work each application of material into corners, crevices, joints, and other difficult to work areas.
5. When painting rough surfaces, hand brush and backroll paint to work into all recesses.
6. Smooth out runs or sags immediately, or remove and recoat entire surface.
7. Allow preceding coats to dry before recoating.
   a. Recoat within time limits specified by paint manufacturer.
   b. If recoat time limits have expired re-prepare surface in accordance with paint manufacturer's printed recommendations.
8. Allow coated surfaces to cure prior to allowing traffic or other work to proceed.
9. Finish colors not otherwise indicated shall be selected by Engineer from paint manufacturer’s complete offering.

B. Fillers, surfacers or patching compounds:
1. Provide fillers, surfacers or patching compounds in accordance with manufacturer’s recommendations and as specified herein as necessary to provide a smooth, defect free substrate.

C. Prime Coat Application:
1. Prime all surfaces indicated to be painted.

a. Apply prime coat in accordance with paint manufacturer's written instructions and as written in this Specification Section.

2. Ensure field-applied paints are compatible with factory-applied paints or existing coatings.
   a. Employ services of coating manufacturer's qualified technical representative.
      1) Certify through material data sheets.
      2) Perform test patch.
   b. If field-applied coating is found to be not compatible, require the coating manufacturer's technical representative to recommend, in writing, product to be used as barrier coat, thickness to be applied, surface preparation and method of application.
   c. At Contractor's option, coatings may be removed, surface re-prepared, and new coating applied using appropriate paint system complying with this Specification Section.
      1) All damage to surface as result of coating removal shall be repaired to original condition or better by Contractor at no additional cost to Government.

D. Finish Coat Application:
   1. Apply finish coats in accordance with paint manufacturer's written instructions and in accordance with this Specification Section.
   2. Touch up damaged finish coats using same application method and same material specified for finish coat.
   3. Hollow metal frames and doors:
      a. Finish coats shall be spray applied only.
      b. Finish edges same as faces of doors.

3.6 FIELD QUALITY CONTROL

A. Application Deficiencies:
   1. Surfaces showing runs, laps, brush marks, telegraphing of surface imperfections or other defects will not be accepted.
   2. Surfaces showing evidence of fading, chalking, blistering, delamination or other defects due to improper surface preparation, environmental controls or application will not be accepted.

B. Provide protection for painted surfaces.
   1. Surfaces showing soiling, staining, streaking, chipping, scratches, or other defects will not be accepted.

C. Maintain Daily Records:
   1. Record the following information during application of each coat of paint applied:
      a. Date, starting time, end time, and all breaks taken by painters.
      b. For exterior painting:
         1) Sky condition.
         2) Wind speed and direction.
      c. Air temperature.
      d. Relative humidity.
      e. Moisture content and surface temperature of substrate prior to each coat.
      f. Provisions utilized to maintain work area within manufacturer's recommended application parameters including temporary heating, ventilation, cooling, dehumidification and provisions utilized to mitigate wind-blown dust and debris from contaminating the wet paint film.
      g. Record environmental conditions, substrate moisture content and surface temperature information not less than once every four (4) hours during application.
         1) Record hourly when temperatures are below 50 degrees F or above 100 degrees F.
   2. Record the following information daily for the paint manufacturer's recommended curing period:
      a. Date and start time of cure period for each item or area.
      b. For exterior painting:
         1) Sky conditions.
         2) Wind speed and direction.
      c. Record environmental conditions not less than once every 12 hours.

1) Record once every 4 hours when ambient temperature is below 35 degrees F.

d. Provisions utilized to protect each item or area and to maintain areas within manufacturer's recommended curing parameters.

3. Format for daily record to be computer generated.

D. Measure surface temperature of items to be painted with surface temperature gage specifically designed for such.

E. Measure substrate humidity with humidity gage specifically designed for such.

F. Provide wet paint signs.

3.7 CLEANING

A. Clean paint spattered surfaces.
1. Use care not to damage finished surfaces.

B. Remove masking, adhesive residue or other foreign materials.

C. Upon completion of painting, replace hardware, accessories, plates, fixtures, and similar items.

D. Remove surplus materials, scaffolding, and debris.

END OF SECTION

SECTION 10 50 00

TEMPORARY LAB TRAILER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Temporary laboratory trailer to serve as the Wastewater Treatment Plant Laboratory while the existing facility is renovated.
   2. The Contractor is responsible and required to provide everything for a full working system.
      a. Sewer and water service will be available on-site.

B. Related Sections include but are not necessarily limited to:
   1. Division 0 – Procurement and Contracting Requirements
   2. Division 1 – General Requirements
   3. Division 26 - Electrical
   4. Section 05 50 00 – Metal Fabrications
   5. Section 26 41 13 – Lightning Protection System

1.2 QUALITY ASSURANCE

A. Manufacturer Qualifications

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Wind Anchorage.
      d. Equipment
      e. Casework
      f. Water and Waste Systems
      g. HVAC system
   3. Drawings:
      a. Plan view showing:
         1) Arrangement of casework and equipment.
         2) Size and location of all openings.
         3) Size and location of entry stairs and landings
         4) Location of tie downs
         5) Minimum plan scale: 1/8 IN = 1 FT.
      b. Exterior elevation
      c. Interior elevations
   4. Calculations:
      a. Provide calculations for wind anchorage.
      b. Calculations will not be reviewed and are submitted for record purposes only.
      c. Calculations shall be sealed by a professional engineer registered in the State of Arizona.

B. Informational Submittals:
   1. Electrical test results.

1.4 SYSTEM DESCRIPTION

A. Design trailer to support a wide variety of laboratory processes.
   1. Provide complete HVAC system, electrical system and water and waste plumbing as specified herein
   2. Provide seamless walls and floor to make maintaining and cleaning trouble-free

B. Provide space for and install the following equipment:
   1. Dishwasher with heating element.
   2. Deionized water unit
      a. Install DI system
      b. Provide additional tap at one sink for DI water use,
      c. Provide additional lines from DI unit to the dishwasher and DI unit
   3. Ultra-pure DI unit.
   4. Small refrigerator with freezer.
   5. Portable fire extinguisher.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Lab-Pro

B. Or equal.

2.2 DIMENSIONS

A. Width of body: 11 FT – 10 IN

B. Length of body hull: 50 FT – 4 IN

C. Overall height (excluding fume hood vents): 13 FT – 8 IN

D. Overall length: 56 FT - 0 IN

E. Finished Ceiling Height: Minimum 8 FT

2.3 CHASSIS

A. Design to support dead loads, including equipment, and minimum live load of 50 LB/SF

B. Entry steps, platforms and ramps:
   1. Dimensions: per Code (IBC 2015)
   2. Materials: Aluminum or galvanized steel per Section 05 50 00
   3. Design loads: per Section 05 50 00

2.4 BODY STRUCTURE

A. Floor System
   1. Floor Main Frame: per supplier.
   2. Floor Sub-Frame: minimum 3 IN x 2 IN x 20 gage steel rectangular tubing @ 12 IN o.c.
   3. Insulation: R-19 Spray Foam
   4. Floor Decking: Double layer 4 x 8 T&G
   5. Floor coating: 3 part epoxy coating with vinyl paint chip coloring (gray, black and white).

B. Wall System:
   1. Wall studs: wood 2” x 6” 16" o.c. with single bottom plate and double top plate.
   2. Exterior siding:
      a. Steel painted siding or aluminum
         1) Smooth, .040 IN thick
         2) Painted to match exterior of project shipping containers, EQ Tank, and MBR Treatment Units.

Exterior Custom Paint Finish
BEHR ULTRA
BASE: 9853
BEHR ULTRA EXT MATTE FINISH
CUSTOM COLOR MATCH

CLRNT		BL	CL	DL	KXL
0Z	16	14	32	6	
384th		316	324	72	11

b. Aluminum sheets to be 49" wide for a 1" overlap.
   1) Attach to studs with aluminum fasteners
   2) Seal each sheet with a VHB double sided tape.
   3) Plywood sheathing: minimum 0.5 IN thick

3. Interior:
   a. Seamless Fiberglass Reinforced Plastic (FRP)
   b. Minimum 0.060 IN thick,
   c. Laminate to 0.375 IN plywood
   d. Provide with corner joints vinyl trimmed and sealed with a high quality silicone sealant to provide a water proof finish.
4. Insulation:
   a. Minimum R-19
   b. Fiberglass with Kraft vapor barrier
   c. Staple to studs
5. Provide air conditioner return air plenum wall.

C. Roof System:
1. Roof rafters: per supplier
2. Roof covering:
   a. One piece 0.045 IN white or black membrane
   b. Fully adhered to minimum 0.5 IN BC plywood decking
   c. Terminate under a .080 mil finish aluminum mate beam top cap
3. Sub-ceiling: 0.625 IN Type X gypsum board.
4. Insulation: Minimum R-30 fiberglass with Kraft vapor barrier.
5. Ceiling:
   a. Suspended T-grid,
   b. 2 FT x 4 FT smooth lay-in panels.
6. Provide scuppers with galvanized box painted white and 4" PVC drain pipe at both ends of trailer.

D. Doors:
1. Heavy-duty steel doors with stainless steel hinges.
2. One (1) exterior door
   a. 36 IN x 84 IN
   b. Door closer,
   c. Aluminum kick plate,
   d. Lever handle, keyed entry lock.
   e. Safety glass viewing window: 24 IN x 36 IN
3. Two (2) exterior double door
   a. 60 IN x 84 IN (36 IN/24 IN leafs)
   b. Door closer
   c. Aluminum kick plate
   d. Lever handle, keyed entry lock.
      1) Inactive door to have surface mounted latch bolts top and bottom ONLY.
   e. Safety glass viewing window: 24 IN x 36 IN in active leaf.

2.5 WATER SYSTEM

A. Provide complete water and waste plumbing with a single point of connection for each.

B. Water supply piping:
   1. Pipe material: Type l copper.
   2. 1IN supply entry with ball valve shut off.
   3. Include rough in piping and connection to stainless steel sinks, emergency shower and eye wash station.
   4. Provide point of use water heaters,
      a. Eemax model no.ex75
      b. Or equal

C. Emergency Eyewash Stations
   1. Provide deck-mounted eyewash stations installed on the right-hand side of each lab sink faucet.
   2. Include the following:
      a. 6 FT reinforced hose, 750 psi burst pressure,
      b. 3/8 IN chrome-plated brass valve
      c. Twin aerated spray heads with dust caps.
   3. Conform to ANSI Z358.1-1998 standard.

D. Safety Shower:
   1. Install overhead safety shower mounted to the ceiling
   2. Include the following:
      a. 8 IN diameter yellow showerhead,
      b. 1 IN NPTF chrome-plated brass ball valve, with stainless steel handle.
   3. Conform to ANSI Z358.1-1998 standard.

E. Waste Plumbing
   1. DWV system material: polypropylene pipe installed to single point service connection.
   2. Minimum one (1) floor drain near emergency shower.

F. Heat trace and insulate all exterior exposed piping

G. Tie in to existing utilities as shown on Drawings

2.6 ELECTRICAL

A. The temporary lab trailer manufacturer shall provide all electrical components for a fully functioning electrical system including but not limited to the items listed in Section 2.6

B. See Division 26 for additional electrical requirements.

C. Provide minimum 400 AMP, 208 V electrical service entry & power distribution system:
   1. One (1) 208/120V 3-phase, 4-wire, 400Amp, externally mounted Nema 3R main circuit breaker for power service from transformer T3B.
      a. Coordinate onsite power connection point with site contractor.
   2. One (1) 120/240 volt 1-phase, 3-wire, 60 Hz. Nema-3R service entry disconnect.
   3. One (1) Main distribution load center Nema-1 120/240 volt, 1-phase, 3-wire, 60 Hz.
      a. Provide with main breaker and branch breakers.
   4. All wiring min. 12 awg type THHN is to be installed in liquid tight flexible conduit or EMT
      a. Concealed, but easily accessible for repairs
      b. Secure all conduits and fasten at appropriate points to prevent sagging and at all points of bending.
      c. All lighting, wiring, switches, and receptacles shall be securely installed, straight and true, and free of loose or faulty connections.
      d. Locate wall outlets and other receptacles at convenient points and install uniformly.
   5. Two (2) emergency exit lights, with battery back up.
   6. Four (4) Exit signs with battery back up.
   7. Nine (9) Interior 2' x 4' 4-tube lay in troffer with acrylic diffuser.

a. Lithonia #2GT 4 40 A12 120 ES or equal.

8. Two (2) Exterior area lights,
   a. Integral Motion/Ambient sensor enabled at 1 FC
   b. Full “Cut-Off” (Nighttime Friendly) visual comfort type II short distribution optics.
   c. Wet Location Rated
9. Two (2) three-way switch for interior lighting.
10. Two (2) Junction boxes for fume hood connection.
11. Wire way series 4000 with (16) duplex outlets mounted above the counter top back splash.
12. Test all wiring and associated equipment
    a. Subject wiring and permanently connected devices to a dielectric voltage test of 900 volts for 1 minute.
    b. Conduct test between the live parts and the neutral conductor and between the live parts and the trailer frame with all switches in the circuit closed.

D. Provide lightening protection system for Temporary Lab building and structure per section 26 41 13 - Lightning Protection System.

E. Fault current calculations shall be completed and provided by the manufacturer to ensure the manufacturer provided electrical equipment interrupting ratings are appropriate.

2.7 HVAC SYSTEM

A. Provide air conditioning and heating system:
   1. 100% single pass conditioned air
   2. Four (4) wall mounted package A/C units with heat strips and heat pump,
   3. Minimum 2.5 ton cooling
   4. Provide digital control to maintain temperature and humidity.
      a. Include two stage thermostat controls
   5. Supply air ducted thru plenum wall and filtered return air via return air filter grilles installed in plenum wall.

B. Ductwork
   1. Material: PVC Duct Pipe.
   2. Provide zero pressure weather caps on all stacks.
   3. Properly support and install stacks to the proper height to avoid any possible down draft.

2.8 CASEWORK

A. Acceptable Manufacturer’s:
   1. Laboratory cabinets:
      a. VWR
      b. Or approved equal.
   2. Counter tops:
      a. Trespa
      b. Or approved equal.

B. Supply and install steel casework, fixtures, and equipment.
   1. Provide all fillers, scribes, knee-space panels, and base moldings as needed.
   2. Each unit self-contained and complete so that individual units can be relocated at any subsequent time without requiring field application of finished ends or other such parts.
   3. Constructed of 18-gauge steel, except as follows:
      a. Corner gussets for leveling bolts and apron corner braces: 12-gauge.
      b. Hinge reinforcements, case and drawer suspension channels:14-gauge.
      c. Top and intermediate front horizontal rails, table aprons, and reinforcement gussets: 16-gauge.
      d. Drawer assemblies, door assemblies and adjustable shelves: 20-gauge
   4. Installing Contractor certified by manufacturer.
   5. Similar to VWR “Contour” type with standard Glacier White finish

C. Countertops: black chemical resistant phenolic resin with 4" backsplash

1. One (1) inch thick Trespa resin

2.9 EQUIPMENT

A. Metering Instruments
   1. Hach PH meter
      a. Quantity: Two (2)
      b. Supply pH4, pH7 and pH10 buffers in 1L bottles
         1) Quantity: Four (4), each
   2. Hach Dissolved Oxygen (DO) Meter
      a. Quantity: Two (2)
         1) Option to supply One Hach pH/DO combo meter in lieu of individual pH and DO meters, two (2)
   3. Hach DR300 Pocket Colorimeter with DR Spec Color Standard, DPD Chlorine – LR Secondary Standard Kit
      a. Quantity: Two (2)
   4. TSS Meter
      a. Quantity: Two (2)
   5. DR3900 Spectrophotometer with DR/Check Absorbance Secondary Standards Kit
      a. Quantity: Two (2)
   6. Turbidimeter
      a. Quantity: Two (2)

B. Miscellaneous Lab Equipment
   1. Pipettes
      a. Quantity: Two (2), per size range
         1) 100 - 1000 uL
         2) 1- 5 mL
         3) Provide additional pipette tips
            a) Quantity: 200, per pipette.
   2. Class A glassware
      a. Quantity: Two (2), per size
         1) Volumetric Flasks
            a) 50 mL
            b) 100 mL
            c) 1000 mL
         2) Beakers
            a) 50 mL
            b) 250 mL
         3) Graduated Cylinders
            a) 100 mL
   3. Stir Plate
      a. Quantity: Two (2)
   4. Settleometer Jars
      a. Quantity: Ten (10)
   5. Plastic pitchers
      a. Quantity: Two (2), per size
         1) 2L
         2) 1L
         3) 50 mL
   6. Recirculating water bath
      a. Quantity: Two (2)
      b. 44.5 degrees C
      c. Thermoscientific Precision Cir 19
         1) Or approved equal
   7. Long Wave Ultraviolet lamp

a. Quantity: Two (2)
b. 365 nm

8. Idexx Quantitrays with Quantitray Sealer
   a. Quantity: Two (2)
9. Idexx Colilert Media
   a. Quantity: Two (2), each
   b. Colilert – 18
   c. Colilert – 24
10. Idexx Colilert Sterile Vessels
    a. Quantity: Two (2)
    b. Volume: 120 mL, Sodium Thiosulfate
11. Desiccator
    a. Quantity: Two (2)
12. Analytical Balance and Weight Set
    a. Quantity: Two (2)
13. Standard Lab Oven
    a. Quantity: Two (2)
    b. Temperature: 105 degrees C
14. Incubator (water sampling)
    a. Quantity: Two (2)
    b. Temperature: 35 degrees C

C. Fume Hoods
1. Quantity: Two (2)
2. Nominal Width: Five FT
3. Standard fluorescent T8 fixture
4. 115 VAC 20 amp receptacle
5. Dished epoxy resin tops
6. Laboratory sink
7. Provide the following utilities for each fume:
   a. Cold water
   b. One (1) remote air service fixture hard piped
   c. All other utilities Located in a repeated pattern (i.e. the location of the services is same from one fume hood to another
8. Constant Volume System
9. Labconco Protector Premier Series or approved equal

D. Acid and Flammable Storage Cabinets
1. Quantity: One (1), per each
2. Dimensions: per manufactuer.
3. Comply with OSHA and NFPA Code 30 requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install per manufacturer's written instructions

B. Anchor trailer with tie downs per approved submittal.

C. Connect utilities and test.

3.2 FIELD QUALITY CONTROL

A. System Supplier shall employ and pay for services of equipment manufacturer’s field service representative(s) to:
1. Inspect equipment covered by this Specification.
2. Supervise pre-startup adjustments and installation checks.
3. Conduct initial startup of equipment and perform operational checks

4. Instruct Owner's personnel for 8 HRS at jobsite on operation and maintenance of HVAC system , Fume hoods and other equipment.

END OF SECTION

SECTION 22 05 03
PIPE AND PIPE FITTINGS - PLUMBING SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plumbing piping material and accessories as shown on the plumbing drawings.
   2. Plumbing piping accessories:
      a. Flex connectors.
      b. Pressure Gauges.
      c. Wye strainers.
      d. Dielectric fittings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 73 20 - Openings and Penetrations in Construction.
   2. Section 22 05 23 - General Duty Valves for Plumbing Piping.
   3. Section 22 05 29 - Hangers and Supports for Plumbing Piping and Equipment.
   4. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.2, Gages and Gaging for Unified Screw Threads.
      b. B31.9, Building Services Piping.
      c. B40.100, Pressure Gauges and Gauge Attachments.
   2. ASTM International (ASTM):
      a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      d. B32, Standard Specification for Solder Metal.
      e. B88, Standard Specification for Seamless Copper Water Tube.
      f. D1784, Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
      g. D1785, Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      h. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
      i. D2665, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
      j. D2855, Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets.
      k. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
   3. American National Standards Institute (ANSI/ASTM):
      a. B16.3, Malleable Iron Threaded Fittings.
      b. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
      c. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
      d. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.

4. American Water Works Association (AWWA):
    a. B300-10, Standard for Hypochlorites.
    b. C651, Disinfecting Water Mains.
5. American Welding Society (AWS):
    a. A5.8M/A5.8, Specification for Filler Metals for Brazing and Braze Welding.
6. National Sanitation Foundation (NSF):
    a. 61/372, Drinking Water System Components.

1.3 SUBMITTALS

A. Shop Drawings:
1. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
    a. Manufacturer catalog data sheets for pipe fittings and accessories furnished under this section indicating materials of construction, dimensions, pressure and temperature ratings.
    b. Acknowledgement that products submitted meet requirements of standards referenced.
    c. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
    d. Separate schedule sheet for each piping system scheduled in this Specification Section showing compliance of all system components.
        1) Attach technical product data on gaskets, pipe, fittings, and other components.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. Qualifications of lab performing disinfection analysis on water systems.
2. Test reports:
    a. Copies of pressure test results on all piping systems.
    b. Disinfection test report.
    c. Notification of time and date of piping pressure tests.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping Systems:
1. Piping systems are scheduled by service in PART 3 of this specification.
2. Piping systems scheduled herein are applicable to piping systems shown on the plumbing drawings.

B. Pipe and Tube:
1. Copper:
    a. Type K, L, or M tube per ASTM B88.
    b. Utilize only annealed (soft) type tubing where flared joints are used and drawn temper (hard) type tubing where soldered or brazed joints are used.
    c. Fittings, per System Type:
        1) Cast copper or bronze (pressure, solder): Per ASTM B16.18.
        2) Wrought copper or bronze (pressure, solder): ASTM B16.22.
    d. Joints:
        1) Soldered or Brazed:
            a) Above ground below 180 degrees F: ASTM B32 solder with a tin/antimony ratio of 95/5 and non-corrosive flux.

b) Above ground 180 degrees F and above: use brazing alloy with melting temperature above 1000 degrees F and suitable flux.
c) Buried: Silver solder per AWS A5.8M/A5.8.
d) Provide unions and valves at equipment.

e. Unions: Class 150, bronze.
f. Provide a polyethylene pipe wrap for copper piping located below ground:
1) Minimum 8 mil thickness, compliant with AWWA C-105.

2. Plastic:
a. PVC:
1) Per ASTM D1785 for schedule 40 or 80.
2) Per ASTM D2665 for Drain, Waste, Vent (DWV), schedule 40.
3) Fittings, per System Type:
a) PVC per ASTM D2466 or ASTM D2467 for pressure pipe.
b) PVC per ASTM D2665 for DWV fittings.
4) Joints:
a) Solvent weld per ASTM D2855.
b) Hub and spigot with solvent weld per ASTM D2855.

b. CPVC:
1) Per ASTM D2846, schedule 40.
2) Fittings: CPVC per ASTM D2846.
3) Joints: Solvent weld per ASTM F493.

2.2 MANUFACTURED UNITS

A. Unions:
1. Copper pipe:
a. Copper ground joint unions for pipe sizes 2 inches and smaller.
b. Brass flanged unions for pipe sizes larger than 2 inches.

2.3 ACCESSORIES

A. Flexible connectors:
1. Provide flexible braided bronze connectors at piping connections to water heaters, pumps and vibrating equipment.
2. Bronze exterior braid and bronze internal corrugated hose.
3. Solder or threaded end connections, size to match equipment connections.

B. Wye strainers:
1. 3 inch and smaller
a. Bronze body and plug, 150 psi working pressure.
b. Removable type 304 stainless steel mesh strainer, 0.062 inch perforations.
c. Threaded or soldered end connections.

C. Pressure gauges:
1. Stainless steel housing.
2. Dial size: 2-1/2” diameter.
3. Piping connection size: 1/2 inch, unless noted otherwise.
4. Liquid filled.
5. NSF-61/372 compliant.
6. Units of measure: PSI
7. Pressure range suitable or the application.

D. Dielectric Fittings:
1. Lead free components.
2. Dielectric unions:
a. Threaded or soldered end connections.
b. Rated at 175 psi, 180 degrees F.
c. Provide dielectric gaskets suitable for continuous operation at union rated temperature and pressure.

3. Dielectric flange kits:
    a. Flat faced.
    b. 1/8 inches thick dielectric gasket, phenolic, non-asbestos.
    c. Suitable for 175 psi, 180 degrees F.
    d. 1/32 inches wall thickness bolt sleeves.
    e. 1/8 inches thick phenolic insulating washers.

E. Pipe Sleeves:
    1. Refer to spec 01 73 20 for pipe sleeves and penetrations through construction.

PART 3 - EXECUTION

3.1 PREPARATION

A. Ream pipe and tube ends.

B. Remove burrs.

C. Remove scale and dirt on inside and outside before assembly.

D. Prepare piping connections to equipment with flanges and unions.

E. Deep open ends of pipe free from scale and dirt.

F. Protect open ends with temporary plugs or caps.

3.2 EXTERIOR BURIED PIPING INSTALLATION

A. Unless otherwise shown on the Drawings, provide a minimum of 3-1/2 feet and maximum of 8 feet earth cover over exterior buried piping systems and appurtenances conveying water, fluids, or solutions subject to freezing.

B. Enter and exit through structure walls, floors, and ceilings by using penetrations and seals specified in Specification Section 01 73 20 and as shown on Drawings.

C. Install expansion devices as necessary to allow expansion and contraction movement.

D. Laying Pipe in Trench:
    1. Excavate and backfill trench in accordance with Specification Section 31 23 33 - Trenching and Backfilling.
    2. Clean each pipe length thoroughly and inspect for compliance to specifications.
    3. Grade trench bottom and excavate for pipe bell and lay pipe on trench bottom.
    4. Install gasket or joint material according to manufacturer's directions after joints have been thoroughly cleaned and examined.
    5. Except for first two joints, before making final connections of joints, install two full sections of pipe with earth tamped along side of pipe or final with bedding material placed.
    6. Lay pipe in only suitable weather with good trench conditions.
        a. Never lay pipe in water except where approved by the Contract Officer Representative.
    7. Seal open end of line with watertight plug if pipe laying is stopped.
    8. Remove water in trench before removal of plug.

E. Lining Up Push-On Joint Piping:
    1. Lay piping on route lines shown on Drawings.
    2. Deflect from straight alignments or grades by vertical or horizontal curves or offsets.
    3. Observe maximum deflection values stated in manufacturer's written literature.
    4. Provide special bends when specified or where required alignment exceeds allowable deflections stipulated.
    5. Install shorter lengths of pipe in such length and number that angular deflection of any joint, as represented by specified maximum deflection, is not exceeded.

F. Anchorage and Blocking:

1. Provide reaction blocking, anchors, joint harnesses, or other acceptable means for preventing movement of piping caused by forces in or on buried piping tees, wye branches, plugs, or bends.
2. Place concrete blocking so that it extends from fitting into solid undisturbed earth wall.
   a. Concrete blocks shall not cover pipe joints.
3. Provide bearing area of concrete in accordance with drawing detail.

G. Install dielectric unions or flanges where dissimilar metals are joined together.

3.3 INTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Drain valves shall be provided at all low points to facilitate complete drainage of the domestic water system.

C. Install piping according to Drawing intent and with clearance and allowance for:
1. Expansion and contraction.
2. Operation and access to equipment, doors, windows, hoists, moving equipment.
3. Headroom and walking space for working areas and aisles.
4. System drainage and air removal.

D. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01 73 20 and as shown on the Drawings.

E. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

F. Pipe Supports:
1. Use methods of piping support as shown on Drawings and as required in Specification Section 22 05 29.
   a. In general, pipe supports for piping smaller than 12 inches diameter are not shown on the Drawings, except for supports shown in the standard details.
   b. Where not shown on the drawings or details, the Contractor is responsible for the design of pipe supports, in accordance with Specification Section 22 05 29.
2. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
   a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
3. Size pipe supports with consideration to specific gravity of liquid being piped.

G. Locate and size sleeves and castings required for piping system.
1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

H. Use reducing fittings throughout piping systems.
1. Bushings will not be allowed unless specifically approved.

I. Equipment Drainage:
1. Provide drip pans and piping at equipment where condensation may occur.
2. Avoid routing piping over electrical components such as motor control centers, panelboards, etc.
   a. If piping must be so routed, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
   b. Hard pipe drainage to nearest floor drain.

J. Miscellaneous Piping:
1. If system is not otherwise specified, provide stainless steel tubing, size to handle application.

K. Unions:
1. Install in position which will permit valve or equipment to be removed without dismantling adjacent piping.

2. Mechanical type couplings may serve as unions.
3. Additional unions are not required at flanged connections.

L. Install expansion devices as necessary to allow expansion/contraction movement.

M. Provide full face gaskets on all systems.

N. Anchorage and Blocking:
1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

O. Equipment Pipe Connections:
1. Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment.
2. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers which are not specified to be provided with or as integral part of equipment.
3. For each water supply piping connection to equipment, furnish and install union and isolation valves.
   a. Provide stop valves at each plumbing fixture cold and hot water supply connections.
   b. Minimum size: 1/2 inches.
4. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system.
   a. Size trap as required by the International Plumbing Code.
5. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed.

P. Provide dielectric fittings with insulating components where dissimilar metals are joined together.

Q. Install piping concealed in finished structures such as administration and office facilities and at locations shown on Drawings.

3.4 CATHODIC PROTECTION

A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.

3.5 INSTALLATION – PIPE SYSTEM SPECIFIC

A. Potable Water Piping Installation:
1. Install drain tees with capped nipples at low points.
   a. If low point occurs in concealed piping, provide approved flush access panel.
   b. These drains are not shown on Drawings.
2. Install all threaded piping with clean-cut tapered threads and with ends thoroughly reamed after cutting to remove burrs.
   a. Pipe joint cement permitted only on external threads.
3. For screwed nipples for connections to flush valves, lavatory supplies, and other equipment with threaded connections use iron, copper, or brass pipe.
4. Install unions between valves and connections to each piece of equipment, and install sufficient number of unions throughout piping system to facilitate installation and servicing.
   a. On copper pipe lines, install wrought, solder-joint, copper to copper unions for lines 2 IN and smaller and, for lines 2-1/2 inches and over install brass flange unions.
5. Construct and equip plumbing fixtures and equipment with anti-siphon devices as to entirely eliminate any danger of siphoning waste material into potable water supply system.

6. Where exposed pipes 6 inches in size and smaller pass through floors, finished walls, or finished ceilings, fit with nickel or chrome-plated plates large enough to completely close hole around pipes.
    a. Secure plates to pipe by set screw in approved manner.
7. Size supply branches to individual fixtures as scheduled or indicated on Drawings.
8. Install piping so as to be free to expand with proper loops, anchors and joints without injury to system or structure.
9. Provide branches to wall hydrants or hose bibbs in exterior locations with interior shutoff.
10. Provide approved type vacuum breaker and backflow preventer installations indicated or as required by Code.

B. Soil and Waste Piping Installation:
1. Install horizontal soil or waste lines less than 4 inches diameter with a slope of not less than 1/4 IN/FT or 2% toward the point of disposal.
2. Piping 4 inches and larger may be sloped at 1/8 INFT.
3. Install as close to construction as possible to maintain maximum head room.
4. Make changes of direction with 1/8 bends and junctions with wye fittings.
5. Use short wye fittings in vertical pipe only.
6. Install cleanouts at dead ends, at changes of direction and at 50 feet intervals on horizontal runs.
    a. Where cleanouts occur in concealed spaces, provide with extensions to floors above or to walls as required.
7. For hub and spigot joints, install hub facing flow.

C. Vent Piping Installation:
1. Run vent stack parallel to each soil or waste stack to receive branch vents from fixtures.
2. Where possible, combine soil, waste or vent stacks before passing through roof so as to minimize roof openings.
3. Offset pipes running close to exterior walls away from such walls before passing through roof to permit proper flashing.
4. Terminate each vent with approved frost proof jacket.
5. Carry vent stacks 4 inches and larger full size through roof.
6. Extend vent stacks at least 12 inches above roofing.

3.6 JOINING

A. Install products in accordance with manufacturer's instructions.

B. Joining Methods - Flanges:
1. Joining method:
    a. Leave 1/8 to 3/8 inches of flange bolts projecting beyond face of nut after tightening.
    b. Coordinate dimensions and drillings of flanges with flanges for valves, pumps, equipment, tank, and other interconnecting piping systems.
    c. When bolting flange joints, exercise extreme care to assure that there is no restraint on opposite end of pipe or fitting which would prevent uniform gasket compression or cause unnecessary stress, bending or torsional strains being applied to cast flanges or flanged fittings.
        1) Allow one flange free movement in any direction while bolts are being tightened.
    d. Do not assemble adjoining flexible coupled, mechanical coupled or welded joints until flanged joints in piping system have been tightened.
    e. Gradually tighten flange bolts uniformly to permit even gasket compression.
    f. Do not overstress bolts to compensate for poor installation.

C. Joining Method - Couplings:
1. Mechanical coupling:
    a. Arrange piping so that pipe ends are in full contact.
    b. Groove and shoulder ends of piping in accordance with manufacturer's recommendations.

D. Joining Method – Soldering
   1. Tubing shall be cut with square ends and reamed to prevent burrs, out-of-round or improperly sized ends.
   2. After cutting, all surfaces to be soldered shall be thoroughly cleaned to a metal-bright finish, free from dirt, grease or other material before fluxing and soldering. This cleaning shall be performed by using emery cloth, sandpaper or steel wool. Clean the outside end of the tubing for a length of 1/2-in greater than the depth of the fitting. The inside of the fittings shall be cleaned in a similar manner.
   3. Apply non-corrosive flux and assemble the joint. Acid solder or acid flux will not be allowed. Flux compound shall be certified by NSF in accordance with NSF Standard Nos. 14 and 61.
   4. The surfaces to be joined shall be heated up slowly and uniformly to the melting point of the solder. The surface being soldered shall be maintained above the melting point of the solder for sufficient time to draw the solder completely into the joint. When the solder congeals to a plastic state the excess metal shall be removed with a cloth brush, leaving a fillet around the end of the fitting.
   5. Full penetration of the solder uniformly throughout the entire socket is required. The soldered joints shall be allowed to cool in still air. Quenching will not be permitted.
   6. Any type of crack, pinhole, area of incomplete penetration, or similar defect will not be accepted. Peening for closing up defects will not be permitted.
   7. Remove all external and internal loose solder and flux after joint cools.

E. Joining Method - Threaded and Coupled (T/C):
   1. Provide T/C end conditions that meet ASME B1.2 requirements.
   2. Furnish pipe with factory-made T/C ends.
   3. Field cut additional threads full and clean with sharp dies.
   4. Leave not more than three pipe threads exposed at each branch connection.
   5. Ream ends of pipe after threading and before assembly to remove burrs.
   6. Use Teflon thread tape on male thread in mating joints.

3.7 FIELD QUALITY CONTROL

A. Pipe Testing - General:
   1. Test piping systems as follows:
      a. Test exposed, non-insulated piping systems upon completion of system.
      b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
      c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
      d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
   2. Isolate equipment which may be damaged by the specified pressure test conditions.
   3. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
      a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
      b. Notify the Contract Officer 24 hours prior to each test.
   4. Completely assemble and test new piping systems prior to connection to existing pipe systems.
   5. Acknowledge satisfactory performance of tests and inspections in writing to Contracting Officer prior to final acceptance.
   6. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:
   1. Testing medium:
      a. Water systems: Water.

b. Waste and drain systems: Water.

2. Testing pressure:
   a. For gravity systems, function flow test to demonstrate water tightness and drainage, visual check for leaks.
   b. For pressurized water and air systems, test at 90 PSI for 2-hours.
3. Allowable leakage rates:
   a. All exposed piping systems, all pressure piping systems and all buried piping systems which are hydrostatically pressure tested shall have zero leakage at the specified test pressure throughout the duration of the test.
   b. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5% of the specified test pressure throughout the duration of the test.
4. Hydrostatic pressure testing methodology:
   a. General:
      1) All joints, including welds, are to be left exposed for examination during the test.
      2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
      3) Provide temporary restraints for expansion joints for additional pressure load under test.
   b. Soil, waste, drain and vent systems:
      1) Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
      2) Eliminate leaks before proceeding with work or concealing piping.
      3) Minimum test heights shall be 10 feet above highest stack inlet.

C. Dielectric Testing Methods and Criteria:
1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

3.8 CLEANING, DISINFECTION AND PURGING

A. Cleaning:
1. Clean interior of piping systems thoroughly before installing.
2. Maintain pipe in clean condition during installation.
3. Before joining piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
4. Immediately prior to pressure testing, clean and remove grease, metal cuttings, dirt, or other foreign materials which may have entered the system.
5. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
   a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
   b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Government.

B. Disinfection of Potable Water Systems:
1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply, source and any appurtenant devices and perform disinfection as prescribed.
2. Perform work, including preventative measures during construction, in full compliance with AWWA C651.
3. Perform disinfection using sodium hypochlorite complying with AWWA B300-10.
4. Flush each segment of system to provide flushing velocity of not less than 2.5 feet per second.
5. Drain flushing water to sanitary sewer.

a. Do not drain flushing water to receiving stream.

6. Use continuous feed method of application.
   a. Tag system during disinfection procedure to prevent use.
7. After required contact period, flush system to remove traces of heavily chlorinated water.
8. After final flushing and before placing water in service, obtain an independent laboratory approved by the Government to collect samples and test for bacteriological quality.
   a. Repeat entire disinfection procedures until satisfactory results are obtained.
9. Secure and deliver to Contracting Officer's Representative, satisfactory bacteriological reports on samples taken from system.
   a. Ensure sampling and testing procedures are in full compliance to AWWA C651, local water purveyor and applicable requirements of the State of Arizona.

3.9 SCHEDULES

A. The piping systems scheduled herein are applicable to piping systems shown on the plumbing drawings.

B. System 1 – Potable and Non-Potable Water:
   1. Piping symbol and service:
      a. CW – Potable Water Cold.
      b. TW – Tepid Water.
   2. Above ground, 3 inch diameter and less:
      a. Pipe: Type L Copper.
      b. Fittings: Wrought Copper.
      c. Joints: Soldered.
   3. Buried, 3 inch diameter and less:
      a. Pipe: Type K Copper.
      b. Fittings: Cast or Wrought Copper.
      c. Joints: Brazed or flared.
      d. Provide polyethylene pipe wrap for corrosion protection of underground copper pipe.

C. System 2 – Process Area Drainage and Vent:
   1. Piping symbol and service:
      a. D – Drain.
      b. V – Vent.
   2. Above Ground and Below Ground (gravity drainage, all sizes):
      a. Pipe: PVC, schedule 40.
      b. Fittings: PVC, DWV fittings.
      c. Joints: Solvent Weld.

D. System 3 - Condensate and Equipment Drains:
   1. Piping symbol and service:
      a. CD – Condensate Drain.
   2. Above Ground (all sizes):
      a. Pipe: CPVC, schedule 40.
      b. Fittings: CPVC, schedule 40 fittings.
      c. Joints: Solvent Weld.

END OF SECTION

SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ball valves.
   2. Butterfly valves.
   3. Check valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Common Work Results for Equipment.
   2. Section 22 05 03 - Pipe and Pipe Fittings - Plumbing Systems.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
      a. SP 67, Butterfly Valves.
      b. SP 71, Cast Iron Swing Check Valves, Flanged and Threaded Ends.
      c. SP 80, Bronze Gate, Globe, Angle and Check Valves.
      d. SP 110, Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.
      e. SP 139, Copper Alloy Gate, Globe, Angle, and Check Valves for Low Pressure/Low Temperature Plumbing Applications.

B. National Sanitation Foundation (NSF):
   1. NSF-61/372, Drinking Water System Components – Health Effects.

C. For drinking water service, provide valves complying with NSF 61 and NSF 372.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Product Data: Submit manufacturers catalog information for each type of valve indicating materials of construction and pressure ratings for each service.
   3. Manufacturer's Installation Instructions: Submit hanging and support methods, joining procedures.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 BALL VALVES

A. 2 inches and Smaller: MSS SP 110, 400 psi WOG, two piece bronze body, chrome plated brass ball, full port, teflon seats, blow-out proof stem, solder or threaded ends, quarter-turn lever handle, provide extended lever handle for insulated pipes.

2.2 BUTTERFLY VALVES

A. 2-1/2 inches and Larger: MSS SP 67, Class 150.

1. Body: Cast or ductile iron, lug ends, stainless steel stem, extended neck.
2. Disc: Nickel-plated ductile iron, Aluminum bronze, or stainless steel.
3. Seat: Resilient replaceable EPDM or Buna N.
4. Handle and Operator: 10 position lever handle.

2.3 CHECK VALVES

A. Horizontal Swing Check Valves:
   1. 2 inches and Smaller: MSS SP 80, 200 psi cold working pressure, bronze body and cap, bronze seat, Buna-N or teflon disc, solder or threaded ends.
   2. 2-1/2 inches and Larger: MSS SP 71, Class 125, cast iron body, bolted cap, bronze or cast iron disc, renewable disc seal and seat, flanged ends.

B. Spring Loaded Check Valves:
   1. 2 inches and Smaller: MSS SP 80, 200 psi cold working pressure, bronze body, in-line spring lift check, silent closing, Buna-N or teflon disc, integral seat, or threaded ends.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install valves with stems upright or horizontal, not inverted.

B. Install brass male adapters each side of valves in copper piped system. Solder adapters to pipe.

C. Install 3/4 inches ball valves with cap for drains at main shut-off valves, low points of piping, bases of vertical risers, and at equipment.

D. Install valves with clearance for installation of insulation and allowing access.

E. Provide access where valves and fittings are not accessible.

F. Refer to Section 22 05 29 for pipe hangers.

G. Refer to Section 40 42 00 for insulation requirements for valves.

H. Refer to Section 22 05 03 for plumbing piping materials applying to various system types.

3.2 VALVE APPLICATIONS

A. Install ball valves for drain service at locations indicated on Drawings in accordance with this Section.

B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.

C. Install ball valves for throttling, bypass, or manual flow control services.

D. Install lug end butterfly valves adjacent to equipment when functioning to isolate equipment.

E. Install ball valves in domestic water systems for shut-off service.

F. Install ball valves in domestic water systems for throttling service.

END OF SECTION

SECTION 22 05 29
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
1. Pipe hangers and supports.
2. Hanger rods.
3. Inserts.
4. Sleeves.
5. Mechanical sleeve seals.
6. Formed steel channel.

B. Related Sections include but are not necessarily limited to:
1. Section 01 61 03 - Equipment – Basic Requirements.
2. Section 01 81 10 - Wind and Seismic Design Criteria.
3. Section 03 31 30 - Concrete Materials and Proportioning.
4. Section 07 84 00 - Firestopping.
5. Section 07 92 00 - Joint Sealants.
6. Section 22 05 03 - Pipe and Pipe Fittings - Plumbing Systems.

1.2 REFERENCES

A. Reference Standards:
1. American Society of Mechanical Engineers (ASME):
   a. B31.9, Building Services Piping.
2. ASTM International (ASTM):
   a. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
   b. E119, Standard Test Methods for Fire Tests of Building Construction and Materials.
   c. E814, Standard Test Method for Fire Tests of Through Penetration Fire Stops.
   d. F708, Standard Practice for Design and Installation of Rigid Pipe Hangers.
   e. E1966, Standard Test Method for Fire-Resistive Joint Systems.
3. American Welding Society (AWS):
   a. D1.1, Structural Welding Code - Steel.
4. FM Global (FM):
   a. Approval Guide, A Guide to Equipment, Materials & Services Approved By Factory Mutual Research For Property Conservation.
5. Manufacturers Standardization Society of the Valve and Fittings Industry (MSS):
   a. SP 58, Pipe Hangers and Supports - Materials, Design and Manufacturer.
   b. SP 69, Pipe Hangers and Supports - Selection and Application.
   c. SP 89, Pipe Hangers and Supports - Fabrication and Installation Practices.
6. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
   a. Seismic Restraint Manual, Guidelines for Mechanical Systems.
7. Underwriters Laboratories Inc. (UL):
   a. 263, Fire Tests of Building Construction and Materials.
   b. 723, Tests for Surface Burning Characteristics of Building Materials.
   c. 1479, Fire Tests of Through-Penetration Firestops.
   d. 2079, Tests for Fire Resistance of Building Joint Systems.
   e. Fire Resistance Directory.
8. Intertek Testing Services (Warnock Hersey Listed):
   a. WH - Certification Listings.

B. Perform Work in accordance with AWS D1.1 for welding hanger and support attachments to building structure.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Indicate system layout with location including critical dimensions, sizes, and pipe hanger and support locations and detail of trapeze hangers.
   2. Product Data:
      a. Hangers and Supports: Submit manufacturers catalog data including load capacity.
      b. Firestopping: Submit data on product characteristics, performance and limitation criteria.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
   2. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers. Indicate calculations used to determine load carrying capacity of trapeze, multiple pipe, and riser support hangers.
   3. Manufacturer's Installation Instructions:
      a. Hangers and Supports: Submit special procedures and assembly of components.

1.4 QUALITY ASSURANCE

A. Manufacturer: Company specializing in manufacturing Products specified in this section with minimum three years of experience.

B. Installer: Company specializing in performing Work of this section with minimum three years' experience.

1.5 ENVIRONMENTAL REQUIREMENTS

A. Materials of construction for pipe supports differs depending on the environment in which they are installed. Corrosive areas require corrosion resistant materials and hardware as specified herein.

B. Corrosive areas include the following:
   1. Headworks.
   2. Secondary Treatment Building.
   3. Chemical rooms at the Water Treatment Building.

C. Non-corrosive areas include the following:
   1. Existing Control Building.
   2. Roaring Springs Pump House.
   3. All areas of the Water Treatment Building, except for the Chemical Rooms.

1.6 RESPONSIBILTY

1. Where pipe supports and seismic bracing are not shown or detailed on the drawings, Contractor shall design pipe supports and bracing.
2. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to design, furnish and install the system of hangers, supports, bracing, guidance, anchorage and appurtenances for piping systems shown on the drawings.
3. General piping support details may be indicated on the Drawings for certain conditions. Incorporate those details with requirements of this specification section to provide the piping support system.

1.7 FIELD MEASUREMENTS

A. Verify field measurements prior to fabrication.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pipe hangers and supports:
      a. Anvil International.
      b. Or equal.
   2. Mechanical sleeve seals:
      a. Link-seal
      b. Or equal.
   3. Formed steel channel:
      a. Unistrut Service Company.
      b. Or equal.

2.2 PIPE HANGERS AND SUPPORTS

A. General Requirements:
   1. Galvanized components:
      a. Hot-dip galvanized components:
         1) General: ASTM 123/123M.
         2) Fasteners and hardware: ASTM 153/153M.
   2. Dissimilar metals protection:
      a. Similar metals in contact, including galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
      b. All other dissimilar metals in contact, including galvanized-to-dissimilar metal, or stainless-to-dissimilar metal: Provide rubber or plastic isolation between metals, such as neoprene or nylon pads, shims, grommets, or furnish supports with rubber or PVC lining to prevent contact.
   3. Allow free expansion and contraction of the piping to prevent excessive stress resulting from operating or testing conditions or from weight transferred from the piping or attached equipment.
   4. Design supports and hangers to allow for proper slope of pipes.
   5. Support vertical pipe runs in pipe chases at base of riser.
      a. Support pipes for lateral movement with clamps or brackets.

B. Provide 20 GA pipe saddle for plastic pipe support points to ensure minimum contact width of 4 inches.
   1. Material: match support.

C. Piping Supports:
   1. Conform to ASME B31.9, MSS SP58.
   2. Hangers for Pipe Sizes 1/2 to 1-1/2 inches:
      a. Adjustable swivel, split ring.
      b. Materials:
         1) Non-corrosive areas: Galvanized steel.
         2) Corrosive areas: Type 316 stainless steel.
   3. Hangers for Pipe Sizes 2 inches and Larger:
      a. Adjustable clevis.
      b. Materials:

1) Non-corrosive areas: Galvanized steel.
2) Corrosive areas: Type 316 stainless steel.

4. Multiple Pipe or Trapeze Type Hangers:
   a. Non-corrosive areas: Galvanized steel channel or Unistrut and galvanized steel hanger rod.
   b. Corrosive areas: Type 316 stainless steel channel or Unistrut and 316 stainless steel hanger rod.
5. Wall Support: wall-mounted Unistrut with pipe clamp.
   a. Materials:
      1) Non-corrosive areas: Galvanized steel.
      2) Corrosive areas: Type 316 stainless steel.
6. Floor Support:
   a. Vertically-adjustable pipe saddle, locking nut, nipple, and vertical support pipe welded to floor flange and anchored to concrete slab.
   b. Materials:
      1) Non-corrosive areas: Galvanized steel.
      2) Corrosive areas: Type 316 stainless steel.

D. Insulated Piping Supports:
1. Hangers are to be installed on outside of pipe insulation such that insulation is continuous.
2. Use a pipe covering protection saddle for insulated pipe at support point.
3. Insulated piping 1-1/2 inches and less:
   a. Provide a 9 inches length of high density perlite or high density calcium silicate at saddle.
4. Insulated piping over 1-1/2 inches: Provide a 12 inches length of high density perlite or high density calcium silicate at saddle.
5. See Specification Section 40 42 00 for pipe insulation.

2.3 ACCESSORIES

A. Hanger Rods:
1. Non-corrosive areas:
   a. Mild steel threaded both ends, threaded on one end, or continuous threaded.
   b. Electro-galvanized or zinc-nickel plated after threads are cut.
2. Corrosive areas:
   a. Type 316 stainless steel threaded rods, per ASTM A276.

B. Nuts, Bolts and Washers:
1. Non-corrosive areas: Galvanized steel.
2. Corrosive areas: Type 316 stainless steel.

C. Inserts: Malleable iron, zinc-plated, with threaded connection; size inserts for required hanger rod size.

2.4 FLASHING

A. Metal Flashing: 26 gage minimum thickness

B. Counterflashing: 22 gauge minimum thickness.

C. Materials:
1. Non-corrosive areas: galvanized steel.
2. Corrosive areas: Type 316 stainless steel.

D. Colors to match adjacent architectural finish.

E. Lead Flashing:
1. Waterproofing: 5 pound/SQFT sheet lead.
2. Soundproofing: 1 pound/SQFT sheet lead.

F. Caps: Steel, 22 gage minimum; 16 gage at fire resistant elements.

2.5 SLEEVES

A. Sleeves for Pipes Through Non-fire Rated Floors: 18 gage thick galvanized steel.

B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Galvanized steel pipe or 18 gage thick galvanized steel.

C. Sealant: Refer to Section 07 92 00.

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular mechanical type seal, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates causing rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

B. Materials: Furnish with type 316 stainless steel bolts and hardware and EPDM sealing elements.

2.7 FORMED STEEL CHANNEL

A. Product Description: 12 gage thick steel channel. With holes 1-1/2 inches on center.

B. Materials:
   1. Non-corrosive areas: Galvanized steel.
   2. Corrosive areas: Type 316 stainless steel

2.8 FIRESTOPPING

A. Firestopping Materials: Comply with requirements of Section 07 84 00.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify openings are ready to receive sleeves.

B. Provide pipe supports for all HVAC and Plumbing piping as required by the building code.

3.2 INSTALLATION - INSERTS

A. Install inserts for placement in concrete forms.

B. Install inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe 4 inches and larger.

D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

3.3 INSTALLATION - PIPE HANGERS AND SUPPORTS

A. Install in accordance with ASME 31.9, MSS SP 58.

B. Support horizontal piping as scheduled.

C. Install hangers with minimum 1/2 inches space between finished covering and adjacent work.

D. Place hangers within 12 inches of each horizontal elbow.

E. Use hangers with 1-1/2 inches minimum vertical adjustment.

F. Support horizontal cast iron pipe adjacent to each hub, with 5 feet maximum spacing between hangers.

G. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.

H. Where piping is installed in parallel and at same elevation, provide trapeze type hangers where possible.

I. Support riser piping independently of connected horizontal piping.

J. Provide copper plated or PVC lined hangers and supports for copper piping.

K. Design hangers for pipe movement without disengagement of supported pipe.

L. Provide clearance in hangers and from structure and other equipment for installation of pipe insulation.

3.4 INSTALLATION - FLASHING

A. Provide metal flashing and counterflashing where piping penetrates weather or waterproofed walls, floors, and roofs.

B. Install flashing in accordance with roofing or siding manufacturer requirements.

C. Flash floor drains in floors with topping over finished areas with lead, 10 inches clear on sides. Fasten flashing to drain clamp device.

D. Seal floor, shower, mop sink drains watertight to adjacent materials.

E. Adjust storm collars tight to pipe with bolts; seal around top edge. Use storm collars above roof jacks.

3.5 INSTALLATION - SLEEVES

A. Exterior watertight entries: Seal with mechanical sleeve seals.

B. Set sleeves in position in forms. Provide reinforcing around sleeves.

C. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.

D. Extend sleeves through floors 2 inches above finished floor level, unless noted otherwise on the drawings.

E. Where piping penetrates floor, ceiling, or wall, close off space between pipe and adjacent work with insulation and seal airtight.

F. Install chrome plated steel escutcheons at finished surfaces.

3.6 SCHEDULES

PIPE HANGER SPACING		
PIPE MATERIAL	MAXIMUM HANGER SPACING (FT)	HANGER ROD DIAMETER (IN)
Cast Iron (All Sizes)	5	5/8
Cast Iron (All Sizes) with 10 feet length of pipe	10	5/8
CPVC, 1 inch and smaller	3	1/2
CPVC, 1-1/4 inches and larger	4	1/2
Copper Tube, 1-1/4 inches and smaller	6	1/2
Copper Tube, 1-1/2 inches and larger	10	1/2
PVC (All Sizes)	4	3/8
Steel, 3 inches and smaller	10	1/2

END OF SECTION

SECTION 22 20 00
PLUMBING FIXTURES AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plumbing fixtures, trim, and equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.
   2. Section 22 05 03 Pipe and Pipe Fittings – Plumbing Systems.
   3. Section 22 05 23 General Duty Valves for Plumbing Piping.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Americans with Disabilities Act (ADA):
      a. Accessibility Guidelines for Buildings and Facilities (ADAAG).
   2. American National Standards Institute (ANSI):
      a. Z358.1, Emergency Eyewash and Shower Equipment.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers/Illuminating Engineering Society of North America (ASHRAE/IESNA):
      a. 90.1, Energy Standard for Buildings Except Low-Rise Residential Buildings.
   4. American Society of Mechanical Engineers (ASME):
      a. A112.19.3, Stainless Steel Plumbing Fixtures (Designed for Residential Use).
   5. American Society of Sanitation Engineers (ASSE):
      a. 1011, Performance Requirements for Hose Connection Vacuum Breaker.
   6. Canadian Standards Association (CSA).
   7. National Sanitation Foundation International (NSF).
      a. 61/372, Drinking Water System Components.
   8. Underwriters Laboratories, Inc. (UL).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Color selection charts for color selection.
   3. Fabrication and/or layout drawings:
      a. Layout plan(s) showing dimensions, elevations, etc.
      b. Details showing connections, installation, rough-in locations, etc.
   4. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Chemical-resistance data.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Emergency shower and eyewash:
      a. Haws
      b. Or equal.
   2. Shock absorbers:
      a. Jay R Smith.
      b. Or equal.
   3. Reduced Pressure Backflow Preventer:
      a. Watts
      b. Or equal

2.2 MANUFACTURED UNITS

A. Emergency Fixtures:
   1. Emergency shower and eye/face wash (ESEW-1 thru 3):
      a. Comply with ANSI Z358.1.
      b. Coated galvanized steel or PVC stanchion pipe with anchor base plate.
      c. 1-1/4" tepid water supply connection.
      d. 1-1/2" waste connection.
      e. Deluge shower head:
         1) Ball valve: Stay-open type; type 316 stainless steel construction for corrosion resistant models.
         2) Pull-chain.
         3) PVC or ABS plastic showerhead construction.
      f. Eye/face wash:
         1) Stay-open, full port ball valve, type 316 stainless steel construction for corrosion resistant models.
         2) Push handle control for eye/face wash.
         3) Supply line strainer for eye/face wash.
         4) PVC or ABS plastic eye wash bowl.
      g. Type:
         1) Haws 8336.

B. Reduced Pressure Backflow Preventer:
   1. Backflow preventers consist of two check valves, test cocks and relief valve, all assembled as an integral unit.
   2. NSF-61/372 certified.
   3. Rated for 150 psi working pressure.
   4. Pressure loss through backflow preventer not exceeding 12 PSI at design flow.
   5. Provide wye strainer upstream to protect valve seats.
   6. Provide dielectric fittings or flanges when connecting to dissimilar pipe materials.
   7. Provide air gap fitting at relief valve and pipe discharge to nearest floor drain as indicated on the drawings, terminate with 1" air gap.
   8. Type:
      a. For line sizes 2-1/2 inch and larger:

1) Cast iron valve body construction, stainless steel seats, resilient seated gate valves, non-rising stem, flanged end connections.
2) Watts LF009 Large, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cross Connection: Do not install any plumbing components that will provide a cross connection between potable and non-potable or drainage systems.

B. Fixtures:
   1. Install fixtures at locations indicated on Drawings and in compliance with local Codes.
   2. Install emergency fixtures in accordance with ANSI Z358.1.

C. Shock Absorbers:
   1. Install on hot and cold water lines adjacent to each battery of fixtures or other equipment where indicated on Drawings and as required by the instant water heater manufacturer.
   2. Size as recommended by manufacturer for length of pipe served.
   3. Locations having two fixtures or less, install capped air chamber 12 inches long on hot and cold water runouts to each fixture, same size as runout.
   4. Install units vertically on top of pipe or as detailed on the Drawings.

D. Reduce Pressure Backflow Preventer: Install on water lines as required by Code and in the locations noted on the drawings.

3.2 FIELD QUALITY CONTROL

A. Test piping and fixtures for leaks per Specification Section 22 05 03.

3.3 TRAINING

A. Provide the service of a qualified manufacturer's representative to thoroughly train designated personnel in the operation and maintenance of systems and equipment furnished and installed under this section.

B. Refer to Section 01 79 00 for Operator training requirements.

C. Provide on-site training sessions, within the contract period, to train personnel designated by the Contracting Officer.

D. Coordinate training sessions with the Contracting Officer.

END OF SECTION

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SECTION 22 33 15
INSTANTANEOUS ELECTRIC SAFETY SHOWER WATER HEATERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Electric, tankless safety shower water heaters and water heater accessories.

B. Related Sections include but are not necessarily limited to:
   1. Section 22 05 03 - Pipe and Pipe Fittings - Plumbing Systems.
   2. Section 22 05 23 - General Duty Valves for Plumbing Piping.
   3. Section 22 20 00 - Plumbing Fixtures and Equipment.
   4. Division 26 - Electrical.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Sanitary Engineering (ASSE):
      a. 1003, Performance Requirements for Water Pressure Reducing Valves for Domestic Water Distribution Systems.
      b. 1010, Performance Requirements for Water Hammer Arresters.
   2. CSA, America, Inc. (CSA/AM):
      a. Z21.22, Relief Valves for Hot Water Supply Systems.
   3. International Safety Equipment Association (ISEA):
      a. Z358.1, American National Standard for Emergency Eyewash and Shower Equipment.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code.
      b. 496, Standard for Purged and Pressurized Enclosures for Electrical Equipment.
   6. NSF International (NSF):
      a. 61, Drinking Water System Components - Health Effects.
   7. Underwriters Laboratories (UL):
      a. 50E, Standard for Safety Enclosures for Electrical Equipment, Environmental Considerations.
      b. 499, Standard for Safety Electric Heating Appliances.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product data for each product:
      a. Manufacturer's data sheets indicating unit performance and compliance with requirements.
      b. Include details of electrical and mechanical operating parts.
      c. Show mounting and securing requirements and utility connection requirements.

B. Information Submittals:
   1. Source quality control test reports.
   2. Field quality control test reports.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 WARRANTY

A. Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric domestic water heaters that fail in materials or workmanship with specified warranty period.
   1. Standard Warranty Period: From Date of Substantial Completion.
      a. Electrical components, two years.
      b. Heating elements, four years.
      c. Heat exchanger free from leaks, eight years.
   2. ASME Warranty Period: From Date of Substantial Completion.
      a. Electrical components, two years.
      b. Heating elements, five years.
      c. Heat exchanger free from leaks, ten years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Bradley Corporation, SNA Series
   2. EEMAX
   3. Approved equal.

2.2 EQUIPMENT (IWH-1 AND IWH-2)

A. Electric tankless safety shower water heater, UL 499, sized for stable, lower temperature duty to meet flow requirements and temperature requirements of IEC Z358.1 compliant safety shower fixtures, with liquid-cooled, solid-state relays, flow activation, external emergency stop button, anti-scald protection, and an overshoot protection purge function.
   1. Capacity:
      a. Temperature Rise at Flow Rate: 23 DEG F at 20 gpm.
      b. Factory Temperature Setpoint: 80 degrees F.
   2. Electrical Characteristics: 72 kW at 480VAC/3-phase/3-wire.
   3. NEMA 4X Enclosure
   4. Internal fused disconnect
   5. ASME heat exchanger with level sensor
   6. Digital control
   7. Maximum amperage: 87
   8. Certified lead free design
   9. Dual Flow activation
   10. Variable temp heat exchanger
   11. Door cutoff switch

2.3 WATER HEATER ACCESSORIES

A. Provide electric tankless water heater system including the following system accessories:
   1. Pressure and Temperature Relief Valves: Brass. Adjust to pressure setting less than water working-pressure rating.
      a. Pressure and Temperature Safety Relief Valve set to 80 psig.
   2. Pressure Reducing Valves: ASSE 1003.
   3. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4
   4. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrestor.
   5. Thread Adapters: NPT to BSPP, stainless steel.
   6. Y-Strainer: Lead Free Brass.

2.4 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect domestic water heaters according to ASME "Boiler and Pressure Vessel Code, "Section III and IV. Submit test reports.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Electric, Tankless, Water Heater Mounting:
   1. Install water heaters in accordance with manufacturer's written instructions.
   2. Install water heaters level and plumb, according to layout drawings and referenced standards. Anchor to structure as recommended by manufacturer.
   3. Maintain manufacturer's recommended clearance and access dimensions.

B. Install water supply piping to each water heater, and from heater to fixture requiring hot water supply connection.
   1. Install stop valves on water supply and outlet piping. Provide stop valve on each supply in readily-serviced location. Lock stop valve in OPEN position.
   2. Comply with Division 22 for plumbing, piping and stop valve requirements.

C. If shipped loose, install pressure and temperature safety relief valves on water heater. Manifold relief valve discharge and over-temperature purge lines as shown in manufacturer's instructions.

D. Extend relief valve/over temperature purge outlet line, and discharge by positive air gap above closest floor drain.

E. Install relief valve/over temperature purge drain piping as indirect waste to spill by positive air gap into open drain or over floor drains. Install hose end drain valves at low points in water piping.

F. Run relief valve/over temperature purge drain piping with creating tripping hazard.

G. Install pressure reducing valve with integral bypass relief valve in water heater cold water inlet piping and water hammer arrester in water heater outlet piping, maximum outlet pressure as recommended by the equipment manufacturer.

3.2 FIELD QUALITY CONTROL

A. Do not energize water heater until hydrostatic testing of domestic water lines is complete. See Division 22, Plumbing.

B. Test and adjust installation.
   1. Replace defective or malfunctioning controls and equipment.

C. Clean unit surfaces, test fixtures, and leave in ready-to-use condition.

END OF SECTION

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SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Vibration isolators.

B. Related Sections include but are not necessarily limited to:
   1. Section 01 81 10 - Wind and Seismic Design Criteria: All vibration and seismic component design and installation must comply with Section 01 81 10 unless otherwise dictated by a more stringent requirement in this section.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE):
      a. Handbook - HVAC Applications.
   2. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA):
      a. HVAC Duct Construction Standards - Metal and Flexible.

1.3 SUBMITTALS

A. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Product Data:
   1. Submit schedule of vibration isolator type with location and load on each.
   2. Submit manufacturer catalog information indicating materials of construction, dimensional data, and load rating

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing products specified in this Section with minimum 5 years' documented experience.

B. Installer: Company specializing in performing Work of this Section with minimum 5 years' documented experience.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Inspection: Accept materials on Site in manufacturer's original packaging and inspect for damage.

B. Store materials according to manufacturer instructions.

C. Protection:
   1. Protect materials from moisture and dust by storing in clean, dry location remote from construction operations areas.
   2. Provide additional protection according to manufacturer instructions.

1.6 EXISTING CONDITIONS

A. Field Measurements:
   1. Verify field measurements prior to fabrication.
   2. Indicate field measurements on Shop Drawings.

1.7 WARRANTY

A. See Section –01 67 00 – Product Requirements.

PART 2 - PRODUCTS

2.1 PERFORMANCE AND DESIGN CRITERIA

A. Provide vibration isolation devices on motor-driven equipment over 0.5 hp, plus connected piping.

B. Minimum Static Deflection of Isolators:
   1. Under 20 hp:
      a. Under 600 rpm: 1.0 inches.
      b. 600 to 800 rpm: 0.5 inches.
      c. Over 800 rpm: 0.2 inches.

2.2 VIBRATION ISOLATORS

A. Open Spring Isolators:
   1. Spring Isolators:
      a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
      b. Code: Color-code springs based on load carrying capacity.
   2. Springs:
      a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
      b. Working Deflection: Between 30 and 60% of maximum deflection.
   3. Spring Mounts: Furnish leveling devices, minimum 0.25 inches thick neoprene sound pads, and zinc chromate-plated hardware.
   4. Sound Pads:
      a. Size: Based on minimum deflection of 0.05 inches.
      b. As specified for neoprene pad isolators.

B. Closed Spring Isolators:
   1. Spring Isolators:
      a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
      b. Code: Color-code springs based on load carrying capacity.
   2. Type: Closed spring mount with top and bottom housing separated by neoprene rubber stabilizers.
   3. Springs:
      a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
      b. Working Deflection: Between 30 and 60% of maximum deflection.
   4. Housings: Incorporate neoprene isolation pad meeting requirements for neoprene pad isolators and neoprene side stabilizers with minimum clearance of 0.25 inches.

C. Spring Hangers:
   1. Spring Isolators:
      a. Exterior and Humid Areas: Furnish hot-dip galvanized housings and neoprene-coated springs.
      b. Code: Color-code springs based on load carrying capacity.
   2. Springs:
      a. Minimum Horizontal Stiffness: 75% of vertical stiffness.
      b. Working Deflection: Between 30 and 60% of maximum deflection.
   3. Housings: Incorporate rubber hanger with threaded insert.
   4. Misalignment: Capable of 20-degree hanger rod misalignment.

D. Neoprene Pad Isolators:
   1. Rubber or neoprene-waffle pads.
      a. Hardness: 30 durometer.
      b. Minimum Thickness: 1/2 inches.
      c. Maximum Loading: 40 psi.
      d. Rib Height: Not greater than 0.7 times width.

2. Configuration: Single layer or 1/2 inches-thick waffle pads bonded to each side of 1/4 inches-thick steel plate.

E. Rubber Mount or Hanger:
1. Material: Molded rubber.
2. Deflection: 0.5 inches.
3. Insert: Threaded.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install isolation for motor-driven equipment. Install equipment level.

B. Install spring hangers without binding.

C. Isolators:
1. Install isolators so they are free of binding through full range of deflection.
2. Closed Spring Isolators: Adjust such that side stabilizers are clear under normal operating conditions.
3. Prior to making piping connections to equipment with operating weights substantially different from installed weights, block up equipment with temporary shims to final height; when full load is applied, adjust isolators to load to allow shim removal.

D. Snubbers:
1. Provide resiliently mounted equipment, piping, and ductwork with seismic snubbers.
2. Provide each inertia base with minimum of four seismic snubbers located close to isolators.
3. Snubbers: Provide clearance between 0.15 and 0.25 inches.

END OF SECTION

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SECTION 23 05 93
HVAC SYSTEMS - BALANCING AND TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Adjusting, balancing, and testing of all heating, ventilating and air conditioning (HVAC) systems.

B. Related Sections include but are not necessarily limited to:
   1. Section 23 80 00 - HVAC - Equipment.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Associated Air Balance Council (AABC):
      a. National Standards for Total System Balance.
   2. American Industrial Hygiene Association (AIHA):
      a. Z9.5, Laboratory Ventilation.
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Laboratories".
      b. HVAC Systems and Equipment Handbook, Chapter entitled "Testing, Adjusting, and Balancing".
   4. National Environmental Balancing Bureau (NEBB):
      a. Procedural Standards for Testing Adjusting Balancing of Environmental Systems.

B. Qualifications:
   1. Work of this Section to be accomplished by an independent testing and balancing firm certified by one (1) of the following:
      a. Associated Air Balance Council (AABC).
      b. National Environmental Balancing Bureau (NEBB).
      c. Other certification entity approved by the Contracting Officer Representative.
   2. The independent firm shall not be the same firm as the firm installing the HVAC equipment, nor under contract to the firm installing the equipment.
   3. The independent testing and balancing firm shall have successfully completed at least five (5) projects of similar size and scope in accordance with AABC or NEBB requirements and recommendations.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Certifications:
      a. Letter stating the name and qualifications of the firm proposed.
   3. Report forms:
      a. Procedures and forms to be used in calibrating of test instruments, balancing systems, and recording and reporting test data.

B. Informational Submittals:
   1. Completed test reports and data forms upon completion of installation, balance and testing of HVAC systems.
      a. Insert recorded information on report forms required by specifications and approved for use on project.
      b. Additional written verification and other related information clearly identifying project, date and specifics of verification.

c. Utilize report forms similar to those shown in Section V of AABC Standard.
d. Provide forms typed and signed by the testing and balancing firm.

PART 2 - PRODUCTS - (NOT USED)

PART 3 - EXECUTION

3.1 PREPARATION

A. Secure approved Shop Drawings of all HVAC equipment.

B. Procedures and Forms:
1. Submit procedures and forms to be used in calibration of test instruments, balancing systems, and recording and reporting test data.
2. Obtain approval before beginning balancing and testing.

C. Do not begin balancing and testing until HVAC systems are complete and in full working order.
1. Place HVAC systems into full operation and continue their operation during each working day of balancing and testing.

D. Provide qualified heating and ventilating Engineer(s) to supervise and perform balancing and testing.

E. Review design Drawings, specifications, approved Shop Drawings and other related items to become thoroughly acquainted with the design of HVAC systems.

F. Check all installed systems against Contract Drawings, Specifications and Shop Drawings to see that system is installed as required.
1. Report deficiencies to the Contracting Officer Representative.
2. Report deficiencies to Contractor for remedial action including providing corrective measures required in the function of any part of system to complete balancing.

G. Make necessary adjustments as required to balance the systems.

3.2 FIELD QUALITY CONTROL

A. Balance and Test Air Systems:
1. Adjust equipment RPM to design requirements.
2. Report motor full load amperes.
3. Obtain design CFM at fans.
4. Test and record system static pressures, suction and discharge.
5. Test and record leaving air temperatures, (DB, heating and cooling).
6. Test and record leaving air temperatures, (WB, cooling).
7. Identify and list size, type and manufacturer of HVAC equipment.
a. Record nameplate manufacturer and model number of installed equipment.
b. Use manufacturer's nameplate ratings on equipment to make required calculations.

B. Balance and Test Water Systems:
a. Examine water in system and determine if water has been treated and cleaned.
1) Clean strainers before and after balancing.
b. Check pump rotation.
c. Set pumps to proper flow delivery.
d. Adjust and record waterflow at system entrance.
e. Adjust and record waterflow through pumps.
f. Upon completion of flow readings and adjustments at coils, mark settings and record data.
g. List mechanical specifications of pumps.
h. Record rated and actual running amperage of pump motor.
i. Prepare and submit report.

j. Refer to equipment manufacturer for specific instructions on how to test and balance the water system.

END OF SECTION

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SECTION 23 74 36
REFRIGERANT PIPING SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Refrigeration piping for split system heat pumps and air conditioning units.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 07 - Pipe Support Systems.
   2. Section 23 80 00 - HVAC - Equipment.
   3. Section 40 42 00 - Pipe, Duct and Equipment Insulation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. 15, Safety Code for Mechanical Refrigeration.
   2. ASTM International (ASTM):
      a. B280, Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
   3. Federal Specification (FS):
      a. WW-T-799, Tube, Copper, Seamless, Water (For Use With Solder-Flared or Compression-Type Fittings).

1.3 SUBMITTALS

A. Shop Drawings:
   1. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   3. Test reports:
      a. A dated declaration of the test of the refrigerant piping for each system shall be provided.
         1) The dated declaration shall include the information outlined in Article 12.3 of ASHRAE 15.
      b. Test reports of the refrigerant piping leak tests for all refrigerant piping systems installed.
      c. The test reports shall contain the following information:
         1) System refrigerant and high and low side pressure used.
         2) Listing of the necessary repairs made before the refrigerant piping system passed the leak test.
         3) Identification of specific system by referencing specific equipment identification numbers.
         4) Leak testing media used.
         5) Suction and discharge refrigerant gas pressures and temperatures taken after the refrigerant system has been charged.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 WARRANTY

A. The completed refrigerant piping system shall be guaranteed to be sufficiently free from leaks so that the loss of refrigerant for 18 months from the date of final payment shall not exceed 5 percent.

PART 2 - PRODUCTS

2.1 REFRIGERANT PIPING AND FITTINGS

A. Refrigerant Piping:
   1. Copper tubing conforming to ASTM B280 and/or FS WW-T-799, dehydrated for refrigerant use, with high-temperature soldered joints and wrought copper (400 psig) fittings.
      a. For aboveground use: Type L.

B. Piping Joints:
   1. Joints between copper tubing and fittings to be high temperature soldered (melting point not less than 1000 degrees F, but less than that of the metal being joined) with phos-copper alloys.
   2. Joints between copper and brass, steel, etc., shall be silver soldered only.

C. Precharged Line Sets: Size per manufacturer's recommendations.

D. Field Assembled Units:
   1. Size refrigeration lines according to manufacturer's published tables using pressure or temperature drops as follows:
      a. Suction lines: 2 degrees F.
      b. Liquid lines: 1 degree F or 2 psi.
      c. Hot gas lines: 1 degree F or 3.6 psi.
      d. Size discharge and hot gas risers for positive oil return to compressors.

E. Hangers: As specified in Specification Section 40 05 07.

F. Insulation: As specified in Section 40 42 00.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Precharged Line Sets: Install per manufacturer's recommendations.

B. Field Assembled Lines:
   1. Refrigerant piping:
      a. Purge refrigerant piping of all air while connections of refrigerant piping are being made.
   2. Testing:
      a. Refrigerant piping systems: Follow general testing guidelines of ASHRAE 15, except as modified herein.
      b. Pressurize the high and low pressure sides of the piping system after completion of the refrigerant piping.
         1) Pressurize at the test pressures specified in ASHRAE 15 for the refrigerant type to be used in the system.
      c. Repair any leaks and repeat tests until no further leaks are found and the system passes a static leak test at test pressure for a duration of 24 hours.
   3. Cleaning:
      a. After complete system is tested, disconnect suction and discharge lines from compressor for cleanup.
      b. Clean uncontaminated system(s) by evacuation and purging procedures currently recommended by refrigerant and refrigerant equipment manufacturers, and as specified

herein, to remove small amounts of air and moisture. Systems containing moderate amounts of air, moisture, contaminated refrigerant or any foreign matter shall be considered contaminated systems.

c. Restore contaminated system(s) to clean condition including disassembly, component replacement, evacuation, flushing, purging, and re-charging using current refrigerant and refrigeration manufacturer's procedures. Restoring contaminated systems shall be at no additional cost to the Government.

4. Evacuation and Drying:
   a. After tests and cleaning have been completed and system proved tight, charge each circuit with dry clean refrigerant to gas pressure as recommended by the equipment manufacturer.
   b. Evacuate to 100 micron Hg and hold for 72 hours.
      1) Use laboratory type vacuum pump capable of holding absolute pressure of 50 micron Hg.
      2) Check the vacuum with a suitable mercury column gage.
   c. Admit another drying charge of refrigerant and allow 4 to 6 hours to absorb moisture and install dryer cores.
   d. Use second evacuation to remove all refrigerant and moisture.
   e. After second evacuation, charge system with refrigerant.
   f. Charge the system with refrigerant as required after final evacuation.

END OF SECTION

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SECTION 23 80 00
HVAC - EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes the following Heating, Ventilating and Air Conditioning equipment:
   1. Electric Unit Heaters.
   2. Split System Air Conditioning Units.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.
   2. Section 23 05 93 - HVAC Systems - Balancing and Testing.
   3. Section 23 74 36 - Refrigerant Piping Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Air Movement and Control Association (AMCA).
   2. Air Conditioning and Refrigeration Institute (ARI).
   3. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE):
      a. HVAC Applications Handbook, Chapter entitled "Sound and Vibration Control."
      b. 20, Methods of Testing for Rating Remote Mechanical-Draft Air-Cooled Refrigerant Condensers.
      c. 52.2, Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size.
   4. Canadian Standards Association (CSA).
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. National Roofing Contractors Association (NRCA).
   8. Underwriters Laboratories, Inc. (UL):
      a. 507, Standard for Electric Fans.

B. Miscellaneous:
   1. Gage thickness specified herein shall be manufacturer's standard gage for steel and Brown and Sharpe gage for non-ferrous metals.
   2. Corrosion protection of equipment to be as specified herein.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Fabrication and/or layout drawings.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
      c. Wiring diagrams.
      d. Control diagrams.
      e. Manufacturer's catalog cut sheets and technical data indicating performance, heating and cooling capacities, airflow capacity, motor sizes, power requirements, dimensions, materials of construction, weight, controls and accessories to be provided.
      f. Corrosion-protection information.

g. Fan curves indicating airflow, static pressure, fan speed, efficiency and power consumption.
h. Sound data.
i. Vibration isolation.
j. Control description.

4. Structural Calculations: Submit design calculations for equipment supports and anchorage, signed and sealed by a Professional Engineer registered in the state having jurisdiction.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 CONTRACTOR RESPONSIBILITY

A. Equipment Supports: (for condensing units and air handling units)
1. Equipment supports and anchorage shall be designed by a Professional Engineer registered in the State of Arizona and retained by the Contractor. Structural calculations shall be submitted for review and approval.
2. Equipment supports and anchorage shall be designed in accordance with the International Building Code and in accordance with project wind and seismic design criteria provided in specification 01 81 10.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Unit heaters - electric:
a. Indeeco UHIR series
b. Or equal.
2. Split System :
a. Mitsubishi MSZ-FS09NA & MUZ-FS09NA
b. Or equal.

2.2 GENERAL

A. All Manufactured Units:
1. Comply with Specification Section 01 61 03.
2. Factory wired and assembled.
3. Use fasteners made of same material as unit.
4. Fabricate motor assemblies and unit housings with vibration isolation assemblies:
a. Type: As per Table 47, Chapter 48, ASHRAE HVAC Applications Handbook.

B. Where indicated in the equipment schedules on the drawings, equipment shall be constructed with corrosion-resistant materials or have corrosion-resistant coating.
1. Type:
a. Corrosion-resistant materials:
1) Aluminum.
2) Stainless steel.

3) FRP.

b. Corrosion-resistant coating:
   1) Phenolic-based coating:
      a) 3 mil minimum dry thickness, air-dried coating, for surfaces exposed to temperatures less than 150 degrees F.
      b) 5 mil baked-on coating for heat transfer surfaces and surfaces exposed to temperatures greater than 150 degrees F.
      c) Factory applied.
      d) Provide factory certification of application.

2.3 MANUFACTURED UNITS

A. Unit Heater - Electric: (UH-1 thru 4)
   1. Type: Forced-air, horizontal discharge as required by the application.
   2. 5 KW, 480/3/60. Total amps: 6.22
   3. Airflow: 350 cfm
   4. Approx. air temp rise: 46F
   5. 2 stage control. Standard control voltage: 24V
   6. UL listed for non-rated areas.
   7. Material:
      a. Cabinet: Galvanized steel with manufacturers standard powder coat finish.
      b. Heating elements: Copper-clad steel.
   8. Fan motors:
      a. See Specification Section 01 61 03.
      b. Built-in automatic reset overload protection.
   9. Dynamically balanced fan.
   10. Built-in automatic reset cutout protection.
   11. Built-in magnetic contactor, control transformer and control circuit.
   12. Accessories:
      a. Mounting bracket.
      b. Provide unit -mounted (built in) 2 stage thermostat. Thermostats shall be adjustable from 40°F to 90°F, with minimum 2°F deadband.
      c. Disconnect switch
      d. “Heater On” pilot light
      e. Summer Fan switch

B. Split System (FCU-1 thru 4 & CU-1 thru 4):
   1. Indoor unit shall be ductless wall mounted equipped with an electronic expansion valve, for installation onto a wall. Unit shall be completely factory assembled and tested.
   2. Cooling rated capacity @ 95F: 9,000 BTUH
   3. Maximum Cooling capacity @ 95F: 12,000 BTUH
   4. Heating rated capacity @ 47F: 9,600 BTUH
   5. Efficiency: 29.8 SEER2 and 16.1 EER2. COP at 47F: 4.54
   6. Voltage: 208/1/60
   7. Indoor MCA: 1
   8. Outdoor MCA and MOCP: 10 & 15
   9. Evaporator Airflow rate (dry): 381 CFM (high)
   10. Inverter Driven compressor
   11. Anti corrosion coating
   12. Freeze base pan heater
   13. Refrigerant: R410A
   14. Maximum pre-charged refrigerant amount: 2 lbs.
   15. Provide disconnect switch
   16. Provide wired remote controller.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with Specification Section 01 61 03.

B. The Contractor shall not install any equipment or materials until submittals have been favorably reviewed. If any equipment or materials are installed prior to approval of the submittals, it shall be at the Contractor's risk.

C. Do not operate equipment without filters. Do not run equipment with dirty filter pressure drop more than twice clean filter pressure drop. A total of two complete sets of filters shall be provided. The first set is to be installed for start-up, test and balancing. The second set shall be installed after final cleanup and acceptance by the Contracting Officer.

D. The Contractor shall start up all equipment and systems in accordance with manufacturer recommendations and shall make all adjustments so that the system is placed in proper operating condition.

E. Install fixed pitched drive sheave after sheave has been sized based on accepted test and balance report.

F. Secure equipment to the structure as required by all local codes. Provide and install all required equipment and pipe supports in accordance with the manufacturer's installation instructions.

G. Install and secure equipment in accordance with the manufacturer’s installation instructions and all applicable codes.

3.2 FIELD QUALITY CONTROL

A. Test and balance systems in accordance with Specification Section 23 05 93.

B. Properly maintain and service all equipment and systems until the particular equipment or the system has been accepted by the Contracting Officer and their representative.

C. This maintenance shall include compliance with the manufacturers operating and maintenance instructions as well as periodic checking and cleaning of the filters and the lubrication of moving parts and all required adjustments.

D. Test and Inspections:
1. After installing HVAC equipment and after electrical circuitry has been energized, test units for compliance with performance requirements.
2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
3. After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Adjust and set supply airflow, supply air temperature setpoints, room temperature setpoints and other user defined parameters to match design values.
6. Complete installation and startup checks according to manufacturer's written instructions.
7. Inspect for visible damage to unit casing.
8. Inspect for visible damage to compressor, coils, and fans.
9. Inspect for visible damage to internal insulation.
10. Verify that labels are clearly visible.
11. Verify that clearances have been provided for servicing.
12. Verify that controls are connected and operable.
13. Verify that filters are installed.
14. Clean condenser coils and inspect for construction debris.
15. Inspect operation of motorized dampers.
16. Verify lubrication on fan and motor bearings.
17. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
18. Adjust fan belts to proper alignment and tension.

19. Install new filters on units which have been running prior to acceptance of Project.

3.3 TRAINING:

A. Provide the service of a qualified manufacturer's representative to thoroughly train designated personnel in the operation and maintenance of systems and equipment furnished and installed under this section.

B. Refer to Section 01 79 00 for Operator training requirements.

C. Provide on-site training sessions, within the contract period, to train personnel designated by the Contracting Officer.

D. Coordinate training sessions with the Contracting Officer's representative.

E. Train the designated staff to enable them to do the following:
   1. Understand system operation, control and optimizing routines.
   2. Understand control system components and configuration.
   3. Log on and off systems with password protected access.
   4. Adjust and change system set points, time schedules, occupied and non-occupied schedules.
   5. Recognize malfunctions of the system by observation of graphical or visual signals.
   6. Understand system drawings and the Operation and Maintenance manual.
   7. Understand the system layout and location of key components.

END OF SECTION

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SECTION 26 05 00
COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 03 - Concrete.
   2. Section 01 61 03 - Equipment - Basic Requirements.
   3. Section 03 15 19 - Anchorage to Concrete.
   4. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   5. Section 26 05 48 - Seismic Bracing Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA):
      a. ADM, Aluminum Design Manual.
   2. American Institute of Steel Construction (AISC):
      a. Steel Construction Manual.
   3. American National Standards Institute (ANSI).
   4. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      c. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip Galvanized) on Iron and Steel Hardware.
   5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C2, National Electrical Safety Code (NESC).
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Industrial Control and Systems Enclosures.
   8. Underwriters Laboratories, Inc. (UL).

B. Products to be listed by a Nationally Recognized Testing Laboratory (NRTL) in accordance with applicable product standards.
   1. Applicable product standards including, but not limited to, ANSI, FM, IEEE, NEMA and UL.
   2. NRTL includes, but is not limited to, CSA Group Testing and Certification (CS), FM Approvals LLC (FM), Intertek Testing Services NA, Inc. (ETL), and Underwriters Laboratories, Inc. (UL).

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

B. For the purposes of providing materials and installing electrical work the following definitions shall be used.
   1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.

2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

C. The North Rim electrical distribution system is served by Garkane Energy and owned by the National Park Service. The point of demarcation between Garkane Energy and NPS is at the north park boundary. The electrical distribution system inside the park beyond the demarcation point is owned and operated by the National Park Service.

New electrical distribution equipment and systems are being designed and shall be constructed to match the standards of Garkane Energy.

Coordinate installation of distribution circuits and equipment, and transformers and electrical metering at the North Rim Temporary WWTP with the NPS Park Staff.

1. The serving utility for this Project is Garkane Energy Cooperative, Inc.
   a. Contact:
      1) Kanab Office: Emal: neal.brown@garkane.com
         Phone: 800-747-5403
2. NPS North Rim Park Staff:
   a. Contact
      1) Park Electrician Name: Josiah Brown
         Email: Josiah_Brown@nps.gov
3. Refer to the Drawings for Contractor work scope listing. Generally:
   a. North Rim TWWTP:
      1) New distribution circuit to the TWWTP site, new padmount distribution transformer with foundation and accessories, new padmounted junction enclosure with foundation and accessories.
      2) Installation of required equipment and power circuits at new TWWTP Units, UV Disinfection Unit, WW Unit, EQ Unit, Hypochlorite / Caustic Storage Container, Citric Room Storage Container, screening channgel, and lift station pumps.
   b. Other site locations: Install selected electrical equipment as indicated on the Drawings.

D. Refer to **Garkane Electrical Service Requirement Manual** for general service requirements:
1. Coordinate with Garkane to obtain Garkane Construction Standards for reference.

1.4 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
1. See Specification Section 01 61 03 and individual specification sections for submittal requirements for products defined as equipment.
2. General requirements:
   a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
   b. Include data sheets that include manufacturer's name and product model number.
      1) Clearly identify all optional accessories.
   c. Acknowledgement that products are NRTL listed or are constructed utilizing NRTL recognized components.
   d. Manufacturer's delivery, storage, handling and installation instructions.

e. Product installation details.
f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
g. See individual specification sections for any additional requirements.

3. Product technical data:
   a. Provide submittal data for all products specified in PART 2 of this Specification Section.
4. Fabrication and/or layout drawings:
   a. Concrete and reinforcing steel, per Division 03 requirements.

C. Operation and Maintenance Manuals:
1. See Specification Section 01 78 23 for requirements for:
   a. The mechanics and administration of the submittal process.
   b. The content process of Operation and Maintenance Manuals.

D. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01 33 23 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 01 67 00 for storage requirements.

B. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
1. Outdoor areas:
   a. Wet.
   b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.
2. Indoor areas:
   a. Dry.
   b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.

B. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufacture of the products and shall be the manufacturer's latest standard design that has been in satisfactory use for at least one year prior to installation.
1. Materials and equipment shall conform to the respective publications and other requirements specified below and to the application requirements of NFPA 70
2. Components shall be UL or third-party certified.

C. Submit request for substitution in accordance with Section 01 67 00.

D. Provide all components of a similar type by one (1) manufacturer.

2.2 MATERIALS

A. Electrical Equipment Support Pedestals and/or Racks:
1. Material requirements:
   a. Modular strut:

1) Galvanized steel (hot-dipped): ASTM A123/123M or ASTM A153/A153M.
2) Stainless steel: AISI Type 316.
3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.
4) Aluminum: AA Type 6063-T6.
5) Fiberglass: Fire-retardant polyester or vinylester resin, ASTM E84, UL 94.

b. Structural members (e.g., I beams, L and C channels):
1) Galvanized steel (hot-dipped): ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
2) Aluminum: AA Type 6061-T6 or 6063-T6.

c. Mounting plates:
1) Galvanized steel (hot-dipped): ASTM A36/A36M steel with galvanizing per ASTM A123/A123M.
2) Aluminum: AA Type 6063-T6.

d. Mounting hardware:
1) Galvanized steel (hot-dipped).
2) Stainless steel.

e. Anchorage per Specification Section 03 15 19.

f. Concrete and reinforcing steel: See Division 03 specifications.

B. Equipment pads (interior and exterior):
1. Concrete and reinforcing steel: See Division 03 specifications.

C. Field touch-up of galvanized surfaces.
1. Zinc-rich primer.
a. One coat, 3.0 mils, ZRC by ZRC Products.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and wire all equipment, including prepurchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.

B. Install equipment in accordance with the requirements of:
1. NFPA 70.
2. IEEE C2.
3. The manufacturer's instructions.

C. In general, conduit routing is not shown on the Drawings.
1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.

D. When complete branch circuiting is not shown on the Drawings:
1. A homerun indicating panelboard name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
4. See Section 26 05 19 for combining multiple branch circuits in a common conduit.

E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.

F. Install equipment plumb, square and true with construction features and securely fastened.

G. Install electrical equipment, including pull and junction boxes, minimum of 6 inches from process, gas, air and water piping and equipment.

H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.

I. Device Mounting Schedule:
   1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
      a. Light switch (to center): 46 inches.
      b. Receptacle in architecturally finished areas (to center): 18 inches.
      c. Receptacle on exterior wall of building (to center): 18 inches.
      d. Receptacle in non-architecturally finished areas (to center): 46 inches.
      e. Telephone outlet in architecturally finished areas (to center): 18 inches.
      f. Telephone outlet for wall-mounted phone (to center): 46 inches.
      g. Safety switch (to center of operating handle): 54 inches.
      h. Separately mounted motor starter (to center of operating handle): 54 inches.
      i. Pushbutton or selector switch control station (to center): 46 inches.
      j. Panelboard (to top): 72 inches.

J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
   1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments of up to 6 inches in equipment location with the Contracting Officer's approval.

K. Provide electrical equipment support system per the following area designations:
   1. Dry areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.
      c. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   2. Wet areas:
      a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
      b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
   3. Corrosive areas:
      a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.
      b. Stainless steel system consisting of stainless steel channels and fittings, nuts and hardware.
      c. PVC coated steel system consisting of PVC coated steel channels and fittings with stainless steel nuts and hardware.
      d. Fiberglass system consisting of fiberglass channels and fittings, nuts and hardware and.
   4. Highly corrosive areas:
      a. PVC coated steel system consisting of PVC coated steel channels and fittings with stainless steel nuts and hardware.
      b. Fiberglass system consisting of fiberglass channels and fittings, nuts and hardware.

L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
   1. See Specification Section 03 15 19.

2. Do not cut, or weld to, building structural members.
3. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.

M. Provide non-metallic corrosion resistant spacers to maintain 1/4 inches separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Basins, Clarifiers, Digesters, Reservoirs, etc.

N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.

O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.

P. Do not use materials that may cause the walls or roof of a building to discolor or rust.

Q. Identify electrical equipment and components with labels.

R. Provide field markings and/or documentation of available short-circuit current (available fault current) and related information for equipment as required by the NFPA 70 and other applicable codes.

S. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
1. Determine the SCCR rating by one of the following methods:
   a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
   b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
   c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

T. NPS will provide labels and tags for medium voltage equipment (transformers, switch, splice vaults, pull vaults).

3.2 POWER EQUIPMENT INSTALLATION SEQUENCING

A. Power plan below only includes MV and LV equipment replacement.

B. Contractor to provide separate construction sequencing plan for all related work required for other areas.

C. Contractor to adjust installation sequencing plan as needed for other areas of work related to the project.

D. Prepare all new equipment, power cable conductor, and appurtenances prior to installation.

E. Set all items to be installed at all locations prior to installation and demolition.

F. Trench and install all new power cable conductor prior to demolition and cutover.

G. Coordinate all required power outages with NPS staff.

H. Utilize temporary generators as needed. Receive approval from the Contracting Officer Representative prior to installation.

I. Sequence:
1. TWWTP Area:
   a. Set all proposed equipment prior to demolition and removal of existing MV equipment.
   b. Excavate equipment vaults for ESB-21 and transformer T1A.

c. Trench and pull new MV power cables from ESB-21 to T1A. Terminate power cables with dead front elbow terminations.
d. Install transfer switch and MCB1. Leave MCB1 in the open position.
e. Trench and pull new power cable from T1A to transfer switch and MCB1.
f. Trench and pull new power cable from MCB1 to all facilities. Terminate all power cables at MCB's and manufacturer provided cable terminals. Leave all MCB's positions open.
g. Open switch at switch PTS-2 at the Power Distribution Center to isolate ESB-12 and existing power feed to ESB-13.
h. Disconnect power cable feeding ESB-13 at junction enclosure ESB-12 to isolate power feed to ESB-13.
i. Close switch at PTS-2 to reenergize ESB-12.
j. Locate, expose, and pull existing power cable feed to existing WWTP area.
k. Cut and terminate power cable into ESB-21 connecting ESB-21 to ESB-13.
l. Open switch at PTS-2 to isolate ESB-12.
m. Reconnect power cable feeding ESB-13 at junction enclosure ESB-12 to reestablish power to ESB-13.
n. Close switch at PTS-2 to reenergize ESB-12 and ESB-13.
o. Coordinate TWWTP equipment energization with Contracting Officer.

3.3 FIELD QUALITY CONTROL

A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
   1. See Specification Section 01 73 20 for openings and penetrations in structures.

B. Replace equipment and systems found inoperative or defective and re-test.

C. Cleaning:
   1. See Specification Section 01 73 40.

D. The protective coating integrity of support structures and equipment enclosures shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
   4. Repair surfaces which will be inaccessible after installation prior to installation.
   5. See Specification Section 26 05 33 for requirements for conduits and associated accessories.

E. Replace nameplates damaged during installation.

END OF SECTION

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SECTION 26 05 13
MEDIUM VOLTAGE CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Medium voltage cable (1000 V and above).
      b. Cable terminations and splices.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   3. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Association of Edison Illuminating Companies (AEIC).
      a. CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 kV.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 48, Standard for 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 Rated 2.5 kV through 35 kV.
      c. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems Rated 5 kV and Above.
      d. 400.3, Guide for Partial Discharge Testing of Shielded Power Cable Systems in a Field Environment.
      e. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV.
   3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 74/S-93-639, 5 - 46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL):
      a. 1072, Standard for Medium-Voltage Power Cables.

B. Qualifications:
   1. Cable technician:
      a. Three years of experience in handling, terminating and splicing medium voltage cables.
      b. Successfully completed minimum 18 medium voltage terminations and underground power cable splices.
      c. Specifically trained by a factory representative on the terminations and splices to be used on the project.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.
b. See Section 26 05 00 for additional requirements.

2. Fabrication and/or layout drawings:
   a. Cable pulling plan.

B. Informational Submittals:
1. Cable pulling tension measurements or photograph of breakaway swivel attached to cable.
2. Submit the following before terminating cables:
   a. Cable Technician qualifications.
3. Submit the following before testing:
   a. Independent testing organization qualifications.
   b. Engineering Technician qualifications.
   c. Sample of testing log sheets to be utilized.
4. Cable test report(s) shall include, at a minimum, the following:
   a. Summary of Project.
   b. Date tests were performed.
   c. Description of equipment/components tested.
   d. Visual inspection report.
   e. Description of tests.
   f. Test results including appropriate test forms.
   g. Conclusions and recommendations for corrective action as appropriate.
   h. Identification of test equipment used.
   i. Identification of company and person that performed the tests.
   j. Reports signed by the contracting officer representative interpreting the data.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Ship cable with removable watertight end seals, and store in dry place.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Contractor to confirm all equipment is rated for installed elevation and provide final equipment ratings for review. Proposed equipment shall be compatible with existing equipment interface.

C. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Non-Armored Wire and Cable.
   a. Southwire Company.
   b. Or approved equal.
2. Lugs, connectors and terminations:
   a. 3M.
   b. Or approved equal.
3. Fault indicators:
   a. Schweitzer Engineering Laboratories.
   b. Or approved equal.

2.2 MEDIUM VOLTAGE CABLES

A. Ratings:
   1. Voltage class as indicated on the Drawings.

B. Standards:
   1. NEMA/ICEA WC 74/S-93-639.
   2. AEIC CS8.
   3. UL 1072.

C. Conductor Material:
   1. Compact or compressed concentric stranded aluminum.

D. Insulation:
   1. Temperature rating: Type MV-105 per NFPA 70.
   2. Ethylene-propylene-rubber (EPR).
   3. 133% insulation level.

E. Shielding:
   1. Shielding on cables rated above 2 kV consists of:
      a. Semiconductor conductor screen.
      b. Semiconductor insulation screen.
      c. Copper concentric neutral

F. Neutrals:
   1. Cables with a concentric neutral shall have 1/3 concentric neutral size.

G. Grounds:
   1. Insulated copper per Section 26 05 19.
   2. Direct buried cables shall be rated for direct bury.
   3. Jacket: Polyvinyl chloride (PVC)

H. Jackets:
   1. Direct buried cables shall be rated for direct bury.
   2. Jacket: Polyethylene (PE).

I. Conduit Fill
   1. MV cable to be installed to meet NEC conduit fill requirements
      a. Single cable – 53 percent filled
      b. Three or more conductors – 40 percent filled
   2. Conduit size as indicated in the drawings.

2.3 CABLE ACCESSORIES

A. Lugs and Connectors:
   1. Lugs:
      a. Compression type.
      b. Standard: UL 486B for aluminum and copper cables.
      c. Voltage rating: Up to 35 kV.
      d. Current rating: Continuous operation at the rating of the cable.
      e. Material: Tin-plated copper or Aluminum with bronze underplating, tin outerplating and aluminum anti-oxide paste.
      f. Number of holes: Two, except one on motor leads.
   2. Splice connectors:
      a. Standard: UL 486B for aluminum and copper cables.
      b. Voltage rating: Up to 35 kV.
      c. Current rating: Continuous operation at the rating of the cable.
      d. Material: Tin-plated copper or Aluminum with bronze underplating, tin outerplating and aluminum anti-oxide paste.

B. Terminations:
   1. End caps:
      a. Cold or hot shrink.
      b. Used to environmentally seal and mechanically protect exposed cable ends.
   2. Cold shrink kits:
      a. Standard: IEEE 48, Class 1 termination.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One-piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicone rubber.
      e. Suitable for contaminated indoor and outdoor locations.
   3. Molded rubber kit:
      a. Standard: IEEE 48.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One-piece design or modular with stress cone and skirts, where high-dielectric constant stress control is integrated within a skirted insulator made of EPDM rubber.
      e. Suitable for contaminated indoor and outdoor locations.
   4. Elbow connectors:
      a. Standard: IEEE 386.
      b. Voltage rating: Same as the cable rating.
      c. Current rating:
         1) 200A Loadbreak
      d. One-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
      e. Deadfront, loadbreak type with:
         1) Hot stick pulling eye.
         2) Grounding tab.
         3) Test point.
      f. Accessories to be constructed in a similar manner as the elbow connector:
         1) Bushing inserts.
         2) Bushing well plugs.
         3) Feed thru inserts.
         4) Protective caps.

C. Splices:
   1. Cold shrink kits:
      a. Standard: IEEE 404.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One-piece design, comprised of an insulation shield, insulation layer and a silicone rubber body.
      e. Suitable for indoor, direct burial, or submersible applications.
   2. Molded rubber kit:
      a. Standard: IEEE 386 or IEEE 404.
      b. Voltage rating: Same as the cable rating.
      c. Current rating: Continuous operation at the rating of the cable.
      d. One- or multi-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
      e. Suitable for indoor, direct burial or submersible applications.
   3. Multi-point Cable Junctions:
      a. Standard: IEEE 386.
      b. Voltage Class: 15 kV.
      c. Configuration: As indicated on the Drawings.
      d. Current rating: 200A loadbreak

e. Bushing: One piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
f. Bus: Structural grade plated aluminum.
g. Wall mount bracket: Adjustable stainless steel with ground lug and parking stands.

D. Cable Shield Grounding Adapters:
1. Type: Molded rubber with constant force spring and solder-blocked tinned copper braid pigtail.
2. Waterproof, providing a positive seal for the cable jacket.
3. May be integral with termination of splice device with contracting officer representative's approval.

E. Fault Indicators:
1. Standards: IEEE 495.
2. Type: Manual reset.
a. Nominal trip rating: 400 A.
b. Reset delay: 4 hours.
3. Integral indicator type: LED.
4. When required, battery shall be a long-life lithium ion.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Do not install cable during wet conditions.
1. Prior to pulling cables, drain or pump out equipment vaults and other low points if standing water is present.
2. Blow out conduits with dried compressed air if moisture is present in conduits.
3. Install end caps immediately on all cut ends of cable prior to pulling, and maintain end caps while pulling in cable.
a. If end caps are damaged, remove and install new end caps.
b. Do not remove end caps until ready to terminate or splice cable.

B. Cable Installation in Equipment Vaults:
1. Arc-proof all cables in Equipment Vaults.
a. Apply in spiral, half-overlap fashion to full exposed length of each cable in manhole.
b. Secure in place with glass cloth electrical tape.
1) Apply in reverse spiral to arc-proofing tape, at maximum interval of 9 inches and double wrapped at each end.

C. Do not install conductors when ambient temperature is near minimum as recommended by manufacturer for installation of the type of conductor insulation.

D. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for each shielded cable termination.
1. Select correct termination to match cable diameter and construction.
2. Form and install terminations in strict accordance with instructions of cable manufacturer and termination manufacturer.

E. Splices:
1. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for the type of cable being used.
2. Prepare cable ends, provide materials and follow all application steps in accordance with manufacturer's instructions.
a. As a minimum requirement:
1) The cable ends shall be cut squarely.
2) The insulation shall be free from nicks or burrs after removal of jacket.
3) The conductors shall be cleaned and an oxide inhibitor applied.

4) For splices, connector indents shall be filled with insulating putty to eliminate voids or prepared per manufacturer's instructions.
5) Attach grounding lead to system ground.

3. Splices shall be avoided whenever possible.
   a. No more than one splice is permitted between termination points without contracting officer representative's approval.
   b. Do not pull splices into duct banks or conduits or leave them under tension.

F. The ground shield grounding adaptors shall be grounded:
   1. Shirted and elbow terminators: Grounded to ground bar or cable loop in equipment.
   2. Connect with insulated, stranded #6 AWG wire.

3.2 FIELD QUALITY CONTROL

A. Cable pulling plan.
   1. Include proposed splice points, cable pulling direction for each pull, and estimated pulling tensions (tension calculation).
   2. Provide measurement of tensions during the pull.
      a. Do no exceed manufacturer's suggested maximum pulling tension.

B. When estimated pulling tension is greater than 75% of cables maximum allowed tension, provide measurement of tensions during the pull or use breakaway swivel of a strength less than the cable's maximum allowed tension.

C. See Specification Section 26 08 13 for acceptance testing requirements.

END OF SECTION

SECTION 26 05 19
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Building wire.
      b. Power cable.
      c. Control cable.
      d. Shielded VFD cable.
      e. Instrumentation cable.
      f. Wire connectors.
      g. Insulating tape.
      h. Pulling lubricant.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Insulated Cable Engineers Association (ICEA):
      a. S-58-679, Standard for Control Cable Conductor Identification.
   2. National Electrical Manufacturers Association (NEMA):
      a. ICS 4, Industrial Control and Systems: Terminal Blocks.
   3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
      a. WC 57/S-73-532, Standard for Control Cables.
      b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
   4. 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.
   5. Telecommunications Industry Association/Electronic Industries Alliance (TIA/EIA):
      a. 598-C, Optical Fiber Cable Color Coding.
   6. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 568, Commercial Building Telecommunications Cabling Standard.
   7. Underwriters Laboratories, Inc. (UL):
      a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
      b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
      c. 467, Standard for Safety Grounding and Bonding Equipment.
      d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
      e. 486C, Standard for Safety Splicing Wire Connections.
      f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.
      g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
      h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
      i. 2250, Standard for Safety Instrumentation Tray Cable.

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

B. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.

C. Instrumentation Cable:
   1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
   2. The following are specific types of instrumentation cables:
      a. Analog signal cable:
         1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 VDC) signals, using No. 16 AWG and smaller conductors.
         2) Commonly used types are defined in the following:
            a) TSP: Twisted shielded pair.
            b) TST: Twisted shielded triad.
      b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.

D. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.

E. Shielded VFD Cable: Multi-conductor, insulated, with shield, drain wire and building wires, No. 12 and larger.

F. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.

G. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.

1.4 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
         1) Wire connectors.
         2) Insulating tape.
         3) Cable lubricant.
      b. See Section 26 05 00 for additional requirements.
   2. Miscellaneous:
      a. Cable pulling plan and data for circuits in underground conduits or duct banks longer than 100FT.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Building wire, power and control cable:
      a. Southwire Company.
      b. Or Equal.
   2. Shielded VFD cable:
      a. Okonite Company.
      b. Or Equal.
   3. Metal Clad (MC) cable:
      a. General Cable.
      b. Or Equal.
   4. Metal Clad - Hazardous Location (MC-HL) Cable:
      a. Okonite Company.
      b. Or Equal.
   5. Instrumentation cable:
      a. Analog cable:
         1) General Cable.
         2) Or Equal.
      b. Thermocouple extension wire:
         1) General Cable.
         2) Or Equal.
   6. Wire connectors:
      a. 3M Co.
      b. Or Equal.
   7. Insulating and color coding tape:
      a. 3M Co.
      b. Or Equal.

2.2 MANUFACTURED UNITS

A. Building Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
   3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   4. When direct buried, UL listed and marked as suitable for direct bury.
   5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
   6. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
   4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
   5. Number of conductors as required, including a bare ground conductor.
   6. Individual conductor color coding:
      a. ICEA S-58-679, Method 4.
      b. See PART 3 of this Specification Section for additional requirements.
   7. When direct buried, UL listed and marked as suitable for direct bury.

8. Conform to NFPA 70 Type TC and IEEE 1202 or CSA FT-4.

C. Control Cable:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
   4. Conform to NEMA/ICEA WC 57/S-73-532 and UL 44 and UL 1277 for type XHHW-2 insulation with an overall PVC jacket.
   5. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.
      a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).
   6. Individual conductor color coding:
      a. ICEA S-58-679, Method 1, Table E-2.
      b. See PART 3 of this Specification Section for additional requirements.
   7. Conform to NFPA 70 Type TC and IEEE 1202, CSA FT-4 or NFPA 262.

D. Electrical Equipment Control Wire:
   1. Conductor shall be copper with 600 V rated insulation.
   2. Conductors shall be stranded.
   3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   4. Conform to UL 44 for Type SIS insulation.
   5. Conform to UL 83 for Type MTW insulation.

E. Metal Clad (MC) Cable:
   1. Sheath: Galvanized steel interlocked armor.
   2. Conductors: Building wire as specified herein.
   3. Quantity and size of conductors: As indicated on the Drawings, including a ground wire.
   4. Individual conductor color coding as specified in PART 3 of this Specification Section.
   5. Conform to NFPA 70 Type MC, UL 1569.

F. Metal Clad - Hazardous Location (MC-HL) Cable:
   1. Sheath: Continuous welded corrugated copper-free aluminum.
   2. Jacket: Low temperature, sun light resistant PVC.
   3. Conductors:
      a. Building wire as specified herein.
      b. Material: Copper or aluminum as indicated on the Drawings.
      c. Size and quantity: As indicated on the Drawings, including ground wire.
      d. Individual conductor color coding or marking per ICEA S-58-679, Method 4.
         1) See PART 3of this Specification Section for additional requirements.
   4. Temperature Ratings:
      a. Normal operation: 90 degrees C.
      b. Emergency overload: 130 degrees C.
      c. Short circuit: 250 degrees C.
   5. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   6. Use manufacturer approved fittings.
   7. Conform to NFPA 70, Type MC-HL, UL 1569, UL 2225, IEEE 1202, IEEE 1580.

G. Shielded VFD Cable:
   1. Conductor shall be copper, stranded with 600 V rated insulation.
   2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
   3. Cables No. 1 AWG and less:

a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 and UL 1277 for type RHW-2 or XHHW-2 insulation with an overall PVC jacket.
b. Shielding: 85% tinned copper braid, full size tinned copper drain wire and 100% foil shield.
c. Number of conductors: 3 PH and 1 full size ground.

4. Cables No. 12 through 750 kcmil:
a. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 type XHHW-2 insulation.
b. Shielding: Continuous corrugated copper-free aluminum sheath covered with a PVC jacket.
c. Number of conductors: 3 PH and 3 equally spaced ground conductors.

5. Individual conductor color coding:
a. ICEA S-58-679, Method 4.
b. See PART 3 of this Specification Section for additional requirements.

6. For continuously corrugated cable, use manufacturer approved fittings.
7. Conform to NFPA 70, Type TC and IEEE 1202 or CSA FT-4.

H. Instrumentation Cable:
1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
2. Analog cable:
a. Tinned copper conductors.
b. 600 V PVC insulation with PVC jacket.
c. Twisted with 100% foil shield coverage with drain wire.
d. Six (6) twists per foot minimum.
e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.
f. Conform to UL 2250, UL 1581 and NFPA 70 Type ITC.

3. Digital cable:
a. As recommended by equipment (e.g., PLC, RTU) manufacturer.
b. Horizontal voice and data cable:
1) Category 6 per TIA/EIA/ANSI 568.
2) Cable shall be label-verified.
3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4) Conductors: No. 24 AWG solid untinned copper.
5) Rated CMP per NFPA 70.
c. Conform to IEEE 1202 NFPA 262 and NFPA 70 Type ITC.

4. Thermocouple extension wire:
a. Extension wire shall match the thermocouple type.
1) Twisted with 100% shield coverage with drain wire.
2) XLPE insulation with PVC jacket.
b. Conform to IEEE 1202 NFPA 262, ISA MC96.1, UL 13, UL 1581 and NFPA 70 Type PLTC.

I. Wire Connectors:
1. Twist/screw on type:
a. Insulated pressure or spring type solderless connector.
b. 600 V rated.
c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
d. Phase and neutral conductors: Conform to UL 486C.

2. Compression and mechanical screw type:
a. 600 V rated.
b. Ground conductors: Conform to UL 467.
c. Phase and neutral conductors: Conform to UL 486A.

3. Terminal block type:
a. High density, screw-post barrier-type with white center marker strip.
b. 600 V and ampere rating as required, for power circuits.

c. 600 V, 20 ampere rated for control circuits.
d. 300 V, 15 ampere rated for instrumentation circuits.
e. Conform to NEMA ICS 4 and UL 486A.

J. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
a. Insulating tape: Black.
b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.

K. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Permitted Usage of Insulation Types:
1. Type XHHW-2:
a. Building wire and power and control cable in all areas.
b. Building wire and power and control cable in conduit in outdoor areas and below grade.
2. Type THHN/THWN and THHN/THWN-2:
a. Lighting and receptacle circuits in indoor locations only.
3. Type SIS and MTW:
a. **Tinned copper**, for the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.

B. Shielded VFD Cable:
1. For wiring between a VFD and motor when routing in cable trays or conduit other than RGS or RAC.

C. Conductor Size Limitations:
1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.
2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.

D. Color Code All Wiring as Follows:
1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
b. Conductors larger than No. 6 AWG:
1) Insulated phase and neutral conductors shall be identified by one of the following methods:
a) Continuous colored outer finish along its entire length.
b) 3 inches of colored tape applied at the termination.
2) Insulated grounding conductor shall be identified by one of the following methods:
a) Continuous green outer finish along its entire length.
b) Stripping the insulation from the entire exposed length.
c) Using green tape to cover the entire exposed length.
3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wireways, manholes and handholes.

2. Power cables ICEA S-58-679, Method 4 with:
a. Phase and neutral conductors identified with 3 inches of colored tape, per the Table herein, applied at the terminations.
b. Ground conductor: Bare.
3. Shielded VFD cable ICEA S-58-679, Method 4 with:
a. Phase conductors identified with 3 inches of colored tape, per the Table herein, applied at the terminations.
b. Ground conductor: Green color insulation or bare.
4. Control cables ICEA S-58-679, Method 1, Table E-2:
a. When a bare ground is not provided, one of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 inches of colored tape, per the Table herein, applied at the terminations.

E. Install all wiring in raceway unless otherwise indicated on the Drawings.

F. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
1. Where specifically indicated on the Drawings.
2. Where field conditions dictate and written permission is obtained from the Contracting Officer.
3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
a. The combinations shall comply with the following:
1) 12 VDC, 24 VDC and 48 VDC may be combined.
2) 125 VDC shall be isolated from all other AC and DC circuits.
3) AC control circuits shall be isolated from all DC circuits.
4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
a. The combinations shall comply with the following:
1) Analog signal circuits may be combined.
5. Multiple branch circuits for similar loads may be combined in a common raceway, such as multiple lighting circuits or multiple receptacle circuits or other 120Vac circuits. Do not combine lighting and receptacle circuits.
a. Do not combine control device circuits with lighting or receptacle circuits.
b. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
2) The neutral conductors may not be shared.
3) Up sizing raceway size for the size and quantity of conductors.

G. Ground the drain wire of shielded instrumentation cables at one end only.
   1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).

H. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
   1. Feeder and branch power circuits:
      a. Device outlet boxes:
         1) Twist/screw on type connectors.
      b. Junction and pull boxes and wireways:
         1) Twist/screw on type connectors for use on No. 8 and smaller wire.
         2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
      c. Motor terminal boxes:
         1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
         2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
      d. Manholes or handholes:
         1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
         2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
   2. Control circuits:
      a. Junction and pull boxes: Terminal block type connector.
      b. Manholes or handholes: Twist/screw on type connectors pre-filled with epoxy.
      c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
   3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Contracting Officer Representative.
      a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
      b. Junction and pull boxes: Terminal block type connector.
      c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.
   4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.

I. Insulating Tape Usage:
   1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
   2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
   3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.

J. Color Coding Tape Usage: For color coding of conductors.

K. Fiber Optic Cable:
   1. Unless indicated otherwise, install all fiber optic cable in conduit.
      a. In cable trays, the cable(s) shall be installed in an innerduct that is placed in the tray for protection of the cable.
   2. Splicing:
      a. Optical fibers shall not be spliced.
   3. Utilize dust tight wall-mounted interconnect center to provide the following:
      a. Interconnect fiber optic cable to jumper cable assemblies for connection to the opto-electronic interface.
   4. Where exposed to contact with electric light or power conductors, the noncurrent carrying metallic members (if applicable) of optical fiber cables entering buildings shall be grounded as close to the point of entrance as practicable in accordance with NFPA 70.
   5. Install cables in accordance with the requirements of NFPA 70.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing:
   1. See Specification Section 26 08 13.

END OF SECTION

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SECTION 26 05 26
GROUNDING AND BONDING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for grounding and bonding system(s).

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   3. Section 26 08 13 - Acceptance Testing.
   4. Section 26 41 13 - Lightning Protection System.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL):
      a. 467, Grounding and Bonding Equipment.

B. Assure ground continuity is continuous throughout the entire Project.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Ground rods and bars and grounding clamps, connectors and terminals:
      a. ERICO by Pentair.
      b. Or Equal.
   2. Exothermic weld connections:
      a. ERICO by Pentair - Cadweld.

b. Or Equal.

3. Prefabricated composite test stations:
   a. Armorcast Products Company.
   b. Or Equal.

2.2 COMPONENTS

A. Wire and Cable:
   1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
   2. Insulated conductors: Color coded green, per Section 26 05 19.

B. Ground Bars:
   1. Solid copper:
      a. 1/4 inches thick.
      b. 2 or 4 inches wide.
      c. 24 inches long minimum in main service entrance electrical rooms, 12 inches long elsewhere.
   2. Predrilled grounding lug mounting holes.
   3. Stainless steel or galvanized steel mounting brackets.
   4. Insulated standoffs.

C. Ground Rods:
   1. Unless otherwise specified in the drawings, ground rods to be 3/4 inches x 10 feet Copper-clad:
      a. 10 mil minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
      b. Corrosion resistant bond between the copper and steel.
      c. Hard drawn for a scar-resistant surface.

D. Grounding Clamps, Connectors and Terminals:
   1. Mechanical type:
      a. Standards: UL 467.
      b. High copper alloy content.
   2. Compression type for interior locations:
      a. Standards: UL 467.
      b. High copper alloy content.
      c. Non-reversible.
      d. Terminals for connection to bus bars shall have two bolt holes.
   3. Compression type suitable for direct burial in earth or concrete:
      a. Standards: UL 467, IEEE 837.
      b. High copper alloy content.
      c. Non-reversible.
      d. Factory filled with oxide inhibiting compound.

E. Exothermic Weld Connections:
   1. Copper oxide reduction by aluminum process.
   2. Molds properly sized for each application.

F. Prefabricated Composite Material Test Stations:
   1. Body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
   2. Minimum load ratings: SCTE 77 Tier 15.
   3. Open bottom.
   4. Stackable design as required for 3 feet depth.
   5. Cover:
      a. Engraved legend of "GROUND".
      b. Lay-in non-bolt down.
   6. Size: 12 inches round or 12 inches square.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install products in accordance with manufacturer's instructions.
   2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.
   3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections. After connection, apply manufacturers approved touch-up paint to protect metallic surface from corrosion.
   4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves and install sleeve per Specification Section 01 73 20.
      a. Seal the sleeve interior to stop water penetration.
   5. Do not splice grounding electrode conductors except at ground rods.
   6. Install ground rods and grounding electrode conductors in undisturbed, firm soil.
      a. Provide excavation required for installation of ground rods and conductors.
      b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
      c. Unless otherwise specified, connect conductors to ground rods with compression type connectors or exothermic weld.
      d. Provide sufficient slack in conductor to prevent conductor breakage during backfill or due to ground movement.
      e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
   7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.

B. Grounding Electrode System:
   1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
      a. All grounding electrode conductors terminate on a main ground bar located adjacent to the service entrance equipment.
   2. Grounding electrode conductor terminations:
      a. Ground bars mounted on wall: Use a two-hole compression type conductor terminal and bolt it to the ground bar with two bolts.
      b. Ground bars in electrical equipment: Use compression type conductor terminal and bolt it to the ground bar or manufacture's provided mechanical type termination device.
      c. Piping systems: Use mechanical type connections.
      d. Building steel, below grade and encased in concrete: Use compression type connector or exothermic weld.
      e. Building steel, above grade: Use a two-hole compression type conductor terminal and bolt to the steel with two bolts or exothermic weld.
      f. Ground rod: Compression type or exothermic weld, unless otherwise specified.
      g. At all above grade terminations, the conductors shall be labeled.
   3. Ground ring grounding system:
      a. Ground ring consists of ground rods and a conductor looped around the structure.
      b. Placed at a minimum of 10 feet from the structure foundation and 2 feet-6 inches below grade unless otherwise shown in drawings.
      c. Provide a minimum of four ground rods placed at the corners of the structure and additional rods so that the maximum distance between ground rods does not exceed 50 FT.
      d. Building/Structure grounding:
         1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
      e. Grounding conductor: Bare conductor, size as indicated on the Drawings.
      f. Ground rod test stations:

1) Provided where indicated on the Drawings.
2) Grounding conductors connected to ground rod with removable ground clamps.

g. Grounding conductor shall connect the ground rods, primary cable neutral wires, secondary neutral, and all groundable parts of the equipment.

C. Supplemental Grounding Electrode:
1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
a. See Grounding Electrode System paragraph for conductor termination requirements.
2. Equipment support rack and pedestals mounted outdoors:
a. Connect metallic structure to a ground rod.
b. Grounding conductor: #6 AWG minimum.
3. Engine generator:
a. Connect generator frame to the ground ring at two locations (opposite corners of frame).
b. Grounding conductor: Bare conductor, size as indicated on the Drawings.

D. Other Bonding Requirements:
1. Other metal piping:
a. Connect in a daisy chain or radial fashion: Interior hot and cold water piping system , process piping , fire sprinkler system service water pipe to the main ground bus as indicated on the Drawings.
b. See Grounding Electrode System paragraph for conductor termination requirements.
2. Lightning protection system:
a. Connect to ground ring.
b. See Specification Section 26 41 13.

E. Transformer Separately Derived Grounding System:
1. Install the System Bonding Jumper at the transformer. At the first disconnect, ensure the neutral is isolated from ground.
2. Structures with a single electrical room/area:
a. Connect grounding electrode conductor to the Grounding Electrode System main ground bar.
3. Structures with multiple electrical rooms/areas:
a. Provide a ground bar mounted in each electrical room/area.
b. Interconnect all ground bars in a daisy chain or radial fashion to the main ground bar as indicated on the Drawings.
c. Connect grounding electrode conductor to the electrical room/area ground bar.
4. See Grounding Electrode System paragraph for conductor termination requirements.

F. Raceway Bonding/Grounding:
1. Install all metallic raceway so that it is electrically continuous.
2. Provide an equipment grounding conductor in all raceways with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduits, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.

G. Equipment Grounding:
1. Ground all utilization equipment with an equipment grounding conductor.

H. Manhole and Handhole Grounding:

1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
    a. Expose a minimum of 4 inches of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.

I. Pad Mounted Transformer Grounding:
1. Per detail on the Drawings.
2. Provide a ground ring around transformer with:
    a. A minimum of two ground rods located at the corners.
    b. A ground rod connected to the ring and located in the conduit stub up area.
    c. Or as indicated on the Drawings.
3. Connect medium voltage cable shields to the ground rod.
4. Connect surge arrestor to the ground rod.
5. Connect elbow terminations to ground ring.
6. Connect the XO and ground pad to the ground rod.
7. Connect exposed metallic conduits to the ground rod.

J. Prefabricated Composite Material Test Station:
1. Place test station on a foundation of compacted 1/4 to 1/2 inches crushed rock or gravel a minimum of 8 inches thick and 6 inches larger than handholes footprint on all sides.
2. Provide concrete encasement ring around test station per manufacturers installation instructions (minimum of 10 inches wide x 12 inches deep).

3.2 FIELD QUALITY CONTROL

A. Leave grounding system uncovered until observed by Contracting Officer Representative.

B. Acceptance testing:
1. See Specification Section 26 08 13.

C. Provide a continuity test on the components of the grounding electrode system.

D. Complete grounding system: Resistance of 5 ohms or less.

E. Test resistance of installed ground system after backfilling and before connection to any other grounded system including underground piping, utility services or other building ground systems.
1. Test ground grid resistance by fall-of-potential method.
2. Perform test at the main ground bar.

END OF SECTION

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SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Conduits.
      b. Conduit fittings.
      c. Conduit supports.
      d. Wireways.
      e. Outlet boxes.
      f. Pull and junction boxes.

B. Related Requirements:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 43 - Underground Work for Electrical Systems.
   3. Section 26 27 26 - Wiring Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Aluminum Association (AA).
   2. American Iron and Steel Institute (AISI).
   3. 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. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
   4. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit.
      c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
      d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
      e. TC 14.AG, Aboveground Reinforced Thermosetting Resin Conduit and Fittings.
      f. TC 14.BG, Belowground Reinforced Thermosetting Resin Conduit and Fittings.
   5. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C80.1, Electric Rigid Steel Conduit (ERSC).
      b. C80.3, Steel Electrical Metallic Tubing (EMT).
      c. C80.5, Electrical Aluminum Rigid Conduit (ERAC).
      d. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
   6. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   7. Underwriters Laboratories, Inc. (UL):
      a. 1, Standard for Flexible Metal Conduit.
      b. 6, Electrical Rigid Metal Conduit - Steel.
      c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      d. 360, Standard for Liquid-Tight Flexible Metal Conduit.
      e. 467, Grounding and Bonding Equipment.
      f. 514A, Metallic Outlet Boxes.

g. 514B, Conduit, Tubing, and Cable Fittings.
h. 651, Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.
i. 797, Electrical Metallic Tubing - Steel.
j. 870, Standard for Wireways, Auxiliary Gutters, and Associated Fittings.
k. 1203, Standard for Explosion-Proof and Dust-Ignition-Proof Electrical Equipment for Use in Hazardous (Classified) Locations.
l. 2420, Belowground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
m. 2515, Aboveground Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rigid metal conduits and electrical metallic tubing:
      a. Allied Tube and Conduit.
      b. or Equal.
   2. PVC coated rigid metal conduits:
      a. Robroy Industries.
      b. Or Equal.
   3. Rigid nonmetallic conduit:
      a. Prime Conduit.
      b. Or Equal.
   4. Flexible conduit:
      a. Southwire Company, LLC.
      b. Or Equal
   5. Wireway:
      a. Square D by Schneider Electric.
      b. Or Equal
   6. Conduit fittings and accessories:
      a. Appleton by Emerson Electric Co.
      b. or Equal
   7. Support systems:
      a. Unistrut by Atkore International, Inc.
      b. Or Equal
   8. Outlet, pull and junction boxes:
      a. Appleton by Emerson Electric Co.
      b. Or Equal

2.2 RIGID METAL CONDUITS

A. Rigid Galvanized Steel Conduit (RGS):
   1. Mild steel with continuous welded seam.
   2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.

3. Threads galvanized after cutting.
4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
5. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6.

B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
   a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
   b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
2. Nominal 2 mil, minimum, urethane interior coating.
3. Urethane coating on threads.
4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends:
   a. Have a plastic sleeve extending a minimum of one pipe diameter or 2 inches, whichever is less beyond the opening.
   b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
6. Pass high temperature water PVC coating adhesion test and be ETL Verified PVC-001.
7. Standards: NFPA 70 Type RMC, NEMA/ANSI C80.1, UL 6, NEMA RN 1.

2.3 ELECTRICAL METALLIC TUBING (EMT)

A. Mild steel with continuous welded seam.

B. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.

C. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.

D. Standards: NFPA 70 Type EMT, NEMA/ANSI C80.3, UL 797.

2.4 RIGID NONMETALLIC CONDUIT

A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 degrees C wire and shall be marked "maximum 90 degrees C".
5. Standards: NFPA 70 Type PVC, NEMA TC 2, UL 651.

B. Fiberglass:
1. Epoxy based resin system using an anhydride curing agent.
2. Continuous E-glass roving.
3. Winding angle approximately 54.75 degrees.
4. Smooth internal walls with all fibers imbedded in the epoxy.
5. Above grade rated: Halogen free additive for flame spread and smoke control.
6. Ultraviolet inhibitor: Carbon black.
7. Two-step curing process.
8. Tensile strength: 11,000 psi per ASTM D2105.
9. Dimensions: Iron Pipe Size (IPS).
10. Wall thickness:
    a. Standard: 3/4 inches to 4 inches nominal size.
    b. Medium: 5 inches to 6 inches nominal size.
    c. Extra Heavy for “bullet proof” and Class 1, Division 2 areas: 3/4 inches to 6 inches nominal size.
11. Integral bell and spigot.
12. Conduits and fittings to be joined with an interference joint and epoxy adhesive creating a concrete and water tight connection.

13. Standard: NFPA 70 Type RTRC, NEMA TC14.AG, NEMA TC14.BG, NEMA TC.XW, UL 2420, UL 2515 , UL 2515A.

2.5 FLEXIBLE CONDUIT

A. Flexible Galvanized Steel Conduit (FLEX):
   1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
   2. Standard: NFPA 70 Type FMC, UL 1.

B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
   1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
   2. Extruded PVC outer jacket positively locked to the steel core.
   3. Liquid and vaportight.
   4. Standard: NFPA 70 Type LFMC, UL 360.

2.6 WIREWAY

A. General:
   1. Suitable for lay-in conductors.
   2. Designed for continuous grounding.
   3. Covers:
      a. Hinged or removable in accessible areas.
      b. Non-removable when passing through partitions.
   4. Finish: Rust inhibiting primer and manufacturer's standard paint inside and out except for stainless steel type.
   5. Standards: UL 870, NEMA 250.

B. General Purpose (NEMA 1 rated) Wireway:
   1. 14 or 16 gage steel without knockouts.
   2. Cover: Solid, non-gasketed and held in place by captive screws.

C. Watertight (NEMA 4X rated) Wireway:
   1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

D. Dusttight (NEMA 12 rated) Wireway:
   1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
   2. Cover: Fully gasketed and held in place with captive clamp type latches.
   3. Flanges: Fully gasketed and bolted.

2.7 CONDUIT FITTINGS AND ACCESSORIES

A. Fittings for Use with RGS :
   1. General:
      a. Finish: Electrostatically applied epoxy powder coat.
      b. In hazardous locations listed for use in Class I, Groups C and D locations.
   2. Locknuts:
      a. Threaded steel or malleable iron.
      b. Gasketed or non-gasketed.
      c. Grounding or non-grounding type.
   3. Bushings:
      a. Threaded, insulated metallic.
      b. Grounding or non-grounding type.
   4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
   5. Couplings:

a. Threaded straight type: Same material and finish as the conduit with which they are used on.
b. Threadless type: Gland compression or self-threading type, concrete tight.

6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. Cover:
      1) Clip-on type with stainless steel screws.
      2) Gasketed or non-gasketed galvanized steel or zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
   a. Body: Zinc plated cast iron with threaded hubs.
   b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron.
9. Sealing fittings:
   a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. With or without drain and breather.
   d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
    a. Liquid tight and arc resistant.
    b. Electrically conductive so no bonding jumper is required.
    c. Dry and wet areas:
       1) Bronze braided covering over flexible brass core.
       2) Bronze end fittings.
       3) Zinc-plated steel or malleable iron unions and nipples.
    d. Corrosive areas:
       1) Stainless steel braided covering over flexible stainless steel core.
       2) Stainless steel end fittings.
       3) Aluminum unions and nipples.
11. Expansion couplings:
    a. 2 inches nominal straight-line conduit movement in either direction.
    b. Galvanized steel with insulated bushing.
    c. Gasketed for wet locations.
    d. Internally or externally grounded.
12. Expansion/deflection couplings:
    a. 3/4 inches nominal straight-line conduit movement in either direction.
    b. 30 degrees nominal deflection from the normal in all directions.
    c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
    d. Internally or externally grounded.
    e. Watertight, raintight and concrete tight.
13. Standards: UL 467, UL 514B, UL 1203.

B. Fittings for Use with PVC-RGS:
   1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS " and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."

C. Fittings for Use with EMT:
   1. Connectors:
      a. Straight, angle and offset types furnished with locknuts.
      b. Zinc plated steel.
      c. Insulated gland compression type.
      d. Concrete and raintight.
   2. Couplings:
      a. Zinc plated steel.

b. Gland compression type.
c. Concrete and raintight.

3. Conduit bodies (ells and tees):
   a. Body: Copper free aluminum with threaded hubs.
   b. Standard and mogul size.
   c. Cover:
      1) Screw down type with steel screws.
      2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
4. Standard: UL 514B.

D. Fittings for Use with FLEX:
1. Connector:
   a. Zinc plated malleable iron.
   b. Squeeze or clamp-type.
2. Standard: UL 514B.

E. Fittings for Use with FLEX-LT :
1. Connector:
   a. Straight or angle type.
   b. Metal construction, insulated and gasketed.
   c. Composed of locknut, grounding ferrule and gland compression nut.
   d. Liquid tight.
2. Standards: UL 467, UL 514B.

F. Fittings for Use with Rigid Nonmetallic PVC Conduit:
1. Coupling, adapters and conduit bodies:
   a. Same material, thickness, and construction as the conduits with which they are used.
   b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
   c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.

G. Fittings for Use with Rigid Nonmetallic Fiberglass Conduit:
1. Coupling and adapters shall be of the same material, thickness, and construction as the conduit.
2. Epoxy adhesive for joining conduits and fittings shall be supplied by the same manufacturer as the conduit and fittings and shall provide a concrete and water tight connection.
3. Standard: NFPA 70 Type RTRC, NEMA TC14.AG, NEMA TC14.BG, [NEMA TC.XW] UL 2420, UL 2415 [, UL 2515A].

H. Weather and Corrosion Protection Tape:
1. PVC based tape, 10 mils thick.
2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.8 ALL RACEWAY AND FITTINGS

A. Mark Products:
1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.9 OUTLET BOXES

A. Metallic Outlet Boxes:
1. Hot-dip galvanized steel.
2. Conduit knockouts and grounding pigtail.
3. Styles:
   a. 2 inches x 3 inches rectangle.

b. 4 inches square.
c. 4 inches octagon.
d. Masonry/tile.

4. Accessories:
   a. Flat blank cover plates.
   b. Barriers.
   c. Extension, plaster or tile rings.
   d. Box supporting brackets in stud walls.
   e. Adjustable bar hangers.
5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:
1. Zinc plated cast iron with manufacturer's standard finish.
2. Threaded hubs and grounding screw.
3. Styles:
   a. "FS" or "FD".
   b. "Bell".
   c. Single or multiple gang and tandem.
   d. "EDS" or "EFS" for hazardous locations.
4. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
5. Standards: UL 514A, UL 1203.

C. Nonmetallic Outlet Boxes:
1. Polyvinyl-chloride (PVC) plastic compound.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Suitable for use with 90 degrees C wire.
5. Styles:
   a. “FS” or “FD”.
   b. Single or multiple gang.
6. Standards: UL 514A, NEMA TC 3.

D. See Section 26 27 26 for wiring devices, wallplates and coverplates.

2.10 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:
1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. With or without concentric knockouts on four sides.
3. Flat cover fastened with screws.

B. NEMA 4X Rated (metallic):
1. Body and cover: 14 GA Type 304 or 316 stainless steel.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged door and stainless steel screws and clamps.
6. Door with oil-resistant gasket.

C. NEMA 4X Rated (Nonmetallic):
1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
2. No knockouts.
3. External mounting flanges.
4. Hinged door with quick release latches and padlocking hasp.
5. Door with oil resistant gasket.

D. NEMA 12 Rated:
1. Body and cover:

a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
6. Flat door with oil resistant gasket.

E. Miscellaneous Accessories:
1. Rigid handles for covers larger than 9 square feet or heavier than 25 pounds.
2. Split covers when heavier than 25 pounds.
3. Weldnuts for mounting optional panels and terminal kits.
4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

F. Standards: NEMA 250, UL 50.

2.11 SPECIAL PURPOSE BOXES

A. Pedestal-Type Floor-Mounted or Counter-Mounted Duplex Receptacles:
1. Horizontal design housing with threaded conduit fittings in base with satin chromium finish.

B. Flush in Floor Duplex Receptacles:
1. Dual level, fully adjustable box with power fitting and brass carpet flange.

2.12 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:
1. Material requirements.
a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.
b. Stainless steel: AISI Type 316.
c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.
d. Aluminum: AA Type 6063-T6.
e. Fiberglass: Fire-retardant polyester or vinylester resin, ASTM E84, UL 94.

B. Single Conduit and Outlet Box Support Fasteners:
1. Material requirements:
a. Zinc plated steel.
b. Stainless steel.
c. Malleable iron.
d. PVC coat malleable iron or steel: 20 mil PVC coating.
e. Steel protected with zinc phosphate and oil finish.

2.13 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

A. Sleeves, smoke and fire stop fitting through walls and floors:
1. See Section 01 73 20.

B. Smoke and Fire Stop Fittings:
1. 3 hour UL rating.
2. Flanged and segmented.
3. Cast malleable iron mounting frame and pressure plate.
a. Elastomeric sealing material.
b. Steel clamping hardware.

C. Sleeves through walls and floors:
1. Uncoated or galvanized iron or steel:
2. Wall thickness: Not less than standard Schedule 40 pipe.

PART 3 - EXECUTION

3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:
   1. NFPA 70.
   2. Manufacturer instructions.

B. Size of Raceways:
   1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.
   2. Unless specifically indicated otherwise, the minimum raceway size shall be:
      a. Conduit: 3/4 inches.
      b. Wireway: 2-1/2 inches x 2-1/2 inches.

C. Field Bending and Cutting of Conduits:
   1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.
   2. Do not reduce the internal diameter of the conduit when making conduit bends.
   3. Prepare tools and equipment to prevent damage to the PVC coating.
   4. Degrease threads after threading and apply a zinc rich paint.
   5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.
   1. Repair galvanized components utilizing a zinc rich paint.
   2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
   3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
      a. Total nominal thickness: 40 mil.
   4. Repair surfaces which will be inaccessible after installation prior to installation.

F. Remove moisture and debris from conduit before wire is pulled into place.
   1. Pull mandrel with diameter nominally 1/4 inches smaller than the interior of the conduit, to remove obstructions.
   2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
   3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.

G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.

H. Seal all conduits that pass from the interior of the building or structure to the exterior of the building or structure at both ends using duct seal putty.
   1. Conduits that terminate in manholes or handholes shall be left unsealed at the end in the manhole or handhole to allow for drainage.

I. Fill openings in walls, floors, and ceilings and finish flush with surface.
   1. See Section 01 73 20.

3.2 RACEWAY ROUTING

A. Raceways shall be routed in the field unless otherwise indicated.
   1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
   2. Run in straight lines parallel to or at right angles to building lines.

3. Do not route conduits:
    a. Through areas of high ambient temperature or radiant heat.
    b. In suspended concrete slabs.
    c. In concrete members including slabs, slabs on grade, beams, walls, and columns unless specifically located and detailed on structural Drawings..
4. Locate sleeves or conduits penetrating floors, walls, and beams so as not to significantly impair the strength of the construction. Do not place conduit penetrations in columns.
5. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
6. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.

B. All conduits within a structure shall be installed exposed except as follows:
1. Concealed above gypsum wall board or acoustical tile suspended ceilings.
2. Conduits in architecturally finished areas shall be concealed.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 feet:
1. Between instrumentation and telecommunication: 1 inch.
2. Between instrumentation and 125 V, 48 V and 24 VDC, 2 inches.
3. Between instrumentation and 600 V and less AC power or control: 6 inches.
4. Between instrumentation and greater than 600 VAC power: 12 inches.
5. Between telecommunication and 125 V, 48 V and 24 VDC, 2 inches.
6. Between telecommunication and 600 V and less AC power or control: 6 inches.
7. Between telecommunication and greater than 600 VAC power: 12 inches.
8. Between 125 V, 48 V and 24 VDC and 600 V and less AC power or control: 2 inches.
9. Between 125 V, 48 V and 24 VDC and greater than 600 VAC power: 2 inches.
10. Between 600 V and less AC and greater than 600 VAC: 2 inches.
11. Between process, gas, air and water pipes: 6 inches.

D. Conduits shall be installed to eliminate moisture pockets.
1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.
1. See Section 01 73 20.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:
1. Power wire or cables: All raceway types.
2. Control wire or cables: All raceway types.
3. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
4. Motor leads from a VFD: RGS, RAC or shielded VFD cables in all other raceways.
5. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:
1. Citric Room
    a. PVC-RGS
2. Membrane Storage Area
    a. PVC-RGS
3. Caustic Room
    a. PVC-RGS
4. Hypochlorite Room

a. PVC-RGS
5. Dry areas:
   a. RGS.
   b. RAC.
6. Wet areas:
   a. RGS.
   b. RAC.
   c. Fiberglass (above grade rated).
7. Corrosive areas:
   a. PVC-RGS.
   b. Fiberglass (above grade rated).
8. Highly corrosive areas:
   a. PVC-RGS.
   b. Fiberglass (above grade rated).
9. NFPA 70 hazardous areas:
   a. RGS.

C. Permitted Raceway Types Per Routing Locations:
1. In stud framed walls:
   a. EMT.
2. In concrete block or brick walls:
   a. PVC-40.
   b. PVC-08
3. Above acoustical tile ceilings:
   a. EMT.
   b. NEMA 1 rated wireway.
4. Embedded in poured concrete walls and floors:
   a. PVC-40.
   b. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
5. Beneath floor slab-on-grade:
   a. PVC-40.
6. Through floor penetrations, see Section 01 73 20:
   a. Fiberglass (above grade rated) in areas designated as wet, corrosive or highly corrosive.
   b. PVC-RGS – extend PVC coating minimum 6 inches above and below finished surfaces.
7. Direct buried conduits:
   a. 90 degrees elbows for transitions to above grade:
      1) PVC-RGS – extend PVC coating minimum 6 inches above finished surface.
   b. Long sweeping bends greater than 15 degrees:
      1) PVC-RGS.
      2) Fiberglass (above or below grade rated).

D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
1. The maximum length shall not exceed:
   a. 6 feet to light fixtures.
   b. 3 feet to all other equipment.

E. FLEX-LT conduits shall be installed as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
1. The maximum length shall not exceed:
   a. 6 feet to light fixtures.
   b. 3 feet to motors.
   c. 2 feet to all other equipment.

F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.
   1. The maximum length shall not exceed:
      a. 3 feet to motors.
      b. 2 feet to all other equipment.

G. NEMA 1 Rated Wireway:
   1. Surface mounted in electrical rooms.
   2. Surface mounted above removable ceilings tiles of an architecturally finished area.

H. NEMA 4X Rated Wireway:
   1. Surface mounted in areas designated as wet and or corrosive.

I. NEMA 12 Rated Wireway:
   1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.

J. Underground Conduit: See Section 26 05 43.

3.4 CONDUIT FITTINGS AND ACCESSORIES

A. Conduit Seals:
   1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
   2. Fill plug and drain shall be accessible.
   3. Pour the conduit seals in a two-step process.
      a. Pour the seal and leave cover off.
      b. After seal is dry, inspect for proper sealing, install cover and mark (for example, paint or permanent marker) as complete.

B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
   1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.

C. Install Expansion Fittings:
   1. Where conduits are exposed to the sun and conduit run is greater than 200 feet.
   2. Elsewhere as identified on the Drawings.

D. Install Expansion/Deflection Fittings:
   1. Where conduits enter a structure.
      a. Except electrical manholes and handholes.
      b. Except where the ductbank is tied to the structure with rebar.
   2. Where conduits span structural expansions joints.
   3. Elsewhere as identified on the Drawings.

E. Threaded connections shall be made wrench-tight.

F. Conduit joints shall be watertight:
   1. Where subjected to possible submersion.
   2. In areas classified as wet.
   3. Underground.

G. Terminate Conduits:
   1. In metallic outlet boxes:
      a. RGS :
         1) Conduit hub and locknut.
         2) Insulated bushing and two locknuts.
         3) Use grounding type locknut or bushing when required by NFPA 70.
      b. EMT: Compression type connector and locknut.
   2. In NEMA 1 rated enclosures:
      a. RGS :
         1) Conduit hub and locknut.

2) Insulated bushing and two locknuts.
3) Use grounding type locknut or bushing when required by NFPA 70.

b. EMT: Compression type connector and locknut.

3. In NEMA 12 rated enclosures:
   a. Watertight, insulated and gasketed hub and locknut.
   b. Use grounding type locknut or bushing when required by NFPA 70.
4. In NEMA 4X rated enclosures:
   a. Watertight, insulated and gasketed hub and locknut.
   b. Use grounding type bushing when required by NFPA07
   c. .
5. When stubbed up through the floor into floor mount equipment:
   a. With an insulated grounding bushing on metallic conduits.
   b. With end bells on nonmetallic conduits.

H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.

3.5 CONDUIT SUPPORT

A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
   1. Dry or wet and/or hazardous areas:
      a. Galvanized system consisting of: Hot-dipped galvanized steel channels and fittings, nuts and hardware and conduit clamps.
   2. Corrosive areas:
      a. Stainless steel system consisting of: Stainless steel channels and fittings, nuts and hardware and conduit clamps.
      b. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
   3. Highly corrosive areas:
      a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.
      b. Fiberglass system consisting of: Fiberglass channels and fittings, nuts and hardware and conduit clamps.
   4. Conduit type shall be compatible with the support system material.
      a. Galvanized steel system may be used with RGS and EMT.
      b. Stainless steel system may be used with RGS and PVC-RGS.
      c. PVC coated galvanized steel system may be used with PVC-RGSand PVC-40and PVC-80.
      d. Fiberglass system may be used with PVC-40 and PVC-80 and PVC-RGS.

B. Permitted single conduit support fasteners per area designations and conduit types:
   1. Architecturally finished areas:
      a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.
      b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
      c. Provide anti-rattle conduit supports when conduits are routed through metal studs.
   2. Dry or wet and/or hazardous areas:
      a. Material: Zinc plated steel, stainless steel and malleable iron.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   3. Corrosive areas:
      a. Material: Stainless steel and PVC coat malleable iron or steel.
      b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.
   4. Highly corrosive areas:

a. Material: PVC coat malleable iron or steel.
b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

5. Conduit type shall be compatible with the support fastener material.
   a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS and EMT.
   b. Stainless steel system may be used with RGS and PVC-RGS.
   c. PVC coated fasteners may be used with PVC-RGS and PVC-40and PVC-80.
   d. Nonmetallic fasteners may be used with PVC-40, PVC-80 and fiberglass.

C. Conduit Support General Requirements:
1. Maximum spacing between conduit supports per NFPA 70.
2. Support conduit from the building structure.
3. Do not support conduit from process, gas, air or water piping; or from other conduits.
4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 pounds.
   a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
   b. Conduit hangers:
      1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
   c. Do not use suspended ceiling support systems to support raceways.
   d. Hangers in metal roof decks:
      1) Utilize fender washers.
      2) Not extend above top of ribs.
      3) Not interfere with vapor barrier, insulation, or roofing.
5. Conduit support system fasteners:
   a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
   b. Do not use concrete nails and powder-driven fasteners.

3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION

A. General:
1. Install products in accordance with manufacturer's instructions.
2. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
3. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.

B. Outlet Boxes:
1. Permitted uses of metallic outlet boxes:
   a. Housing of wiring devices:
      1) Recessed in all stud framed walls and ceilings.
      2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
   b. Pull or junction box:
      1) Above gypsum wall board or acoustical tile ceilings.
      2) Above 10 feet in an architecturally finished area where there is no ceiling.
2. Permitted uses of cast outlet boxes:
   a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
   b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.
3. Set device outlet boxes plumb and vertical to the floor.
4. Outlet boxes recessed in walls:
   a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.

b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.

5. Place barriers between switches in boxes with 277 V switches on opposite phases.
6. Back-to-back are not permitted.
7. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.

C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
   a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
   a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
3. Permitted uses of NEMA 4 enclosure:
   a. Pull or junction box surface mounted in areas designated as wet.
4. Permitted uses of NEMA 4X metallic enclosure:
   a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
5. Permitted uses of NEMA 7 enclosure:
   a. Pull or junction box surface mounted in areas designated as Class I hazardous.
      1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
6. Permitted uses of NEMA 12 enclosure:
   a. Pull or junction box surface mounted in areas designated as dry.

END OF SECTION

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SECTION 26 05 43
ELECTRICAL - EXTERIOR UNDERGROUND

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Manholes.
      b. Handhole.
      c. Underground conduits

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 03 - Concrete.
   2. Section 03 31 30 - Concrete, Materials and Proportioning.
   3. Section 26 05 26 - Grounding.
   4. Section 31 23 33 - Trenching and Backfilling.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. HB-17, Standard Specifications for Highway Bridges.
   2. ASTM International (ASTM):
      a. A536, Standard Specification for Ductile Iron Castings.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Society of Cable Telecommunications Engineers (SCTE):
      a. 77, Specifications for Underground Enclosure Integrity.

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

B. Direct-Buried Conduit(s):
   1. Individual (single) underground conduit.
   2. Multiple underground conduits, arranged in one or more planes, in a common trench.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide signed and sealed design computations for manholes and handholes indicating compliance with design load rating.
   2. Fabrication and/or layout drawings:
      a. Provide dimensional drawings of each manhole and handhole indicating all specified accessories and conduit entry locations.
      b. Submittals:
         1) Organize and submit required product information and fabrication/layout drawings into discrete packages as follows:
            a) North Rim Temporary Wastewater Treatment Plant

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Prefabricated composite handholes:
      a. Armorcast Products Company.
      b. Or Equal.
   2. Precast handholes:
      a. Lister Industries Ltd.
      b. Or Equal.
   3. Handhole accessories:
      a. Cantex, Inc.
      b. Or Equal.

2.2 HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
   2. Minimum load ratings: SCTE 77 Tier 8.
   3. Open bottom.
   4. Stackable design as required for specified depth.
   5. Cover:
      a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
      b. Non-gasketed bolt down with stainless steel penta head bolts.
      c. Gasketed bolt down with stainless steel penta head bolts.
      d. Lay-in non-bolt down, when cover is over 100 pounds.
      e. One or multiple sections so the maximum weight of a section is 125 pounds.
   6. Cover lifting hook: 24 inches minimum in length.

B. Precast Handholes:
   1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
   2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
   3. Mating edges: Tongue and groove type.
   4. Solid bottom with a 12 inches x 12 inches or 12 inches diameter french drain in the bottom of each manhole.
   5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
   6. Cover extension rings as required.
   7. Cable pulling eyes opposite all conduit entrances.
      a. Coordinate exact location with installation contractor.

2.3 CONCRETE HANDHOLE ACCESSORIES

A. Cover and Frame:
   1. Cast ductile iron: ASTM A536.
   2. AASHTO live load rating: H-20.
   3. Diameter: 30 inches.
   4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into handhole covers.
      a. Stainless steel penta-head bolts.

B. Cable Racks and Hooks:
   1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
   2. Hook loading capacity: 400 pounds minimum.
   3. Rack loading capacity: Four hooks maximum.
   4. Hook deflection: 0.25 inches maximum.
   5. Hooks: Length, as required, with positive locking device to prevent upward movement.
   6. Mounding hardware: Stainless steel.

C. Cable Pulling Irons:
   1. 7/8 inches diameter hot-dipped galvanized steel.
   2. 6000 pound minimum pulling load.

D. Ground Rods and Grounding Equipment: See Specification Section 26 05 26.

PART 3 - EXECUTION

3.1 GENERAL

A. Drawings indicate the intended location of handholes and routing of direct buried conduit.
   1. Field conditions may affect actual routing.

B. Handhole Locations:
   1. Approximately where shown on the Drawings.
   2. As required for pulling distances.
   3. As required to keep pulling tensions under allowable cable tensions.
   4. As required for number of bends in conduit routing.
   5. Shall not be installed in a swale or ditch.
   6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
   7. Locations are to be approved by the Contracting Officer prior to excavation and placement or construction of manholes and handholes.

C. Install products in accordance with manufacturer's instructions.

D. Install handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.

E. Comply with Specification Section 31 23 33 for trenching, backfilling and compacting.

3.2 HANDHOLES

A. Prefabricated Composite Material Handholes:
   1. For use in areas subjected to occasional non-deliberate vehicular traffic.
   2. Place handhole on a foundation of compacted 1/4 to 1/2 inches crushed rock or gravel a minimum of 8 inches thick and 6 inches larger than handholes footprint on all sides.
   3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 inches wide x 12 inches deep).
   4. Install so that the surrounding grade is 1 inch lower than the top of the handhole.
   5. Size: As indicated on the Drawings or as required for the number and size of conduits.
   6. Provide cable rails and pulling eyes as needed.

B. Precast Handholes:
   1. For use in vehicular and non-vehicular traffic areas.
   2. Construction:
      a. Grout or seal all joints, per manufacturer's instructions.
      b. Support cables on walls by cable racks:
         1) Provide a minimum of two racks, install symmetrically on each wall of manholes and handholes.
            a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.

2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.

c. In each handhole, drive 3/4 inches x 10 feet long copper clad ground rod into the earth with approximately 6 inches exposed above finished floor.
   1) Drill opening in floor for ground rod.
   2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
   3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three.
      a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.

3. Place handhole on a foundation of compacted 1/4 to 1/2 inches crushed rock or gravel a minimum of 8 inches thick and 6 inches larger than manholes or handholes footprint on all sides.
4. Install so that the top of cover is 1 inch above finished grade.
   a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.
5. After installation is complete, backfill and compact soil around manholes and handholes.
6. Handhole size:
   a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
   b. Minimum floor dimension of 4 feet x 4 feet and minimum depth of 4 feet.

3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:
   1. Do not place soil until conduits have been observed by the Contracting Officer.
   2. During construction and after conduit installation is complete, plug the ends of all conduits.
   3. Provide conduit supports and spacers.
      a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:
         1) 1 inches and less: 3 feet.
         2) 1-1/4 to 3 inches: 5 feet.
         3) 3-1/2 to 6 inches: 7 feet.
      b. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.
   4. Stagger conduit joints at intervals of 6 inches vertically.
   5. Make conduit joints watertight and in accordance with manufacturer's recommendations.
   6. Accomplish underground changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 10 feet.
      a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.
   7. Furnish manufactured elbows at end of runs as the conduit transitions to above grade.
      a. Minimum radius of 18 inches for conduits less than 3 inches trade size and 36 inches for conduits 3 inches trade size and larger.
   8. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.
   9. After the conduit run has been completed:
      a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.
         1) Test mandrel:
            a) Length: Not less than 12 inches.
            b) Diameter: Approximately 1/4 inches less than the inside diameter of the conduit.
      b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.

10. Pneumatic rodding may be used to draw in lead wire.
    a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.
    b. Extend cord 3 feet beyond ends of conduit.
11. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 26 05 33, prior to entering a structure or going above ground.
    a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.
    b. Terminate rigid PVC conduits with end bells.
    c. Terminate steel conduits with insulated bushings.
12. Place warning tape in trench directly over direct-buried conduit and direct-buried wire and cable.
13. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Direct-Buried Conduit(s):
    1. Install so that the top of the uppermost conduit, at any point:
        a. Is not less than 24 inches below grade.
        b. Is below pavement sub-grading.
        c. See Drawings for additional details.
    2. Provide a uniform minimum clearance of 3 inches between conduits for different cabling types.
        a. Maintain the separation of multiple planes of conduits by one of the following methods:
            1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations and backfill.
            2) Install the multilevel conduits one level at a time.
                a) Each level is backfilled with the appropriate amount of soil and compaction, per Specification Section 31 23 33, to maintain the required separations.

END OF SECTION

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SECTION 26 05 48
ELECTRICAL SEISMIC RESTRAINT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. The design and installation of seismic bracing and anchorage required for electrical equipment, conduit, cable tray, and bus ducts.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 81 10 – Wind and Seismic Design Criteria

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Civil Engineers (ASCE):
      a. 7, Minimum Design Loads and Associated Criteria for Buildings and Other Structures.
   2. ASTM International (ASTM):
      a. A36/A36M, Standard Specification for Carbon Structural Steel.
      b. A307, Standard Specification Carbon Steel Bolts, Studs, and Threaded Rod, 60,000 psi Tensile Strength.
      c. A500/A500M, Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
      d. A588/A588M, Standard Specification for High-Strength Low-Alloy Structural Steel, up to 50 ksi (345 MPa) Minimum Yield Point, with Atmospheric Corrosion Resistance.
      e. A992/A992M, Standard Specification for Structural Steel Shapes.
      f. F1554, Standard Specification for Anchor Bolts, Steel, 36, 55, and 105 ksi Yield Strength.

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

1.4 SYSTEM DESCRIPTION

A. Contractor is responsible for design and installation of seismic bracing and anchorage systems.

B. Description of Systems:
   1. Transverse and longitudinal bracing for seismic forces on suspended electrical systems including conduit, cable tray, bus duct, and equipment.
   2. Anchorage of floor and roof mounted electrical equipment.

C. Seismic Design Requirements:
   1. Seismic design criteria: Provide bracing and anchoring for equipment, conduit, cable tray, bust duct, designed, constructed, and installed to resist stresses produced by lateral forces.

D. Design and install seismic anchorage and bracing for all floor or roof mounted equipment weighing 400 pounds or more and all suspended or wall mounted equipment weighing 20 pounds or more.

E. The following components are exempt from the requirements of this Specification Section:
   1. Electrical components in structures assigned to Seismic Design Category C provided that the importance factor (I_p) is equal to 1.0.
   2. Electrical components in Seismic Design Categories D, E, and F where I_p = 1.0 and flexible connections between the components and associated conduit are provided and that are mounted at 4 feet (1.22 M) or less above a floor level and weigh 400 LBS (1780 N)or less.

3. Electrical components in Seismic Design Categories D, E, and F weighing 20 pounds (95 N) or less where I_p = 1.0 and flexible connections between the components and conduit are provided, or for distribution systems, weighing 5 pounds/FT (7 N/M) or less.

F. Seismic forces shall be presumed to act through the center of mass of the equipment in a direction that will produce the largest single anchor force.

1.5 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Seismic control devices.
   2. Fabrication and/or layout drawings:
      a. Layout and mounting detail drawings showing system and proposed brace locations for all systems including pre-engineered systems.
      b. The specific detail for each type of brace or anchor must be referenced on a plan that identifies the required location.
         1) Supplying a book of details without referencing the proper detail to a specific location on a plan is not acceptable.
      c. Structural calculations for required lateral force level for each component.
      d. All submittals, including pre-approved systems, shall be signed and sealed by a licensed engineer, licensed in the state in which the project is located.

1.6 PROJECT CONDITIONS

A. Wind and Seismic Loads:
   1. Comply with Section 01 81 10 – Wind and Seismic Design Criteria

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Pre-engineered suspended bracing systems:
      a. Unistrut by Atkore International, Inc.
      b. Or Equal.
   2. Custom engineered systems designed using specified criteria and common building materials.

2.2 EQUIPMENT ANCHORS AND SUPPORTS

A. Drilled-in-place concrete anchors shall have an approved ICBO Evaluation Services Report.

B. Cast-in-place anchors shall comply with ASTM A36, ASTM A307, or ASTM F1554, 36 ksi.

C. Anchors permanently exposed to weather or corrosive environments shall be stainless steel or hot-dipped galvanized.

D. Structural steel for supports: ASTM A36, A588, A992 or A500.

E. Cold formed metal and connection material: Unistrut, or equal.

F. Any details provided are based on assumed equipment and arrangement.

1. The Contractor shall be responsible for design and acquiring approval for support and anchorage of equipment and arrangement which varies from equipment and arrangement assumed in detail provided.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Every run which requires bracing shall have a minimum of two transverse braces and one longitudinal brace.
   1. A "run" is defined as suspended pipe, conduit, cable tray, bus ductor trapeze rack having a minimum 10 feet straight run length.

B. Brace spacing shall not exceed the maximum allowable brace spacing as engineered by the manufacturer or custom bracing designer.

C. Bracing may be omitted from conduit, cable tray and bus duct runs less than 10 feet in length.

D. Bracing may be omitted from conduit, cable tray and bus duct runs where rod hung supports of less than 12 inches. (305 mm) in length are required.
   1. All unbraced suspended utility systems having 2 inches conduit and larger or systems weighing more then 5 pounds/FT shall be installed with a minimum 6 inches clearance to suspended ceiling vertical hanger wires.
   2. The conduit, cable tray, or bus duct shall be installed such that the lateral motion of the members will not cause damaging impact with other systems or structural members or loss of vertical support.

E. A longitudinal brace at a 90 degrees change in direction may act as a transverse brace if it is located within 2 feet of the change in direction.

F. A transverse brace may act as a longitudinal brace if it is located within 2 feet of a change in direction and if the brace arm and anchorage have been sized to meet or exceed the requirements of the longitudinal brace.

G. When bracing equipment or a utility system that is suspended from an overhead deck, brace back to the overhead deck or to the supporting structure supporting the deck.
   1. Do not brace to another element of the structure which may respond differently during a seismic event.

H. Obtain approval from the Contracting Officer prior to attaching any brace elements to structural steel or wood framing.

I. When utilizing cable bracing, tension the cable to remove slack without inducing uplift of the suspended element.
   1. Tension seismic bracing system prior to system start-up and adjust if necessary after equipment start-up.

J. As a general rule, do not mix rigid bracing with cable bracing in the same run.
   1. However, once bracing has transitioned a 90 degrees change in run direction, the bracing may switch from rigid to cable or vice versa if required due to a significant change in overhead deck elevation or to provide an implementable bracing scheme in a congested area.

K. Install brace members at an angle of 45 degrees from horizontal within a tolerance of +2-1/2 DEG or -45 degrees provided the brace length is accounted for in design.
   1. Brace angle may be increased to 60 degrees provided the brace spacing is reduced to 1/2 that required for a 45 degrees brace.

L. Seismic bracing may not pass through a building separation joint.
   1. Utility systems that pass through a separation joint must be seismically restrained no greater than 5 feet from the point of connection.

2. Any hardware designed to accommodate seismic movement across the span of the separation joint shall be installed per manufacturer's installation and listing instructions.

M. With approval of the Contracting Officer, utility systems that are suspended from the overhead deck may be braced to load bearing concrete or CMU (concrete masonry) walls provided that the walls and the overhead decks will respond similarly during a seismic event.

N. Each layer of a multiple layer trapeze rack shall be braced individually based on the weight of the individual layer.

O. Conduit, cable tray, or bus duct constructed of non ductile material (plastic or fiberglass), shall have brace spacing reduced to 1/2 of the spacing allowed for ductile materials.

P. Where brace elements are through-bolted, the mounting hole in the element is to be no more than 1/16 inches in diameter larger then the bolt or threaded rod.

Q. Seismic braces shall directly brace the support and not the hanger.

3.2 SUSPENDED ELECTRICAL SYSTEMS

A. Install seismic bracing for all conduit 2-1/2 inches trade size or greater.

B. All trapeze assemblies supporting conduits, cable trays or bus ducts shall be braced considering the total weight of the elements on the trapeze.
   1. For the purposes of calculating weight, all conduits are to be treated as full.

C. Brace all trapeze racks which support conduit 2-1/2 inches trade size or larger.
   1. Brace all other conduit rack, cable tray or bus duct trapezes having a minimum weight in excess of 10 pounds/LF.
   2. Include a minimum 10% additional capacity for future additions.

D. Seismic bracing may be omitted from cable trays, conduit and bus ducts suspended by rod hung supports 12 inches or less in length form the top of the element to the bottom of the structural attachment of the hanger provided lateral motion will not cause damaging impacts to other systems or loss of system vertical support.

E. For steel and aluminum bus ducts, conduit and cable trays:
   1. Provide transverse bracing at 40 feet maximum spacing unless otherwise noted.
   2. Provide longitudinal bracing at 80 feet maximum spacing unless otherwise noted.

F. All vertical risers involving conduit 2-1/2 inches in diameter or larger shall include lateral restraint at maximum 30 feet intervals and at the top and bottom of the riser.

G. Make provisions to eliminate seismic impact between components.

3.3 FLOOR OR ROOF MOUNTED EQUIPMENT

A. Provide one anchor on each leg or corner.
   1. Support with a minimum of three 3/8 inches diameter anchors.

B. Friction shall be neglected when designing anchors for shear.

C. Vertical seismic forces, when required, shall be presumed to act concurrently with horizontal seismic forces.

D. Batteries on racks or for generators shall have wrap around restrains to ensure that the batteries will not slide laterally. Spacers shall be used between the restraints and cases to prevent damage to the cases.

E. Electrical cabinet design shall comply with the applicable NEMA standards. Cutouts in the lower shear panel that have not been made by the manufacturer and reduce significantly the strength of the cabinet shall be specifically evaluated.

END OF SECTION

SECTION 26 05 73
UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Underground Ducts and Raceways for Electrical Systems, as indicated, in accordance with provisions of Contract Documents.

B. Definitions:
   1. Unsuitable material: Debris and/or soil material judged unsuitable by Contracting Officer Representative for support of slabs or other site improvements.
   2. Rock excavation:

C. Completely coordinate with work of other trades.

1.2 SUBMITTALS

A. Shop Drawings:
   1. Handholes.

B. Product Data:
   1. Conduit separation.

C. Project Information:
   1. Test reports.

1.3 QUALITY ASSURANCE

A. Compaction density test:
   1. Standard Proctor, ASTM D698.
   2. Contractor to pay for retests of materials failing initial tests.
   3. Notify Contracting Officer Representative at least 48 hours prior to anticipated date of testing.
   4. Contractor will pay additional cost if work is delayed due to Contractor's failure to notify Contracting Officer Representative as specified above.

B. Comply with Safety Rules & Regulations for Excavation for local jurisdiction.

1.4 JOB CONDITIONS

A. Avoid overloading. Keep surcharge sufficient distance back from edge of excavation to prevent slides or caving. Maintain and trim excavated materials in such a manner to be as little inconvenience as possible to public and adjoining property owners.

B. Provide full access to public and private premises, to fire hydrants, sidewalks, and other points to prevent serious interruption of travel.

1.5 EXTRA WORK

A. Removal and replacement of unsuitable material below design elevations will be paid for as extra work.
   1. Notify Contracting Officer in time to have Contracting Officer Representative measure and record quantity removed.
   2. Recorded quantity will be basis for payment.
   3. Include unit price on Bid Form.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Handholes:
   1. Base:
      a. Hubbell Power Systems, Inc.
      b. Or Equal

2.2 MATERIALS

A. Conduit System:
   1. Single or multiple, round bore PVC conduits direct buried, open trench.
      a. Rigid PVC conduit: As specified below.
      b. Separators: Plastic, or other non-metallic, non-decaying material.
   2. Pull wire: Heavy nylon cord, free of kinks and splices.
   3. Marker tape: 3 inches wide, .005 inches thick brightly colored plastic tape with continuous metallic backing and a .001 inches corrosion resistant metallic foil core. Tape shall be labeled ELECTRIC, TELEPHONE or SIGNAL at intervals not exceeding 10 feet.

B. Concrete Handholes:
   1. Electric and communication handholes: Types as indicated.
      a. Concrete: 4,000 psi. Conform to Division 03 requirements.
      b. Precast or poured-in-place manholes acceptable.
      c. Cover and frame: 36 inches diameter, gray cast iron, with machine finished seat for perfect joint between cover and frame.
      d. Embossed identification on cover: ELECTRIC or COMMUNICATIONS
      e. Provide floor drain with grate.
      f. Provide cable racks, ladder rungs, 2 ground rods, cable pulling iron.
   2. Cable racks: Non-metallic, mounted on wall.
      a. Equip with minimum of 8 adjustable hooks, minimum 2 spare hooks on each rack.
      b. Insulators: Best quality, high-glazed porcelain; provide for each hook.
      c. Space racks so each end of splices is supported horizontally.
   3. Ladder rungs: Galvanized, 12 x 12 inches x 3/4 inches diameter.
      a. Set with 7 inches clearance from rung to wall.
   4. Ground rods: 3/4 inches x 10 feet long, copper weld.

C. Polymer Handholes:
   1. Properties:
      a. Construction: Polymer concrete.
      b. Suitable for light vehicular traffic (5000 pound over 10 x 10 inches area).
      c. Designed and tested to temperatures of -50 degrees F.
      d. Meet the requirements ANSI/SCTE 77 Specification for Underground Enclosure Integrity
      e. Secure cover with minimum 2 hex head fastener nuts.
      f. Open bottom.
      g. Embossed identification on cover: ELECTRIC or COMMUNICATION
      h. Dimensions: See Drawings for dimensions.
      i. Provide 2 inches cover.

D. Backfill material:
   1. As approved by the Contracting Officer Representative.
   2. Free of rock, cobbles, roots, sod, organic matter, and frozen material.
   3. Moisture content at time of placement:

a. 3% plus/minus of optimum moisture content.
b. Add water to dry material, or dry wet material as required, or furnish off site material as needed.

PART 3 - EXECUTION

3.1 PREPARATION

A. Remove and dispose of materials determined to be unsuitable by the Contractor and approved by the Contracting Officer Representative.

B. Coordinate layout and installation of duct trench, handholes, and boxes with other utilities, site grading, and surface features as determined in the field. Notify Contracting Officer Representative if there is a conflict between areas of excavation and existing structures or archaeological sites to remain.

C. Coordinate elevations of trench entrances into handholes and boxes with final locations and profiles of trench, as determined by coordination with other utilities, underground obstructions, and surface features.
   1. Revise locations and elevations as required to suit field conditions and to ensure that trench duct will drain to handholes and as approved by Contracting Officer Representative.
   2. Lay conduit lines to minimum grade of 4 inches in 100 feet.
   3. Grade may be from one handhole to next, or both ways from high point between handholes, depending on contour of finished grade.

3.2 INSTALLATION

A. Excavate trenches by open cut method to depth indicated and necessary to accommodate the work.
   1. Do not excavate below indicated grades unless required to remove unsuitable material.
   2. Backfill over-excavations in firmly compacted 6 inches lifts.
   3. Keep trenches free of water.
   4. Brace and sheet trenches as soil conditions dictate. Do not remove until backfilling has progressed to a stage that no damage to conduit will result from removal.
   5. Permission may be granted for tunnel work for crossing under crosswalks, driveways, or existing utility lines.
   6. Such tunnels are limited to 10 feet in length.
   7. Coordinate crossings with other utilities.

B. Open no more than 300 linear foot of trench at one time.

C. Clean conduit before using or laying.

D. Lay no conduit in water or in unsuitable weather or trench conditions.

E. Accomplish changes in direction of runs exceeding total of 15 degrees, either vertical or horizontal, by long sweep bends with minimum radius of 25 feet.
   1. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.

F. Furnish manufactured bends at end of runs.
   1. Minimum radius of 18 inches for conduits less than 3 inches trade size and 36 inches for ducts of 3 inches trade size and larger.

G. During construction and after conduit line is completed, plug ends of conduits to prevent water washing into conduit or handholes.
   1. Keep conduits clear of concrete, dirt, and any other substance during course of construction.

H. Where it is necessary to cut tapered end on a piece of conduit at site, make cut with tool or lathe designed to cut taper to match taper of particular conduit being used.

I. Terminate conduits in end bells where duct lines enter handholes.

J. After conduit line has been completed, pull standard flexible mandrel not less than 12 inches long, with diameter approximately 1/4 inches less than inside diameter of conduit, through each conduit. Then pull brush with stiff bristles through each conduit to make certain that no particles of earth, sand, or gravel have been left in line.

K. Pneumatic rodding may be used.

L. Install pull wire in unused new ducts.
   1. Extend minimum of 3 feet into each handhole or above pads beyond ends of ducts.

M. Provide uniform spacing between conduits: Not less than 2 inches.
   1. Place separators on maximum 4 feet centers.

N. Make conduit joints in accordance with manufacturer's recommendations for conduit and coupling selected.
   1. Make conduit joints watertight.
   2. Brush plastic solvent cement on inside of plastic coupling fitting and outside of conduit ends.

O. Place marker tape above service lines, electrical feeders, and communication outside building footprint. Locate tape 12 inches below finished grade.

3.3 INSTALLATION OF HANDHOLES

A. Determine exact location of each handhole after careful consideration has been given to location of other utilities, grading, and paving.
   1. Do not begin construction until location of each handhole has been approved by Contracting Officer Representative.

B. Construct handholes of type indicated in accordance with applicable details.
   1. Mix, place and cure concrete in accordance with Division 03 requirements.

C. Set handhole frames and covers.
   1. Paint with 2 coats asphaltic paint after inspection and approval and before setting.
   2. In unpaved areas, set top of handhole covers approximately 1/2 inches above finished grade.
   3. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of manhole frame to temporarily elevate manhole cover to existing grade level.

D. Install cable racks, ladder rungs and cable pulling iron.

E. Drive 2 ground rods into earth not less than 9 feet before manhole floor is placed.
   1. Extend ground rods approximately 4 inches above floor.

F. Apply waterproofing to exterior surfaces of handholes after concrete has cured at least three days.

3.4 BACKFILLING

A. Perform field tests and verify electrical system complies with specified requirements before backfilling.

B. Hand or pneumatic tamp backfill around and over pipe in lifts not exceeding 8 inches loose thickness.

C. Backfill carefully to avoid displacing pipe joints either horizontally or vertically and to avoid breaking pipe.

D. Do not water flush for consolidation.

3.5 COMPACTION

A. Compact trench backfill in areas under paved roads, parking areas, sidewalks and other structures as directed by Contracting Officer Representative to at least 95% of maximum dry density.

B. In locations where trench will not be under paved areas, compact backfill to minimum 90% of maximum dry density.

C. Remove materials which cannot be compacted as specified.

D. Replace with suitable material and compact.

3.6 FIELD QUALITY CONTROL

A. Perform backfill density tests as directed by Contracting Officer Representative.
   1. Allow for one test per 100 feet of trench.

END OF SECTION

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SECTION 26 08 13
ACCEPTANCE TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for acceptance testing.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.
      b. 400.3, Guide for Partial Discharge Testing of Power Cable Systems in a Field Environment.
   2. InterNational Electrical Testing Association (NETA):
      a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.
   3. Nationally Recognized Testing Laboratory (NRTL).
   4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 455-78-B, Optical Fibres - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:
   1. Testing firm:
      a. An independent firm performing, as the sole or principal part of its business for a minimum of 10 years, the inspection, testing, calibration, and adjusting of systems.
      b. Must have an established monitoring and testing equipment calibration program with accuracy traceable in an unbroken chain, according to NIST.
   2. Field personnel:
      a. Minimum of one year field experience covering all phases of electrical equipment inspection, testing, and calibration.
      b. Relay test technician having previous experience with testing and calibration of relays of the same manufacturer and type used on project and proficient in setting and testing the types of protection elements used.
      c. Supervisor certified by NETA or NICET.
         1) As an alternative, supervising technician may be certified by the equipment manufacturer
   3. Analysis personnel:
      a. Minimum three years combined field testing and data analysis experience.
      b. Supervisor certified by NETA or NICET.
         1) As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:
   1. Coordinate with Utility Company and NPS staff for phase rotations and Phase A, B and C markings.
      a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Equipment Monitoring and Testing Plan.

B. Informational Submittals:
   1. Prior to energizing equipment:
      a. Coordinated phasing diagram.
      b. Photocopies of continuity tests.
   2. Within two weeks after successful completion of Demonstration Period (Commissioning Period):
      a. Single report containing information including:
         1) Summary of Project.
         2) Information from pre-energization testing.
         3) Testing and monitoring reports.

PART 2 - PRODUCTS

2.1 FACTORY QUALITY CONTROL

A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of specified field acceptance testing requirements.

PART 3 - EXECUTION

3.1 FIELD QUALITY CONTROL

A. General:
   1. Complete electrical testing in three phases:
      a. Pre-energization testing phase.
      b. Equipment energized with no load.
      c. Equipment energized under load.
   2. Perform testing in accordance with this Specification Section and NETA ATS.
   3. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.
   4. Equip testing and analysis personnel with all appropriate project related reference material required to perform tests, analyze results, and provide documentation including, but not limited to:
      a. Contract Drawings and Specifications.
      b. Related construction change documentation.
      c. Approved Shop Drawings.
      d. Approved Operation and Maintenance Manuals.
      e. Other pertinent information as required.

B. Equipment Monitoring and Testing Plan:
   1. Approved in accordance with Shop Drawing submittal schedule.
   2. Included as a minimum:
      a. Qualifications of firm, field personnel, and analysis personnel doing the Work.
      b. List and description of testing and analysis equipment to be utilized.
      c. List of all equipment to be testing, including:
         1) Name and tag numbers identified in the Contract Documents.
         2) Manufacturer’s serial numbers.
         3) Other pertinent manufacturer identification,

C. Instruments Used in Equipment and Connections Quality Control Testing:
   1. Minimum calibration frequency:

a. Field analog instruments: Not more than 6 months.
b. Field digital instruments: Not more than 12 months.
c. Laboratory instruments: Not more than 12 months.
d. If instrument manufacturer's calibration requirements are more stringent, those requirements shall govern.

2. Carry current calibration status and labels on all testing instruments.
3. See individual testing programs for additional instrumentation compliance requirements.

D. Testing and Monitoring Program Documentation:
1. Provide reports with tabbed sections for each piece of equipment tested.
2. Include all testing results associated with each piece of equipment under that equipment's tabbed section.
a. Include legible copies of all forms used to record field test information.
3. Prior to start of testing, submit one copy of preliminary report format for Contracting Officer review and comment
a. Include data gathering and sample test report forms that will be utilized.
4. In the final report, include as a minimum, the following information for all equipment tested:
a. Equipment identification, including:
1) Name and tag numbers identified in the Contract Documents.
2) Manufacturer's serial numbers.
3) Other pertinent manufacturer identification,
b. Date and time of each test.
c. Ambient conditions including temperature, humidity, and precipitation.
d. Visual inspection report.
e. Description of test and referenced standards, if any, followed while conducting tests.
f. Results of initial and all retesting.
g. Acceptance criteria.
h. "As found" and "as left" conditions.
i. Corrective action, if required, taken to meet acceptance.
j. Verification of corrective action signed by the Contractor, equipment supplier, and Contracting Officer Representative.
k. Instrument calibration dates of all instruments used in testing.
5. Provide three (3) bound final reports prior to Project final completion.

E. Electrical Equipment and Connections Testing Program:
1. See individual Division 26 Specification Sections for equipment specific testing requirements.
2. Test all electrical equipment.
a. Perform all required NETA testing.
b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.

3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS

A. Switchboards:
1. Perform inspections and tests per NETA ATS 7.1.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

B. Transformers - Small Dry Type:
1. Perform inspections and tests per NETA ATS 7.2.1.1.
2. Perform the following additional tests:
a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
3. Adjust tap connections as required to provide secondary voltage within 2-1/2% of nominal under normal load after approval of Contracting Officer.
4. Record as-left tap connections.

C. Transformers - Large Dry Type:
   1. Perform inspections and tests per NETA ATS 7.2.1.2.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following additional tests:
      a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
   4. Adjust tap connections as required to provide secondary voltage within 2-1/2% of nominal under normal load.
   5. Record as-left tap connections.

D. Transformers - Liquid Filled:
   1. Perform inspections and tests per NETA ATS 7.2.2.
   2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
   3. Perform the following additional tests:
      a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
   4. Adjust tap changer setting as required to provide secondary voltage within 2-1/2% of nominal under normal load after approval of Contracting Officer.
   5. Record as-left tap changer setting.

E. Cable - Low Voltage:
   1. Perform inspections and tests per NETA ATS 7.3.2.
   2. DC High Potential test for all 480V power circuits.
   3. Submit results as an informational submittal.

F. Cable - Medium Voltage:
   1. Perform inspections and tests per NETA ATS 7.3.3.
   2. Perform Dielectric Withstand Test.
   3. Perform tan delta or partial discharge Baseline Diagnostic Tests.
   4. Prior to energization, perform a very low frequency (VLF) test following IEEE 400.2 Guide for Field Testing of Shielded Power Cable systems for baseline data for future VLF maintenance testing:
      a. VLF testing shall include:
         1) Withstand test to evaluate whether the cable can handle the test voltage (See IEEE 400.2 Table 3).
         2) Tangent delta test, including differential tangent delta and tangent delta stability, for baseline comparison:
         3) VLF testing shall be completed by technicians trained to use testing equipment with at least three years of experience in performing VLF testing on medium voltage cables.
      b. Results for new cable shall be compared to Table G.2 in IEEE 400.2.
         1) Discrepancies between field test results and Table G.2 shall be notated and discussed with testing equipment manufacturer to determine validity of results.
   5. Shield continuity test.
   6. Cable test report(s) shall include the following at minimum
      a. Summary of Project.
      b. Date tests were performed.
      c. Description of equipment/components tested.
      d. Visual inspection report.
      e. Description of tests.
      f. Test results, including appropriate test forms.
      g. Conclusions and recommendations for corrective action as appropriate.
      h. Identification of test equipment used.
      i. Identificatation of company and person that performed the tests.
      j. Reports signed by the engineering technician or engineer interpreting the data.

7. Non-destructive partial discharge (PD) test:
    a. After energization, perform a partial discharge test for baseline data for future partial discharge maintenance testing.
    b. Perform the work while the medium voltage circuits and equipment are energized.
        1) The cables shall not be disconnected or de-energized and the testing shall not expose the cables to voltages that exceed normal operating voltage.
    c. Use a frequency domain detection process incorporating a spectrum analyzer with radio frequency current transformer (RF CT) sensors.
        1) The detection system, including spectrum analyzer, RF CT's and interconnecting cable, shall have a partial discharge detection range that at least covers the frequency range of 10 kHz to 300 MHz.
        2) Testing shall be performed in a manner that complies with the requirements of IEEE 400 and IEEE 400.3.

G. Cable - Optical Fiber:
1. Perform inspections on tests per TIA/EIA/ANSI 455-78-B, including:
    a. Optical time domain reflectometer test.
    b. Power attenuation test.
    c. Gain margin test.

H. Transfer Switch:
1. Perform applicable inspections and test per:
    a. NETA ATS for Transfer Switches.
    b. Manufacturer's instructions.

I. Low Voltage Power Circuit Breakers:
1. Perform inspections and tests per NETA ATS 7.6.1.2.
    a. Tests shall include primary current injection testing of all breakers at final settings.
    b. Where short-time or instantaneous settings on large frame breakers are beyond the current capability of field testing, primary injection tests at reduced currents shall be permitted if combined with secondary injection calibration test of trip unit at final settings.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
    a. Shunt trip devices minimum tripping voltage.
4. Record as-left settings.

J. Low Voltage Molded Case Circuit Breakers:
1. Perform inspections and tests per NETA ATS 7.6.1.1.
2. Components:
    a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.
    b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.
    c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.
3. Record as-left settings.

K. Metering:
1. Perform inspections and tests per NETA ATS 7.11.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

L. Grounding:
1. Perform inspections and tests per NETA ATS 7.13.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

M. Ground Fault Protection:

1. Perform inspections and tests per NETA ATS 7.14.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
    a. Control wiring insulation resistance.
4. Perform the following additional tests for four-wire systems:
    a. Primary current injection into switchgear bus with test set configured to simulate transformer source and high current jumper used to simulate unbalanced load and ground fault conditions.
    b. Verify no tripping for unbalanced load on each feeder and each main breaker.
    c. Verify no tripping for unbalanced load across tie breaker for dual-source schemes.
    d. Verify tripping for ground fault on load side of feeder each feeder and on each main bus.
    e. Verify tripping for ground fault on a single feeder and on each main bus through tie breaker(s) for multiple-source schemes.

N. Motors:
1. Perform inspections and tests per NETA ATS 7.15.

O. Motor Controllers:
1. Perform inspections and tests per NETA ATS 7.16.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

END OF SECTION

SECTION 26 09 13
ELECTRICAL METERING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Digital metering equipment.

B. Related Sections include but are not necessarily limited to:
   1. Section 26 05 00 – Common Work Results for Electrical.
   2. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   2. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. C12.20, For Electricity Meter - 0.2 and 0.5 Accuracy Classes.
   3. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout drawings.
      a. Electrical wiring/connection diagrams.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
      b. Content of Operation and Maintenance Manual:
         1) Data sheet of the meters electrical parameters, configuration and characteristics including a complete model number and associated equipment connected too.
         2) Operating instructions of the meter(s) supplied.
         3) Operating instructions of the Power Management software.
         4) Maintenance instructions.
         5) As-constructed electrical wiring/connection diagrams.
         6) Acceptance testing data.

C. Refer to Section 01 81 33 – Cyber Security Requirements for required cyber security related submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Siemens.
   2. Or Equal

2.2 DIGITAL METERING DEVICES

A. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.

B. General:
   1. Direct reading metered or calculated values.
   2. Microprocessor based.
   3. Integral LED or LCD display.
   4. Current and potential transformers as required.
   5. Integral fusing.
   6. Operating temperature: 0 degrees F to 150 degrees F.
   7. Standards:
      a. NEMA/ANSI C12.20.
      b. UL 508.

C. Type 'C' High Range Meter:
   1. Display the following minimum electrical parameters (accuracy):
      a. RMS current per phase (+0.2% full scale).
      b. RMS voltage line-to-line and line-to-neutral (+0.2% full scale).
      c. Real power (W): 3 PH total (+0.4% full scale).
      d. Apparent power (VA): 3 PH total (+0.4% full scale).
      e. Reactive power (VAR): 3 PH total (+0.4% full scale).
      f. Power factor (+1.0%).
      g. Frequency (+0.04%).
      h. Percent current individual harmonic and total harmonic distortion (50th).
      i. Percent voltage individual harmonic and total harmonic distortion (50th).
      j. Watt-hours (0.5%).
      k. VAR-hours (1.0%).
      l. VA-hours (0.5%).
      m. Ampere demand (+0.2% full scale).
      n. Watt demand (+0.4% full scale).
      o. VAR demand (+0.4% full scale).
      p. VA demand (+0.4% full scale).
   2. Data logging:
      a. 128 KB.
      b. Selectable for parameters listed above for display.
      c. Software for configuration, retrieval, and trending.
   3. NEMA/ANSI C12.20, Class 0.2 revenue accuracy.
   4. Communication ports and protocols: Ethernet TCP/IP.
   5. Supply voltage: 120 VAC.

2.3 ACCESSORIES

A. Operator Interface Personal Computer:
   1. Computer to be industry standard office type with the following minimum features:
      a. Processor: Intel or clone.
      b. USB ports.
      c. Hard drive.
      d. CD/DVD drive.

e. Keyboard.
f. Mouse.
g. 17 inches LCD Monitor:
h. Operating System: Microsoft Windows.
i. Compatible with the Power Management and Control Software.

B. Printer:
1. Color ink jet office type.
2. Letter size paper.
3. 250 sheet input tray.
4. Duplex printing.
5. Connectivity: USB and Ethernet.

C. Power Management and Control Software:
1. Manufacturer's standard, see Part 3 for minimum functionality.

2.4 MAINTENANCE MATERIALS

A. One set of replacement printer ink cartridges.

B. One eam (500 sheets) printer paper.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.
1. Provide all equipment including CTs and PTs as necessary to provide a complete and functioning system.
2. Coordinate with Contracting Officer on final computer screen layouts, trending requirements and printouts.

B. Meter Type Application:
1. Type C meters: Integral to equipment as indicated on the Drawings.

C. Current transformers shall be connected to shorting type terminal blocks.

D. Potential transformers shall have primary and secondary fuses with a disconnecting means.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Section 26 08 13.

3.3 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide 8 hours of on-site training in the operation and maintenance of the metering system and its components.

B. See Section 01 79 00 for Operator training requirements.

3.4 CLOSEOUT ACTIVITIES

A. Refer to Section 01 81 33 – Cyber-Security Requirements for cyber security related closeout requirements.

B. Provide field training at each project site
1. North Rim Temporary Wastewater Treatment Plant

END OF SECTION

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SECTION 26 09 16
CONTROL EQUIPMENT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Operator control devices (selector switches, pushbuttons, indicator lights, etc.).
   2. Control devices (timers, relays, contactors, etc.).
   3. Industrial Control Panels.
   4. Operator Control Stations.

B. Related Sections include but are not necessarily limited to:
   1. Section 01 81 33 – Cyber Security Requirements.
   2. Section 26 05 00 - Common Work Results for Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and System Controllers, Contactors and Overload Relays Rated 600 Volts.
      c. ICS 5, Control Circuit and Pilot Devices.
   2. Underwriters Laboratories, Inc. (UL):
      a. 508, Standard for Safety Industrial Control Equipment.
      b. 508A, Standard for Industrial Control Panels.
      c. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.

1.3 SYSTEM DESCRIPTION

A. This Specification specifies components used within other equipment as referenced in other technical specifications.

B. This Specification is used to specify the components and construction of Operator Control Stations as shown in the Drawings.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
         1) When components are used within equipment specified in another Section, submittal data for components specified herein shall be included with the submittal for the equipment the components are used in.
      b. Industrial Control Panel bill of material.
      c. Control Station bill of material.
      d. See Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout drawings.
      a. Industrial Control Panel:
         1) Interior and exterior layout.
         2) Wiring/connection diagrams.
         3) Copy of the UL 508A label.
         4) Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations.
      b. Operator Control Station:

1) Interior (if applicable) and exterior layout.
2) Wiring/connection diagrams.

c. Associate Industrial Control Panel and Operator Control Stations with associated equipment name and tagging.

B. Informational Submittals:
1. Functional Test Plan.

C. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
b. Content of Operation and Maintenance Manual:
1) Product technical data of components used within Operator Control Stations.
2) As-constructed wiring/connection diagrams for Operator Control Stations.
3) Operating instructions for adjustable and programmable devices.
4) Functional Test Report.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pilot devices, relays, contactors, and termination equipment:
a. Eaton.
b. Or Equal.
2. Alarm devices:
a. Edwards Signaling by United Technologies Corp.
b. Or Equal.
3. Enclosures:
a. B-Line by Eaton.
b. Or Equal.

C. Submit request for substitution in accordance with Section 01 33 23.

2.2 PILOT DEVICES

A. General Requirements:
1. Standards: NEMA ICS 5, UL 508.
2. Heavy-duty NEMA 4/13 watertight/oiltight.
3. Heavy-duty NEMA 4/4X corrosion resistant.
4. Heavy-duty factory sealed, explosion-proof and dust ignition-proof (Class I and II).
5. Mounting hole: 30.5 mm.
6. Contact blocks: 10 amp, NEMA A600 rated, number as required to fulfill functions shown or specified.
7. Legend plate marked as indicated on Drawings or specified.

B. Selector Switches:
1. Two, three- or four-position rotary switch as required to fulfill functions shown or specified.
2. Maintained contact type.

3. Knob or lever type operators.

C. Pushbuttons:
1. Non-illuminated type:
a. Protective boot.
b. Momentary contact.
c. Standard flush and mushroom operators.
d. Green colored buttons for START or ON and red color for STOP or OFF.
e. Emergency stop pushbuttons: Mushroom head operator and maintained contact.
2. Illuminating type:
a. Protective boot.
b. Momentary contact.
c. Standard flush operator.
d. Serves as both pushbutton control and indicating light.
e. Green colored lenses: START or ON.
f. Red colored lenses: STOP or OFF.
g. Resistor-type full voltage light unit with lens and panel gasket.

D. Indicating Lights:
1. Allowing replacement of bulb without removal from control panel.
2. Lamp: LED, 120 V or 24 V as required.
3. Full voltage type.
4. Push-to-test indicating lights.
5. Plastic lens.
6. Color code lights as follows:
a. Green: ON or running; valve open.
b. Amber: Standby; auto mode; ready.
c. Red: OFF or stopped; valve closed.

2.3 RELAYS

A. General Requirements:
1. Standards: NEMA ICS 5, UL 508.

B. Control Relays:
1. General purpose (ice cube) type:
a. Plug-in housing.
b. Clear polycarbonate dust cover with clip fastener.
c. Coil voltage: 120 VAC or as required.
d. Contacts:
1) 10 amp continuous.
2) Silver cadmium oxide.
3) Minimum of 3 SPDT contacts.
e. Sockets: DIN rail mounted.
f. Internal neon or LED indicator is lit when coil is energized.
g. Manual operator switch.
2. Industrial type:
a. Coil voltage: 120 VAC or as required.
b. Contacts:
1) 10 amp, NEMA A600 rated.
2) Double break, silver alloy.
3) Convertible from normally open to normally closed or vice versa, without removing any wiring.
4) Expandable from 2 poles to 12 poles.
c. Provide contacts for all required control plus two spares.

C. Time Delay Relays:
1. General purpose type:

a. Timing modes: On and Off delay, interval, one shot and repeat cycle.
b. Plug-in housing.
c. Polycarbonate dust cover with clip fastener.
d. Coil voltage: 120 VAC or as required.
e. Contacts:
1) 10 amp continuous.
2) Silver cadmium oxide.
3) Two normally open and two normally closed DPDT contacts.
f. Sockets: DIN rail mounted.
g. External timing adjustment knob.
h. Timing ranges: 0.05 seconds to 16.65 hours.
i. Repeat accuracy: +1%.

2. Solid State industrial type:
a. Timing modes: On and Off delay and repeat cycle.
b. Industrial housing.
c. Coil voltage: 120 VAC or as required.
d. Contacts:
1) 5 amp, NEMA B150 rated.
2) Silver alloy.
3) Convertible On Delay and Off Delay contacts.
4) One normally open and one normally closed timed contacts.
5) One normally open and one normally closed instantaneous contacts.
e. Furnish with "on" and "timing out" indicators.
f. External timing adjustment knob.
g. Timing ranges: 0.05 seconds to 10 hours.
h. Repeat accuracy: +1%.

3. Mechanical industrial type:
a. Timing modes: On and Off delay.
b. Coil voltage: 120 VAC or as required.
c. Contacts:
1) 10 amp, NEMA A600 rated.
2) Double break, silver alloy.
3) Convertible On Delay and Off Delay contacts.
4) Convertible normally open and normally closed timed contacts.
5) Convertible normally open instantaneous contacts.
d. External timing adjustment knob.
e. Timing ranges: 0.2 - 60 seconds or 5 - 180 seconds.
f. Repeat accuracy: Greater than +10%.

2.4 CONTACTORS

A. General Requirements:
1. Standards: NEMA ICS 2, UL 508.

B. Lighting and Remote Control Switches:
1. See Section 26 09 43 for requirements for lighting and remote control contactor switches.

C. Definite Purpose:
1. Coil voltage: 120 VAC or as required.
2. Contacts: Totally enclosed, double-break silver-cadmium-oxide.
3. Resistive load and horsepower rated.
4. Number of poles, continuous ampere rating and voltage, as indicated on Drawings or as specified.
5. Auxiliary contacts, as indicated on Drawings or as specified.

2.5 ALARM DEVICES

A. Alarm Horns:

1. Vibrating horn type.
2. PLC compatible as required.
3. Heavy-duty die cast housing with corrosion resistant finish.
4. Adjustable volume: 78 to 103 dB at 10 feet.
5. Voltage: 120 VAC or as required.
6. Enclosures/mountings:
    a. Flush wall or panel mounting in dry areas.
    b. NEMA 4X panel mounting in wet areas.
    c. Surface mounting in dry areas.
    d. NEMA 4X surface mounting in wet areas.
    e. NEMA 4X, hazardous location surface mounting in wet and hazardous areas.
        1) Fixed volume: 97 dB at 10 feet.

B. Alarm Lights:
1. Panel mounted:
    a. Strobe type.
    b. Shatter resistant polycarbonate lens and base.
    c. Lens color as indicated on Drawings.
    d. NEMA 4X enclosure.
    e. PLC compatible.
    f. Voltage: 120 VAC.
2. Wall mounted:
    a. Heavy-duty strobe type.
    b. Weatherproof shatter resistant polycarbonate lens and cast base.
    c. Optically designed fresnel lens with color as indicated on Drawings.
    d. Immune to shock and vibration, no moving parts.
    e. Xenon flash tube providing a minimum of 65 single flashes per minute.
    f. Mounting: Wall or corner wall brackets.
3. Hazardous and corrosive locations:
    a. Heavy-duty strobe type.
    b. Weatherproof and rated for the indicated hazardous location.
    c. Body: Zinc plated cast iron or cast copper free aluminum and/or coated with 20 mils of PVC.
    d. High impact glass dome with guard.
    e. Shatter resistant polycarbonate lens with color as indicated on Drawings.
    f. Immune to shock and vibration, no moving parts.
    g. Xenon flash tube providing a minimum of 65 single flashes per minute.
    h. Mounting: Wall bracket or pendant.

2.6 MISCELLANEOUS DEVICES

A. Run Time Meters:
1. Six-digit wheels including a 1/10 digit.
2. Non-reset type.
3. Time range in hours.
4. Automatic recycle at zero.
5. Accuracy: 1%.
6. Sealed against dirt and moisture.
7. Tamperproof.

B. Control Power Transformer:
1. Primary voltage: 480 V.
2. Secondary voltage: 120 V.
3. Sized for 125% of required load.
4. Fused on primary and secondary.
5. Standard: NEMA ST 1.

C. DeviceNet Interface Module:

1. Connects discrete input and output devices to a DeviceNet network.
2. Inputs:
    a. Quantity: 4.
    b. Ratings: 120 VAC.
    c. Automatic reset of faulted input.
3. Outputs:
    a. Quantity: 2.
    b. Ratings: Relay, 240 VAC, 5 A.
4. Communications:
    a. ODVA Certified.
    b. Autobaud detection.
    c. Faulted node recovery.
    d. Change-of-state messaging.
    e. Individual LED status indicatin for both inputs and outputs.
5. Manufacturer: Allen-Bradley Bulletin 100 DeviceNet System Accessory (DSA).

D. Actuator Sensor Interface (ASi):
1. Connects discrete input and output devices to a Profibus DP interface module.
2. Inputs:
    a. Quantity: 4.
    b. Ratings: 120 VAC.
    c. Automatic reset of faulted input.
3. Outputs:
    a. Quantity: 4.
    b. Ratings: Relay, 240 VAC, 5 A.
4. Manufacturer: Siemens SlimLine S45.
5. Profibus DP interface module: Siemens DP/AS-Interface Link 20 or 20E.

2.7 TERMINATION EQUIPMENT

A. General Requirements:
1. Modular type with screw compression clamp.
2. Screws: Stainless steel.
3. Current bar: Nickel-plated copper alloy.
4. Thermoplastic insulation rated for -40 to +90 degrees C.
5. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
6. End sections and end stops at each end of terminal strip.
7. Machine-printed terminal markers on both sides of block.
8. Spacing: 6 mm.
9. Wire size: 22-12 AWG.
10. Rated voltage: 600 V.
11. DIN rail mounting.

B. Standard-Type Block:
1. Rated current: 30 A.
2. Color: Gray body.

C. Bladed-Type Disconnect Block:
1. Terminal block with knife blade disconnect which connects or isolated the two sides of the block.
2. Rated current: 10 A.
3. Color:
    a. Panel control voltage leaves enclosure - normal: Gray body, orange switch.
    b. Foreign voltage entering enclosure: Orange body, orange switch.

D. Grounded-Type Block:
1. Electrically grounded to mounting rail.
2. Terminal ground wires and analog cable shields.

3. Color: Green and yellow body.

E. Fuse Holders:
1. Blocks can be ganged for multi-pole operation.
2. Spacing: 9.1 mm.
3. Wire size: 30-12 AWG.
4. Rated voltage: 300 V.
5. Rated current: 12 A.
6. Fuse size: 1/4 x 1-1/4.
7. Blown fuse indication.
8. DIN rail mounting.

2.8 ENCLOSURES

A. Industrial Control Panels:
1. NEMA 4 rated:
   a. Seams continuously welded and ground smooth.
   b. No knockouts.
   c. External mounting flanges.
   d. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
   e. Cover with oil resistant gasket.
2. NEMA 4X rated:
   a. Body and cover: 14 GA Type 304 or 316 stainless steel.
   b. Seams continuously welded and ground smooth.
   c. No knockouts.
   d. External mounting flanges.
   e. Hinged door and stainless steel screws and clamps.
   f. Door with oil-resistant gasket.
3. NEMA 7 and 9 rated:
   a. Cast gray iron alloy or copper-free aluminum.
   b. Drilled and tapped openings or tapered threaded hub.
   c. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
   d. External mounting flanges.
   e. Grounding lug.
   f. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
4. NEMA 12 enclosure:
   a. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
   b. No knockouts.
   c. External mounting flanges.
   d. Non-hinged stainless steel cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
   e. Flat door with oil resistant gasket.
5. Control panel miscellaneous accessories:
   a. Back plane mounting panels: Steel with white enamel finish or Type 304 stainless steel.
   b. Interiors shall be white or light gray in color.
   c. Wire management duct:
      1) Bodies: PVC with side holes.
      2) Cover: PVC snap-on.
      3) Size as required.
   d. Rigid handles for covers larger than 9 square feet or heavier than 25 pounds.
   e. Split covers when heavier than 25 pounds.
   f. Floor stand kits made of same material as the enclosure.
   g. Weldnuts for mounting optional panels and terminal kits.
   h. Ground bonding jumper from door, across hinge, to enclosure body.
6. Standards: NEMA 250, UL 508.

B. Operator Control Stations:
   1. NEMA 4/13 rated:
      a. Die cast aluminum body with manufacturer's standard finish.
      b. Gasketed die cast aluminum cover with manufacturer's standard finish.
      c. Number of device mounting holes as required.
   2. NEMA 4X rated:
      a. Type 304 or 316 stainless steel body.
      b. Gasketed Type 304 or 316 stainless steel cover.
      c. Number of device mounting holes as required.
   3. NEMA 7 and 9 rated:
      a. Zinc plated cast iron or die-cast copper free aluminum, with threaded hubs, grounding screw and with manufacturer's standard finish.
      b. "EDS" or "EFS" style.
      c. Single or multiple gang or tandem.
      d. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.

2.9 FABRICATION

A. Supplier of Industrial Control Panels shall build control panel under the provisions of UL 508A or UL 698A.
   1. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
   2. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
      a. Determine the SCCR rating by one of the following methods:
         1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
         2) Method 2: SCCR rating meets or exceeds the source equipment’s Amp Interrupting Current (AIC) rating as indicated on the Drawings.
         3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
      b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
   3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

2.10 MAINTENANCE MATERIALS

A. Provide 100% replacement lamps for indicating lights.

B. Provide 10% replacement caps for indicating lights.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Operator Control Stations:
   1. Permitted uses of NEMA 4X enclosure:
      a. Surface mounted in all areas.

3.2 FIELD QUALITY CONTROL

A. See Section 26 05 00.

B. Operator Control Station Functional Test:
   1. The test is to prove the correct interaction of all sensing, processing and action devices.
   2. Develop a test plan and parameters for the purpose of evaluating the performance of the system.

a. Plan shall have witness signature lines for the contractor and Contracting Officer Representative and submitted when system pass the test.

3. Perform the following tests:
   a. Verify functionality of all control states.
   b. Verify the correct operation of all interlock safety devices for fail-safe functions
   c. Verify the correct operation of all sensing devices, alarms and indicating devices.

3.3 CLOSEOUT ACTIVITIES

A. Refer to Section 01 81 33 – Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

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SECTION 26 12 19
DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Distribution pad-mounted transformers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. FM Global (FM).
   3. Institute of Electronic and Electronics Engineers, Inc. (IEEE):
      a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
      b. C57.12.00, Standard General Requirements for Liquid-Immersed Distribution, Power, and Regulating Transformers.
      c. C57.12.28, Standard for Pad-Mounted Equipment - Enclosure Integrity.
      d. C57.12.34, Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers (2500 kVa and Smaller) - High-Voltage: 34 500 GrdY/19 920 Volts and Below; Low-Voltage: 480 Volts and Below.
      e. C57.12.70, Standard for Standard Terminal Markings and Connections for Distribution and Power Transformers.
      f. C57.12.80, Standard Terminology for Power and Distribution Transformers.
      g. C57.12.90, Standard Test Code for Liquid-Immersed Distribution, Power, and Regulating Transformers.
      h. C62.11, Standard for Metal-Oxide Surge Arresters for Alternating Current Power Circuits (>1 kV).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).

1.3 DEFINITIONS

1. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR)

1.4 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products including subcomponents specified in PART 2 of this Specification Section.
      b. See Specification Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout Drawings.
      a. Outline Drawing including dimensions, weight and identification of all components and features.
      b. Nameplate Drawing.
      c. Weights, center of gravity, lifting points.

d. Enclosure paint color chart for Contracting Officer selection of final exterior color.

3. Certifications:
   a. Letter stating compliance with current Department of Energy efficiency requirements.

C. Contract Closeout Information:
1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   b. Content of Operation and Maintenance Manual:
      1) Instruction and maintenance manual.
      2) Product technical data provided in the submittal.
      3) Outline drawing updated for as-built conditions.
      4) Nameplate Drawing updated for as-built conditions.
      5) Actual impedance data.
      6) Factory test report.
      7) Acceptance testing report.

D. Informational Submittals:
1. Factory test report.

1.5 DELIVERY, STORAGE, AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Contractor to confirm all equipment is rated for installed elevation and provide final equipment ratings for review. Proposed equipment shall be compatible with existing equipment interface.

C. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Eaton.
2. Or Equal.

2.2 THREE-PHASE TRANSFORMER

A. General:
1. Transformer to be designed and constructed in accordance with:
   a. IEEE C57.12.00, IEEE C57.12.28, IEEE C57.12.34, IEEE C57.12.70, IEEE C57.12.80.
   b. FM Global approved.

B. Ratings and Configurations:
1. Type: Outdoor, pad-mounted, liquid-immersed, self-cooled, compartmental type.
2. Operation and application: Step-down operation.
3. Configuration:
   a. Dead-front, loop-feed primary.
4. Voltage and kVA Ratings: As specified on the Drawings.
5. Number of phases: Three (3).
6. Frequency: 60 Hz.
7. Polarity: ANSI standard.

8. Percent impedance: ANSI standard.
9. Basic impulse level (BIL):
    a. BIL voltage ratings shown are for equipment installations at 9000 Feet. Contractor to confirm final elevation height and provide final BIL equipment ratings for review.
    b. Equipment cable termination bushings to be compatible with existing cable termination BIL ratings.
    c. 25kV Medium Voltage
        1) Primary: 150 kV.
        2) Secondary: 30kV.
10. Temperature rise: 65 degrees C.
11. Efficiency: Meet all current Department of Energy rules.
12. Sound Rating: Per NEMA TP 1.
13. Transformers size and BIL ratings meet IEEE recommendations for operational altitudes at and above 8,000 feet.
14. Connections:
    a. Delta or Wye: As indicated on the Drawings.
    b. Primary: 200 ampere bushing wells and insert for loadbreak elbows.
    c. Secondary (480/277V):
        1) Less than 500 kVA: Four-hole, tin plated, spade-type minimum or as required.
        2) 750 - 1500 kVA: Six-hole, tin plated, spade-type minimum or as required.
        3) Molded case circuit breaker, ratings as indicated on the Drawings.
        4) Removable ground strap on neutral terminal.
15. Tap-changer: De-energized type on H-winding, five total with:
    a. Two 2.5% above and two 2.5% below nominal tap.
16. Sectionalizing oil immersed load break primary switch:
    a. Rating: 200A.
    b. Four position, 'T' blade, with the switch positions labeled:
        1) "SOURCE A" (Loop is open and the coil is energized by Source A).
        2) "SOURCE B" (Loop is open and the coil is energized by Source B).
        3) "SOURCE A & B" (Loop is closed and the coil is energized by both sources).
        4) "LOOP CLOSED & XFMR OPEN" (Loop is closed and the coil is de-energized).

C. Components:
1. Core and Coil:
    a. Coil material: Aluminum or copper.
    b. Windings designed to reduce losses.
    c. Insulating materials rated for 120 degrees C class.
    d. For grounded wye to grounded wye application, the core assembly shall be a 5-legged distributed-gap, wound core.
        1) For ratings above 2500 kVA, a stacked core design may be utilized.
    e. Core material: High-grade, grain-oriented, non-aging silicon core steel with high magnetic permeability, low hysteresis and eddy current losses.
        1) Magnetic flux densities are to be kept well below saturation to allow for a minimum 10% overvoltage excitation.
        2) Properly annealed to reduce stresses induced during the manufacturing processes and reduce core losses.
    f. Core frame:
        1) Designed to provide maximum support for the core and coil assembly.
        2) Welded or bolted to ensure maximum short-circuit strength.
    g. Designed and manufactured to meet the short circuit requirements of ANSI C57.12.90.
    h. Vacuum processed and energized or baked in an oven prior to tanking to set the epoxy coating on the insulating paper and remove moisture from the insulation prior to vacuum filing.
2. Tank and Terminal Cabinet Enclosure:
    a. Carbon steel reinforced with external, internal or sidewall braces, with all seams and joints continuously welded.

b. Design the tank and attached components to withstand pressures greater than the required operating design value without permanent deformation.
c. Sealed-tank construction:
    1) 1000kVA and below: Bolted main tank cover.
    2) 1500kVA and above: Welded main cover and bolted tamper-resistant handhole.
d. Lifting lugs welded to tank.
    1) Lugs shall have manufacturer-drilled holes or other means for secure connection of bolted shackles for use in transport by helicopter.
e. Steel divider between high-voltage (left side) and low-voltage (right side) compartments.
f. No exposed screws, bolts, or other fastening devices that are externally removable.
g. Tamper resistant per IEEE C57.12.28.
h. Cabinet depth: IEEE standard or 20 inches minimum.
i. 1 inches upper fill plug.
j. 1 inches drain valve with sampling device mounted in an enclosure outside of the main terminal cabinet.
k. Automatic pressure relief device.
l. Ground pad(s):
    1) 500kVA and below: Two steel pads with one hole.
    2) Above 500kVA: Two stainless steel pads with two holes.
m. Door:
    1) Each compartment will have removable, three-point latching hinged doors equipped for latching in the open position.
    2) The high-voltage compartment door will have a fastening device that is accessible only through the low-voltage compartment.
    3) The hinge assemblies made of corrosion-resistant material.
        a) Provide stainless-steel hinge pins of 3/8 inches minimum diameter.
    4) Both compartment doors capable of securing with a single padlock having a maximum 1/2 inches diameter shackle.
    5) Door secured with a hex-head bolt.
    6) Provisions for mounting fault indicator.

3. Overcurrent protection:
    a. Less than 750kVA
        1) Internal partial-range current limiting backup fuse.
        2) Provide full range protection two fuse system.
        3) Partial-range current limiting backup fuse.
            a) Interrupting rating: 50,000A.
            b) Under oil, non-field replaceable.
        4) Current sensing, expulsion-type, Bay-O-Net fuse.
            a) Under oil, field-replaceable
    b. 750kVA or larger
        1) 38kV Bay-O-Net
            a) Under oil, field-replaceable
        2) Provide full range protection two fuse system.
        3) Partial-range current limiting backup fuse.
            a) Interrupting rating: 50,000A.
            b) Under oil, non-field replaceable.
        4) Current sensing, expulsion-type, 38kV Bay-O-Net fuse.
            a) Under oil, field-replaceable
4. Finish:
    a. Manufacturer's standard corrosion protection system in accordance with IEEE C57.12.28.
    b. Dark "padmount" green, or other color as selected by the Contracting Officer.
5. Dielectric Fluid:
    a. Tested for compatibility with the transformer.

b. Less-flammable, natural or synthetic ester, biodegradable per US EPA OPPTS 835.3100 and certified to comply with US EPA Environmental Technology Verification requirements.
c. High fire point silicone approved by FM and UL.
d. Permanently affix nameplate stamped "Non PCB".

6. Accessories:
   a. Liquid level gage.
   b. Dial-type thermometer gage.
   c. Pressure vacuum gage.
   d. Stainless steel or laser-scribed anodized aluminum nameplate, with date of manufacturer and mounted on exterior of transformer.
   e. Cable parking stands, one per bushing.

2.3 INSULATING SECONDARY COVERS

A. Insulated secondary covers shall be included on all secondary terminals.

B. Covers shall be installed over terminals and cable, without the need to remove cables.

C. Rated for 600V minimum.

2.4 SURGE ARRESTORS

A. Surge arrestors shall be included on all radial fed or normal open looped transformers, or where indicated on the Drawings.

B. Standards: IEEE 386 and IEEE C62.11.

C. MOV gapless elbow type.

D. Elbow Connector:
   1. One-piece design, comprised of an insulation layer and outer shield constructed of EPDM rubber.
   2. 200A, dead front, load break type with hot stick pulling eye and grounding tab.
   3. #4 Copper ground or larger
   4. One arrester per phase

E. Rating:
   1. Nominal 24.9kV line to line: 18kV (17.0 MCOV)

2.5 SOURCE QUALITY CONTROL

A. Factory Tests: At a minimum, provide all routine tests as specified in IEEE C57.12.00 inches accordance with IEEE C57.12.90.

2.6 MAINTENANCE MATERIALS

A. Touch-up paint, two separate one quart containers per color.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install on pad as detailed on the Drawings and in accordance with NFPA 70 and manufacturer's instructions.

B. Transformer locations as shown on the Drawings are intended to be used as a guide.
   1. Field conditions may affect actual transformer location.
   2. Coordinate final location with contracting officer representative.
   3. Coordinate final metering equipment and metering location with Contracting Officer.

C. Install three-phase transformers on pad per detail on the Drawings.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

END OF SECTION

SECTION 26 13 23
SECTIONALIZING EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pad mounted sectionalizing junction enclosure.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Conditions.
   2. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electronic and Electrical Engineers (IEEE):
      a. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Rated 2.5 kV through 35 kV.
      b. C57.12.28, Standard for Pad-Mounted Equipment - Enclosure Integrity.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Nameplate data.
      c. See Specification Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout drawings:
      a. General arrangement plan view showing door swings, cable entrance locations, etc.
   3. Test reports:
      a. Certified reports of all factory production tests.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. Record of test results, inspections and procedures witnessed or performed by factory service representative.

1.4 DELIVERY, STORAGE AND HANDLING

A. See Specification Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Contractor to confirm all equipment is rated for installed elevation and provide final equipment ratings for review. Proposed equipment shall be compatible with existing equipment interface.

C. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Cooper Power Systems by Eaton.
   2. Or Equal.

2.2 PADMOUNT TYPE SECTIONALIZING JUNCTION ENCLOSURE

A. Configuration:
   1. Three phase.
   2. Three, Four-way junctions

B. Enclosure:
   1. Material: Heavy-duty stainless steel or fiberglass.
   2. Tamperproof per IEEE and ANSI standards.
   3. Top hinged cover.
   4. Universal cable junction mounting plates.
   5. Parking stands.
   6. Ground nuts.
   7. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.
      a. Finish color: Dark green.
   8. Ground sleeve to increase cable termination height.
      a. Material: Fiberglass Reinforced Composites (FRC) incorporating fire retardant polyester resins and a UV stabilizer coating.
      b. Height: 18 inches minimum.

C. Multi-point Variable Cable Junctions:
   1. Standard: IEEE 386.
   2. Voltage Class: 25 kV.
   3. Current rating: 200A dead-front, loadbreak.
   4. Bushing: One piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
   5. Bus: Structural grade plated aluminum.
   6. Bracket: Stainless steel U-strap.

2.3 SOURCE QUALITY CONTROL

A. Switchgear factory tests in accordance with IEEE and ANSI standards.

2.4 MAINTENANCE MATERIALS

A. Touch-up paint.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Arrange as shown on the Drawings.

C. Padmount Type Sectionalizing Junction Enclosure: Install on contractor provided ground sleeve.

D. Miscellaneous: Paint any scratched surfaces with touch-up paint.

3.2 FIELD QUALITY CONTROL

A. A qualified factory-trained manufacturer’s representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer’s recommendations.

3.3 TRAINING

A. A qualified factory-trained manufacturer's representative shall provide the contracting officer with 2 hours of on-site training in the operation and maintenance of the unit substation and its components.

B. See Section 01 79 00 for Operator training requirements.

END OF SECTION

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SECTION 26 22 13
LOW-VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Dry-type distribution transformers, 1000 kVA and less.

B. Related Requirements: Include, but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 26 - Grounding.
   3. Section 26 08 13 - Acceptance Testing.

1.2 REFERENCES

A. Reference Standards: Standards referenced in this section include, but are not necessarily limited to, the following:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C57.96 - Guide for Loading Dry-Type Distribution and Power Transformers.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ST 20 - Dry Type Transformers for General Applications.
   3. Underwriters Laboratories, Inc. (UL):
      a. 506 - Specialty Transformers.
      b. 1561 - Dry-Type General Purpose and Power Transformers.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Applicable electrical code is indicated 01 42 00 - References.
   2. The Work of this Section shall comply with 10 CFR 431, Energy Efficiency Program For Certain Commercial and Industrial Equipment, administered by the United States Department of Energy.

1.4 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

1.5 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Action Submittals. Submit the following:
   1. Shop Drawings:
      a. Schedule (in tabular format), indicating low-voltage transformers proposed. Indicate for each proposed location, whether the item will be installed within a panel such as a motor control center or other panel, voltage, manufacturer and model, and other pertinent data.
      b. Fabrication drawings for each size and type of equipment to be furnished. Show and indicate dimensions, arrangement, points of connection, parts and elements, and materials.
   2. Product data:
      a. Acknowledgement or indication that items submitted comply with requirements of standards referenced in this Section.

b. Low-voltage transformer manufacturer's published product data for each type of transformer and accessory required, including catalogs and similar published literature, marked to indicate items to be furnished for the Work and employing cross outs to indicate items not proposed and that will not be furnished.
c. Sound level certifications.
d. Comply with Section 26 05 00 - Common Work Results for Electrical for additional requirements concerning Submittals.

C. Informational Submittals. Submit the following:
1. Supplier Instructions:
a. Serial numbers of items furnished, equipment nameplate information, and similar information for all items furnished.
b. Instructions for handling, storing, installing, and startup.
2. Source Quality Control Submittals:
a. Upon Contracting Officer's request, submit results of tests, inspections, and other quality control activities required by the Contract Documents and performed at the place of production or fabrication.

D. Closeout Submittals. Submit the following:
1. Operation and Maintenance Data:
a. Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 GENERAL PURPOSE DRY-TYPE TRANSFORMERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Manufacturers: Subject to compliance with the Contract Documents, furnished required quantity of items from one of the following:
1. Eaton.
2. Or equal.

C. Description:
1. Furnish low-voltage distribution transformers in accordance with this Section, other provisions of the Contract Documents, and Laws and Regulations.
2. Transformers shall be ventilated or non-ventilated, air-cooled, two-winding type.
3. Transformers shall comply with the following: IEEE C57.96, NEMA ST 20, UL 506, UL 1561.

D. Performance Criteria:
1. Ratings: 60 Hertz, voltage, kVA and phase shall be as indicated on the Drawings.
2. During operation, sound levels shall not exceed the following, measured three feet from the associated transformer:
a. Average sound levels for ventilated units:
1) Up to 9 kVA: 40 dB.
2) 10 to 50 kVA: 45 dB.
3) 51 to 150 kVA: 50 dB.
4) 151 to 300 kVA: 55 dB.
5) 301 to 500 kVA: 60 dB.
6) 500 to 700 kVA: 62 dB.
7) 701 to 1000 kVA: 64 dB.

b. Average sound levels for non-ventilated units:
   1) Up to 9 kVA: 45 dB.
   2) 10 to 50 kVA: 50 dB.
   3) 51 to 150 kVA: 55 dB.

3. Efficiency shall be not less than the following:
   a. Ventilated:
      1) Single-phase, 15 to 333 kVA: In accordance with 10 CFR 431.
      2) Three-phase, 15 to 1000 kVA: In accordance with 10 CFR 431.
4. K-Factor rated:
   a. Suitable for circuits with harmonic profile equal to or less than K-factor of 4 or 13 without exceeding allowable temperature rise.
   b. Neutral conductor and lugs rated for 200 percent of normal phase current.

E. Materials and Fabrication:
1. Cores:
   a. High-grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
   b. During operation, magnetic flux densities shall be well below saturation point.
2. Coils:
   a. Continuous wound with **copper** windings.
3. Ventilated Transformer Units:
   a. Core and coils assembly shall be impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture, completely isolated from enclosure using vibration dampening pads.
   b. Enclosure: Drip-proof, NEMA 3R in accordance with NEMA 250, finished steel enclosure for outdoor locations.
   c. Weather-resistant, finished steel enclosure that restricts entry of rain, sleet, or snow using baffles, grills, or barriers on ventilation openings.
4. Taps: Provide Taps for Transformers as follows:
   a. Single-phase, 2 kVA and below: None.
   b. Single-phase, 3 to 25 kVA: Two, 5 percent FCBN.
   c. Single-phase, 25 kVA and above: Two, 2.5 percent FCAN and four, 2.5 percent FCBN.
   d. Three-phase, 3 to 15 kVA: Two, 5 percent FCBN.
   e. Three-phase, 15 kVA and above: Two, 2.5 percent FCAN and four, 2.5 percent FCBN.
5. Insulating Material (600 V and below):
   a. 3 to 10 kVA units: 185 degrees C insulation system with 115 degrees C rise.
   b. 15 kVA and above units: 220 degrees C insulation system with 150 degrees C rise.
6. Nameplates: Provide for each transformer furnished corrosion-resistant nameplate and connection diagram in accordance with NEMA ST 20 including date of manufacture.
7. Provide the following when so indicated on the Drawings:
   a. Electrostatic shielded transformer: Provide shield consisting of a single turn of thin sheet of aluminum or copper, extending over full width of windings, installed between primary and secondary winding, and grounded.
   b. Isolation transformer: Primary and secondary windings shall be electrically isolated from each other.
   c. Shielded isolation transformer: Provide system Incorporating both electrostatic shield and isolation features indicated above.
   d. SCR drive shielded isolation transformer:
      1) Specially intended and fabricated for use as drive isolation transformer.
      2) Core bracing shall withstand current reversals and short circuits associated with SCR drive circuitry.
      3) Incorporate both electrostatic shield and isolation features as indicated above.

F. Finishes:
1. Provide for each transformer furnished finish protecting against corrosion.

2. Appropriately clean and prepare surfaces to be finished in accordance with written instructions of finish system manufacturer.
3. Provide protective coating of paint or enameling, inside and out.

2.2 SOURCE QUALITY CONTROL

A. Tests and Inspections:
1. Perform manufacturer's routine tests and inspections, in accordance with NEMA ST 20.
2. Comply with Section 26 08 13 – Acceptance Testing.
3. Remedy defects prior to shipping items from assembly and testing location.
4. Upon Contracting Officer's request, submit to Contracting Officer written results of successful completion of required tests and inspections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Installing the Work constitutes Contractor's approval of underlying work, related, connected systems, and field conditions prevailing at the time of the Work.

3.2 INSTALLATION

A. Installation Requirements:
1. Install items in accordance with the Contract Documents, manufacturer's written instructions, and Laws and Regulations. Where such requirements conflict, obtain interpretation or clarification from Contracting Officer prior to commencing the associated Work.
2. Outdoor Locations:
a. Provide ventilated transformers for 15 kVA units and above.
b. Mount 15 kVA units and above on chamfered, four-inch-high concrete housekeeping pad.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
1. Comply with Section 26 08 13 - Acceptance Testing.
2. Field-verify proper operation and functionality of each transformer installed.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage switchboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 09 13 - Electrical Metering Devices.
   3. Section 26 09 16 - Control Equipment Accessories.
   4. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.
   5. Section 26 43 13 - Surge Protection Devices for Low-Voltage Electrical Power Circuits.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 2, Deadfront Distribution Switchboards.
   2. Underwriters Laboratories, Inc. (UL):
      a. 891, Switchboards.

B. Verify the space required for the switchboard is equal to or less than the space allocated.

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR)

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
   2. See Specification Section 26 05 00 for additional requirements.
   3. Fabrication and/or layout drawings:
      a. Switchboard layout with alphanumeric designation, protective devices size and type, as indicated in the one-line diagram or switchboard schedule.
      b. Front elevation and plan drawing of the assembly.
      c. Three-line or single line and schematic diagrams.
      d. Conduit space locations within the assembly.
      e. Dimensions, weight, center of gravity, and lifting points/provisions for each switchboard assembly.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Fabrication and/or layout drawings updated with as-build conditions

C. Informational Submittals:
   1. Equipment marking and documentation.
   2. Ground fault protection system test report signed by the projects supervising electrical foreman.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Siemens.
   2. Or Equal.

2.2 SWITCHBOARDS

A. Ratings:
   1. Voltage, number of phases, number of wires, and main bus current rating as indicated on the Drawings.
   2. Assembly short circuit current and interrupting device rating as indicated on the Drawings.
   3. Assembly short circuit current and interrupting device rating of 65 KAIC RMS symmetrical minimum or as indicated on the Drawings.
   4. When low voltage power circuit breakers are utilized, the switchboard shall have a 30 cycle withstand rating corresponding to the breaker rating.
   5. Service Entrance Equipment rated when indicated on the Drawings.
   6. 100% rated when 100% rated breakers are installed.

B. Construction:
   1. Standards: NEMA PB 2, UL 891.
   2. Completely enclosed, dead-front, self-supporting metal structure.
   3. Vertical panel sections bolted together.
   4. Frames bolted together to support and house bus, cables and other equipment.
   5. Frames and insulating blocks to support and brace main buses for short circuit stresses up to ratings indicated on the Drawings.
   6. All sections front and rear aligned.
   7. Devices front removable and load connections front accessible for mounting switchboard against a wall.
   8. NEMA 3R rated weatherproof enclosure:
      a. Nonwalk-in type with sloping roof downward toward rear.
      b. Thermostatically controlled space heaters to minimize internal condensation.
      c. Power for heater derived internal to the switchboard.
   9. Interior and exterior steel surfaces cleaned and painted with rust inhibiting primer and manufacturer's standard paint.

C. Buses:
   1. Material: Tin-plated copper.
   2. Main horizontal bus:
      a. Fully rated and continuous over length of switchboard with all three phases arranged in the same vertical plane.
      b. Sufficient size to limit temperature rise to 65 degrees C over average air temperature outside the enclosure of 40 degrees C.
   3. Neutral bus: Fully rated and continuous over length of switchboard.
   4. Ground bus: 1/4 x 2 inches copper, continuous over length of switchboard and solidly grounded to each vertical section structure.
   5. Bus joints connected using through bolts and conical spring-type washers for maximum conductivity.

D. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Individually mounted molded case circuit breaker.
   2. Feeder overcurrent protective devices:
      a. Compartmentally mounted molded case circuit breaker.
   3. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
   4. Factory installed.
   5. Means to padlock all main and feeder devices in the open position.

E. Surge Protective Device: Integrally mounted, see Specification Section 26 43 13.

F. Metering:
   1. Power monitor:
      a. Through cabinet mounting.
      b. See Specification Section 26 09 13 for meter requirements.
   2. Integrally mounted Current Transformers, Current Transformer shorting block, and Power Transformers

G. Accessories:
   1. Thermograph viewing windows for infrared surveys without opening doors:
      a. Provide windows at manufacturer's recommended locations to view cable connections and bus connections.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install switchboards in accordance with manufacturer's instructions.

B. Arrange switchboard to fit number of the number of interrupting devices as shown on the Drawings.

C. Outdoor Locations:
   1. Minimum NEMA 3R enclosure.
   2. Install on concrete housekeeping pad, align front of switchboard with top edge of pad chamfer and securely fasten to pad.

D. Equipment Marking and Documentation:
   1. Provide labeling per NFPA 70 and other applicable codes.
   2. Service equipment:
      a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
      b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
   3. Other than service equipment:
      a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
      b. Available fault current label. (Ref. NFPA 70 Article 408.6)
   4. Identify (tag) all equipment and equipment components.
   5. Provide labels and tags.
   6. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents.

E. Miscellaneous:
   1. Provide circuit protective devices and other associated equipment as indicated on the Drawings.
   2. All control wiring shall be neatly laced and have flexibility at hinge locations.

3.2 FIELD QUALITY CONTROL

A. Test the ground fault protection system as indicated in Specification Section 26 28 00.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Branch circuit panelboards.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. PB 1, Panelboards.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
      b. 67, Standard for Panelboards.

1.3 DEFINITIONS

A. Branch Circuit Panelboard: Bus rating of 400A and less or where labeled as Branch Circuit Panelboard on the Drawings.

B. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

1.4 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Product technical data.
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout drawings:
      a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Panelboard schedules updated with as-built conditions.

D. Informational Submittals:
   1. Service equipment marking and documentation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. Or Equal.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.

B. Ratings:
   1. Current, voltage, number of phases, number of wires as indicated on the Drawings.
   2. Short Circuit Current Rating (SCCR) and/or Ampere Interrupting Current (AIC) ratings equal to or greater than the interrupting rating indicated on the Drawings or in the schedule.
      a. Series rating is not acceptable.
      b. When fault current or minimum interrupting rating is not indicated, use rating of upstream equipment or infinite bus calculation of transformer secondary.
   3. Service Entrance Equipment rated when indicated on the Drawings or when shown to be fed from a utility source.

C. Construction:
   1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
   2. Multi-section panelboards: Feed-through or sub-feed lugs.
   3. Main lugs: Solderless type approved for copper and aluminum wire.

D. Bus Bars:
   1. Main bus bars:
      a. Tin-plated copper sized to limit temperature rise to a maximum of 65 degrees C above an ambient of 40 degrees C.
      b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
   2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
   3. Neutral bus bars: Insulated 100% rated or 200% rated, when indicated on the Drawings and with solderless mechanical type connectors.

E. Overcurrent and Short Circuit Protective Devices:
   1. Main overcurrent protective device:
      a. Molded case circuit breaker.
   2. Branch overcurrent protective devices:
      a. Molded case circuit breaker.
   3. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.
   4. Factory installed.

F. Integral surge protective device:
   1. Provide for panelboards where indicated on the Drawings
   2. See Specification Section 26 43 13.

G. Enclosure:

1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Branch circuit panelboard:
    a. Trims supplied with hinged door-in-door construction.
        1) Outer door:
            a) Allows access to the interior of the enclosure.
            b) Hinged to the enclosure.
            c) Opened by removal of screws or by operating a mechanical latch located behind the inner door.
        2) Inner door:
            a) Allows access to breakers (non-live parts).
            b) Hinged to outer door.
            c) Opened by operation of a keyed corrosion resistant chrome-plated combination lock and catch. Locks for all branch circuit panelboards keyed alike.
    b. Trims for surface mounted panelboards, same size as box.
    c. Trims for flush mounted panelboards, overlap the box by 3/4 inches on all sides.
    d. Nominal 20 inches wide and 5-3/4 inches deep with gutter space in accordance with NFPA 70.
    e. Clear plastic cover for directory card mounted on the inside of each door.
    f. Where NEMA 3R or NEMA 12 rating is indicated: Door gasketed.
    g. Where NEMA 4X is indicated: Stainless Steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Section 26 05 00.

C. Provide NEMA rated enclosure as indicated on the Drawings. Where enclosure type is not indicated, provide enclosure rating suitable for the atmosphere where equipment is installed.

D. Equipment Marking and Documentation:
1. Provide labeling per NFPA 70 and other applicable codes.
2. Service equipment:
    a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A) and (B))
    b. Available fault current label and documentation of the calculations made for compliance with marking requirements. (Ref. NFPA 70 Article 110.24)
3. Other than service equipment:
    a. Arc-flash hazard warning label. (Ref. NFPA 70 Article 110.16(A))
    b. Available fault current label. (Ref. NFPA 70 Article 408.6)
4. Identify (tag) all equipment and equipment components.
5. Provide labels and tags.
6. Available fault current and other required label data from Coordinated Power System Study as required by the contract documents.

E. Provide each panelboard with a typed directory:
1. Identify all circuit locations in each panelboard with the load type and location served.
2. Use Contracting Officer-furnished mechanical equipment designation if different than designation indicated on the Drawings.
3. Use final building room names and numbers as identified by the Contracting Officer if different than designation indicated on the Drawings.
4. Identify spare overcurrent devices.

END OF SECTION

SECTION 26 27 26
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Wall switches.
      b. Receptacles.
      c. Device wallplates and coverplates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. WD 1, General Color Requirements for Wiring Devices.
      c. WD 6, Wiring Devices - Dimensional Requirements.
   2. Underwriters Laboratories, Inc. (UL):
      a. 20, General-Use Snap Switches.
      b. 498, Standard for Attachment Plugs and Receptacles.
      c. 514A, Metallic Outlet Boxes.
      d. 894, Standard for Switches for Use in Hazardous (Classified) Locations.
      e. 943, Ground-Fault Circuit-Interrupters.
      f. 1010, Standard for Receptacle-Plug Combinations for Use in Hazardous (Classified) Locations.
      g. 1310, Standard for Class 2 Power Units.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Wall switches and receptacles:
      a. Cooper Wiring Devices by Eaton.

b. Or Equal.

2.2 WALL SWITCHES

A. Basic requirements unless modified in specific requirements paragraph of switches per designated areas or types:
   1. Industrial Specification Grade.
   2. Quiet action, snap switch.
   3. Self-grounding with grounding terminal.
   4. Back and side wired.
   5. Solid silver cadmium oxide contacts.
   6. Rugged thermoplastic and/or nylon housing and one-piece switch arm.
   7. Ratings: 20 A, 120/277 VAC.
   8. Switch handle type: Toggle.
   9. Switch handle color: Gray.
   10. Types as indicated on the Drawings:
      a. Single-pole.
      b. Double-pole.
      c. 3-way.
      d. 4-way.
      e. Momentary contact.
   11. Standards: UL 20, UL 514A, NEMA WD 1, NEMA WD 6.

B. Specialty Switch Specific Requirements:
   1. Momentary Contact Switch for Lighting Control:
      a. SPDT, 3-position, center “off”.
      b. Rating: 15A, 120/277VAC.

C. Architecturally Finished Area Specific Requirements:
   1. Commercial Specification Grade.
   2. Ratings: 15A, 120/277V.
   3. Switch handle type: Decorator rocker or paddle.
   4. Switch handle color: Ivory.
   5. Wallplate:
      a. 302 or 304 brushed finish stainless steel.
      b. Single or multiple gang as required.
      c. High impact thermoplastic or nylon, color to match handle.

D. Dry Non-architecturally Finished Area Specific Requirements:
   1. Coverplate for use on surface mounted outlet boxes:
      a. Raised steel, galvanized.
      b. Cast iron alloy, galvanized and factory painted finish.
      c. Cast aluminum, natural, lacquer, or factory painted finish.
      d. Sheet aluminum.
      e. High impact thermoplastic or nylon, color to match handle.
      f. 302 or 304 brushed finish stainless steel.
      g. Single or multiple gang as required.
   2. Wallplate for use on recessed outlet boxes:
      a. Steel, galvanized.
      b. 302 or 304 brushed finish stainless steel.
      c. Single or multiple gang as required.
      d. High impact thermoplastic or nylon, color to match handle.

E. Dry and Dusty Non-Architecturally Finished Area Specific Requirements:
   1. Coverplate:
      a. Cast iron alloy, gasketed, stainless steel hardware, galvanized and factory painted finish.

b. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
c. Operator type:
1) Side mounted rocker type handle to operate snap switch.
2) Front mounted lever type handle to operate snap switch.
3) Push/pull operator to operate snap switch.
4) Spring type door to cover snap switch.
d. Single or multiple gang as required.

F. Wet or Damp Non-Architecturally Finished or Exterior Area Specific Requirements:
1. Coverplate:
a. Cast iron alloy, gasketed, stainless steel hardware, galvanized and factory painted finish.
b. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
c. Operator type:
1) Side mounted rocker type handle to operate snap switch.
2) Front mounted lever type handle to operate snap switch.
3) Push/pull operator to operate snap switch.
4) Spring type door to cover snap switch.
d. Wet location rated.
e. Single or multiple gang as required.

G. Corrosive and Dry Area Specific Requirements:
1. Corrosion resistant nickel plated metal parts.
2. Coverplate for use on metallic outlet boxes:
a. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
b. Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
c. Single or multiple gang as required.
3. Coverplate for use on non-metallic outlet boxes:
a. High impact thermoplastic or nylon, color to match handle, stainless steel screws.
b. High impact thermoplastic, stainless steel screws.
1) Front mounted lever to operate snap switch.
2) Spring type door to cover snap switch.
c. Single or multiple gang as required.

H. Corrosive and Wet or Damp Area Specific Requirements:
1. Corrosion resistant nickel plated metal parts.
2. Coverplate for use on metallic outlet boxes:
a. Cast iron alloy, gasketed, stainless steel hardware, galvanized and factory painted finish.
b. Cast aluminum, gasketed, stainless steel hardware, natural, lacquer, or factory painted finish.
c. Operator type:
1) Front mounted lever to operate snap switch.
2) Push/pull operator to operate snap switch.
3) Spring type door to cover snap switch.
d. Wet location rated.
e. Single or multiple gang as required.
3. Coverplate for use on non-metallic outlet boxes:
a. High impact thermoplastic, gasketed, stainless steel screws.
1) Front mounted lever to operate snap switch.
2) Spring type door to cover snap switch.
b. Wet location rated.
c. Single or multiple gang as required.

I. Highly Corrosive and Dry Area Specific Requirements:

1. Corrosion resistant nickel plated metal parts.
2. Coverplate for use on PVC coated metallic outlet boxes:
    a. PVC coated galvanized cast iron alloy, stainless steel hardware.
    b. PVC coated cast aluminum, stainless steel hardware.
    c. Single or multiple gang as required.
3. Coverplate for use on non-metallic outlet boxes:
    a. High impact thermoplastic or nylon, color to match handle, stainless steel screws.
    b. High impact thermoplastic, stainless steel hardware.
        1) Front mounted lever to operate snap switch.
        2) Spring type door to cover snap switch.
    c. Single or multiple gang as required.

J. Highly Corrosive and Wet or Damp Area Specific Requirements:
1. Corrosion resistant nickel plated metal parts.
2. Coverplate for use on PVC coated metallic outlet boxes:
    a. PVC coated galvanized iron alloy, gasketed, stainless steel hardware.
    b. PVC coated aluminum, gasketed, stainless steel hardware.
    c. Operator Type:
        1) Front mounted lever to operated snap switch.
        2) Push/pull operator to operate snap switch.
        3) Spring type door to cover snap switch.
    d. Wet location rated.
    e. Single or multiple gang as required.
3. Coverplate for use on non-metallic outlet boxes:
    a. High impact thermoplastic, gasketed, stainless steel hardware.
        1) Front mounted lever to operate snap switch.
        2) Spring type door to cover snap switch.
    b. Wet location rated.
    c. Single or multiple gang as required.

K. Hazardous and Dry Area Specific Requirements:
1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. Assembly consists of outlet box, snap switch and coverplate.
    a. NEMA 7 and 9 rated.
3. Outlet box:
    a. Cast iron alloy, galvanized and factory painted finish.
    b. Cast aluminum, natural, lacquer, or factory painted finish.
4. Snap switch (EDS Type):
    a. Enclosed in separate sealing chamber and approved for installation without additional external sealing fittings.
    b. Sealing chamber has prewired factory sealed pigtail leads.
5. Snap switch (EFS Type):
    a. Not enclosed in separate sealing chamber requiring external sealing fittings.
6. Coverplate:
    a. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
    b. Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
    c. Operator type:
        1) Front mounted lever to operate snap switch.
        2) Side rocker arm operator to operate snap switch.
7. Standards: UL 894.

L. Hazardous and Wet or Damp Area specific requirements:
1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. Assembly consists of outlet box, snap switch and coverplate.
    a. NEMA 3, 7 and 9 rated.

3. Outlet box:
    a. Cast iron alloy, galvanized and factory painted finish.
    b. Cast aluminum, natural, lacquer, or factory painted finish.
4. Snap switch (EDS Type):
    a. Enclosed in separate sealing chamber and approved for installation without additional external sealing fittings.
    b. Sealing chamber has prewired factory sealed pigtail leads.
5. Snap switch (EFS Type):
    a. Not enclosed in separate sealing chamber requiring external sealing fittings.
6. Coverplate:
    a. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
    b. Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
    c. Operator type:
        1) Front mounted lever to operate snap switch.
        2) Side rocker arm operator to operate snap switch.
7. Standards: UL 894.

M. Hazardous and Corrosive or Highly Corrosive and Dry, Wet or Damp Area Specific Requirements:
1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. Assembly consists of outlet box, snap switch and coverplate.
    a. NEMA 3, 7 and 9 rated.
3. Outlet box:
    a. PVC coated galvanized cast iron alloy.
    b. PVC coated cast aluminum.
    c. Cast iron alloy, galvanized and factory painted finish.
    d. Cast aluminum, natural, lacquer, or factory painted finish.
4. Snap switch (EDS Type):
    a. Enclosed in separate sealing chamber and approved for installation without additional external sealing fittings.
    b. Sealing chamber has prewired factory sealed pigtail leads.
5. Snap switch (EFS Type):
    a. Not enclosed in separate sealing chamber requiring external sealing fittings.
6. Coverplate:
    a. PVC coated galvanized cast iron alloy, gasketed, stainless steel hardware.
    b. PVC coated cast aluminum, gasketed, stainless steel hardware.
    c. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
    d. Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
    e. Operator type:
        1) Front mounted lever to operate snap switch.
        2) Side rocker arm operator to operate snap switch.
7. Standards: UL 894.

N. Hazardous and Corrosive or Highly Corrosive and Dry, Wet or Damp Area Specific Requirements:
1. Rated for Class I, Division 1 and 2, Groups C and D.
2. Assembly consists of outlet box, snap switch and coverplate.
    a. NEMA 3X, 7 and 9 rated.
3. Outlet box:
    a. High strength glass reinforced non-metallic compound.
    b. Aluminum grounding grid imbedded into enclosure.
4. Snap switch (EFS Type):
    a. Not enclosed in separate sealing chamber. External sealing fittings required.
5. Coverplate:

a. High strength glass reinforced non-metallic compound, gasketed and coated stainless steel hardware.
b. Operator type: Non-metallic, front mounted lever to operate snap switch.

6. Standards: UL 894.

2.3 RECEPTACLES

A. Basic requirements unless modified in specific requirements paragraph of receptacles and per designated areas:
1. Industrial Specification Grade.
2. Straight blade.
3. Brass triple wipe line contacts.
4. One-piece grounding system with double wipe brass grounding contacts and self-grounding strap with grounding terminal.
5. Back and side wired.
6. Rating: 20 A, 125 VAC.
7. High impact nylon body.
8. Receptacle body color:
a. Normal power: Gray.
b. Generator or UPS power: Red.
9. Duplex or simplex as indicated on the Drawings.
10. Configuration: NEMA 5-20R.
11. Standards: UL 498, UL 514A, NEMA WD 1, NEMA WD 6.

B. Receptacle Type Specific Requirements:
1. Basic receptacles:
a. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
1) Identification: Letters “WR” on face of receptacle.
2. Ground Fault Circuit Interrupter (GFCI):
a. Specification Grade.
b. Class A protection.
c. Feed through type.
d. Test and reset buttons.
e. Self-testing.
f. Visual indicator light.
g. Weather-resistant when located in exterior locations or interior damp or wet areas as indicated on the Drawings.
1) Identification: Letters “WR” on face of receptacle.
h. Additional standards: UL 943.
3. Plug load (PL) control receptacle.
a. Commercial Specification Grade.
b. Dual controlled (PLD) or half controlled (PLH) as indicated on the Drawings.
c. Identification: NEMA approved controlled receptacle marking on face of receptacle.
4. Combination receptacle and USB charging station:
a. Commercial Specification Grade.
b. Compatible with USB 2.0 and 3.0 devices.
c. USB ports ratings: 5 VDC, 2.1A minimum total charging capacity.
d. Configurations as indicated on the drawings:
1) Simplex receptacle with two (2) USB ports.
2) Duplex receptacle with two (2) USB ports.
e. Additional standards: UL 1310.
5. USB charging station:
a. Compatible with USB 2.0 and 3.0 devices.
b. USB ports ratings: 5 VDC, 4.2A minimum total charging capacity.
c. Configuration: Four (4) USB ports.
d. Additional standards: UL 1310.

6. Isolated ground:
    a. Grounding terminal is isolated from the grounding strap.
    b. Identification: Orange triangle.
7. Surge protective device receptacle:
    a. MOV protection for L-N, L-G and N-G.
    b. Failure indicator light.
    c. Additional standards: UL 1449.

C. Architecturally Finished Areas Specific Requirements:
1. Commercial Specification Grade.
2. Ratings: 15A, 125V.
3. Configuration: NEMA 5-15R.
4. Decorator style.
5. Body color: Ivory.
6. Wallplate:
    a. 302 or 304 brushed finish stainless steel.
    b. Single or multiple gang as required.
    c. High impact thermoplastic or nylon, color to match body.

D. Dry Non-Architecturally Finished Areas Specific Requirements:
1. Coverplate for use on surface mounted outlet boxes:
    a. Raised steel, galvanized.
    b. Cast iron alloy, galvanized and factory painted finish.
    c. Cast aluminum, natural, lacquer or factory painted finish.
    d. Sheet aluminum.
    e. High impact thermoplastic or nylon, color to match body.
    f. 302 or 304 brushed finish stainless steel.
    g. Single or multiple gang as required.
2. Wallplate for use on recessed outlet boxes:
    a. Steel, galvanized.
    b. High impact thermoplastic or nylon, color to match body.
    c. 302 or 304 brushed finish stainless steel.
    d. Single or multiple gang as required.

E. Dry and Dusty Non-Architecturally Finished Areas Specific Requirements:
1. Coverplate:
    a. Cast aluminum, gasketed, self-closing cover, stainless steel hardware, natural, lacquer or factory painted finish.
    b. Single or multiple gang, as required.
    c. Cast iron alloy, gasketed, self-closing cover, stainless steel hardware, galvanized and factory painted finish.

F. Damp Non-Architecturally Finished Areas Specific Requirements:
1. Coverplate:
    a. Cast aluminum, gasketed, self-closing cover, stainless steel hardware, natural, lacquer or factory painted finish.
    b. Weatherproof when receptacle is covered.
    c. Single or multiple gang as required.
    d. Cast iron alloy, gasketed, self-closing cover, stainless steel hardware, galvanized and factory painted finish.

G. Wet Non-architecturally Finished Areas Specific Requirements:
1. Coverplate:
    a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 inches minimum cover depth for #12 AWG cords.
    b. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 inches minimum cover depth for #12 AWG cords.

H. Exterior Locations Specific Requirements:
   1. Coverplate:
      a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 inches minimum cover depth for #12 AWG cords.
      b. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 inches minimum cover depth for #12 AWG cord.

I. Corrosive and Dry Area Specific Requirements:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Gray.
   3. Coverplate for use on metallic outlet boxes:
      a. Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
      b. Cast aluminum, stainless steel hardware, natural, lacquer or factory painted finish.
      c. Single or multiple gang as required.
   4. Coverplate for use on non-metallic outlet boxes:
      a. High impact thermoplastic or nylon, gray in color, stainless steel screws.
      b. High impact thermoplastic, self-closing cover, stainless steel hardware.
      c. Single or multiple gang as required.

J. Corrosive and Wet or Damp Area Specific Requirements:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Gray.
   3. Weather-resistant.
      a. Identification: Letters “WR” on face of receptacle.
   4. Ground Fault Circuit Interrupter (GFCI):
      a. Standards: UL 943.
   5. Coverplate for use on metallic outlet boxes:
      a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, copper-free aluminum, 3.2 inches minimum cover depth for #12 AWG cord.
      b. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 inches minimum cover depth for #12 AWG cords.
   6. Coverplate for use on non-metallic outlet boxes:
      a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 inches minimum cover depth for #12 AWG cords.

K. Highly Corrosive and Dry Area Specific Requirements:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Gray.
   3. Coverplate for use on PVC coated metallic outlet boxes:
      a. PVC coated galvanized cast iron alloy, stainless steel hardware.
      b. PVC coated cast aluminum, stainless steel hardware.
   4. Coverplate for use on non-metallic outlet boxes:
      a. High impact thermoplastic or nylon, gray in color, stainless steel screws.
      b. High impact thermoplastic, self-closing cover, stainless steel hardware.

L. Highly Corrosive and Wet or Damp Area Specific Requirements:
   1. Corrosion resistant nickel plated metal parts.
   2. Receptacle body color: Gray.
   3. Weather-resistant.
      a. Identification: Letters “WR” on face of receptacle.
   4. Ground Fault Circuit Interrupter (GFCI):
      a. Standards: UL 943.
   5. Coverplate for use on PVC coated metallic outlet boxes:

a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 inches minimum cover depth for #12 AWG cords.
b. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 inches minimum cover depth for #12 AWG cords.

6. Coverplate for use on non-metallic outlet boxes:
   a. Extra-duty rated, weatherproof (NEMA 3R) while in use, gasketed, stainless steel hardware, flame retardant, UV stabilized polycarbonate, 3.2 inches minimum cover depth for #12 AWG cords.

M. Hazardous and Dry Area Specific Requirements:
1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. Assembly consists of outlet box and a combination receptacle/switch and housing.
   a. NEMA 3, 7 and 9 rated.
3. Outlet box (EDS Type):
   a. Cast iron alloy, galvanized and factory painted finish.
   b. Cast aluminum, natural, lacquer, or factory painted finish.
4. Receptacle/switch and housing:
   a. Receptacle and switch enclosed in a factory sealed chamber and approved for installation without additional external sealing fittings.
   b. Insertion of "interchanger" plug and plug rotation will close the switch to energize receptacle and lock plug into the receptacle.
   c. "Interchanger" plug to be compatible with other manufacturers hazardous receptacle and work in ordinary convenience receptacles.
   d. Ordinary equipment plugs will not active the hazardous receptacle.
   e. Housing:
      1) Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
      2) Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
      3) Spring-loaded door seats against neoprene gasket. Stainless steel spring.
5. "Interchanger" plug:
   a. Aluminum housing.
   b. 30% Glass-reinforced thermoplastic polyester housing.
   c. Provide 5 plugs for NPS use.
6. Standards: UL 894 and 1010.

N. Hazardous and Wet or Damp Area Specific Requirements:
1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
2. Assembly consists of outlet box and a combination receptacle/switch and housing.
   a. NEMA 3, 7 and 9 rated.
3. Outlet box (EDS Type):
   a. Cast iron alloy, galvanized and factory painted finish.
   b. Cast aluminum, natural, lacquer, or factory painted finish.
4. Receptacle/switch and housing:
   a. Receptacle and switch enclosed in a factory sealed chamber and approved for installation without additional external sealing fittings.
   b. Insertion of "interchanger" plug and plug rotation will close the switch to energize receptacle and lock plug into the receptacle.
   c. "Interchanger" plug to be compatible with other manufacturers hazardous receptacle and work in ordinary convenience receptacles.
   d. Ordinary equipment plugs will not active the hazardous receptacle.
   e. Housing:
      1) Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
      2) Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.

3) Spring-loaded door seats against neoprene gasket. Stainless steel spring.

5. Ground Fault Circuit Interrupter (GFCI):
   a. Mount in same type of outlet box as receptacle.
   b. Enclosed in factory sealed chamber.
   c. Cover cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
   d. Buttons stainless steel and gasketed.
   e. Standards: UL 943.
6. "Interchanger" plug:
   a. Aluminum housing.
   b. 30% Glass-reinforced thermoplastic polyester housing.
   c. Provide five plugs for NPS use.
7. Standards: UL 894 and 1010.

O. Hazardous and Corrosive or Highly Corrosive and Dry, Wet or Damp Area Specific Requirements:
   1. Rated for Class I, Division 1 and 2, Groups C and D; and Class II, Division 1 and 2 areas, Groups E, F, and G.
   2. Assembly consists of outlet box and a combination receptacle/switch and housing.
      a. NEMA 3, 7 and 9 rated.
   3. Outlet box (EDS Type):
      a. PVC coated galvanized cast iron alloy.
      b. PVC coated cast aluminum.
      c. Cast iron alloy, galvanized and factory painted finish.
      d. Cast aluminum, natural, lacquer, or factory painted finish.
   4. Receptacle/switch and housing:
      a. Receptacle and switch enclosed in a factory sealed chamber and approved for installation without additional external sealing fittings.
      b. Insertion of "interchanger" plug and plug rotation will close the switch to energize receptacle and lock plug into the receptacle.
      c. "Interchanger" plug to be compatible with other manufacturers hazardous receptacle and work in ordinary convenience receptacles.
      d. Ordinary equipment plugs will not active the hazardous receptacle.
      e. Housing:
         1) Cast iron alloy, stainless steel hardware, galvanized and factory painted finish.
         2) Cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
         3) Spring-loaded door seats against neoprene gasket. Stainless steel spring.
   5. Ground Fault Circuit Interrupter (GFCI):
      a. Mount in same type of outlet box as receptacle.
      b. Enclosed in factory sealed chamber.
      c. Cover cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
      d. Buttons stainless steel and gasketed.
      e. Standards: UL 943.
   6. "Interchanger" plug:
      a. Aluminum housing.
      b. 30% Glass-reinforced thermoplastic polyester housing.
      c. Provide five plugs for NPS use.
   7. Standards: UL 894 and 1010.

P. Hazardous and Corrosive or Highly Corrosive and Dry, Wet or Damp Area Specific Requirements:
   1. Rated for Class I, Division 1 and 2, Groups C and D.
   2. Assembly consists of outlet box and a combination receptacle/switch and housing.
      a. NEMA 3, 7 and 12 rated.
   3. Outlet box (EDS Type):

a. High strength glass reinforced non-metallic compound.
b. Aluminum grounding grid imbedded into enclosure.

4. Receptacle/switch and housing:
   a. Receptacle and switch not enclosed in separate sealing chamber. External sealing fittings required.
   b. Insertion of "interchanger" plug and plug rotation will close the switch to energize receptacle and lock plug into the receptacle.
   c. "Interchanger" plug to be compatible with other manufacturers hazardous receptacle and work in ordinary convenience receptacles.
   d. Ordinary equipment plugs will not active the hazardous receptacle.
   e. Housing:
      1) Cast aluminum, stainless steel hardware, factory epoxy painted finish.
      2) Spring-loaded door seats against neoprene gasket. Stainless steel spring.
5. Ground Fault Circuit Interrupter (GFCI):
   a. Mount in same type of outlet box as receptacle.
   b. Enclosed in factory sealed chamber.
   c. Cover cast aluminum, stainless steel hardware, natural, lacquer, or factory painted finish.
   d. Buttons stainless steel and gasketed.
   e. Standards: UL 943.
6. Standards: UL 894 and 1010.

Q. Special Purpose Receptacles:
   1. NEMA configuration as indicated on the Drawings.
   2. Coverplate: See requirements per area designations herein.

2.4 MISCELLANEOUS WIRING DEVICES

A. Plug-In Strip:
   1. Surface dual-channel, aluminum raceway plug-in strip with single 15 A, 125 V, 3-wire grounding-type receptacles spaced 24 inches on-center and single data port outlet spaced 72 inches on-center.
   2. Prewired with two #12 TW and one #12 TW green insulated ground per branch circuit shown on plans and cat6 cable per data port outlet.
   3. Minimum 4-1/2 inches wide x 3/4 inches deep.
   4. Suitable fittings and snap-in cover.
   5. Finish: Brushed Aluminum.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Mount devices where indicated on the Drawings.

C. Where more than one receptacle is installed in a room, they shall be symmetrically arranged.

D. Provide blank plates for empty outlets.

END OF SECTION

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SECTION 26 28 00
OVERCURRENT AND SHORT CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Low voltage circuit breakers.
   2. Low voltage fuses.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
      b. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).
      c. C37.13, Standard for Low-Voltage AC Power Circuit Breakers Used in Enclosures.
      d. C37.16, Low-Voltage Power Circuit Breakers and AC Power Circuit Protectors - Preferred Ratings, Related Requirements, and Application Recommendations.
      e. C37.17, Trip Devices for AC and General Purpose DC Low Voltage Power Circuit Breakers.
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Underwriters Laboratories, Inc. (UL):
      a. 248-8, Low-Voltage Fuses - Part 8: Class J Fuses.
      b. 489, Standard for Safety Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures.
      c. 943, Standard for Safety for Ground-Fault Circuit-Interrupters.
      d. 1053, Standard for Ground-Fault Sensing and Relaying Equipment.
      e. 1066, Standard for Low-Voltage AC and DC Power Circuit Breakers Used in Enclosures.
      f. 1699, Standard for Arc-Fault Circuit-Interrupters.

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

1.4 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Shop Drawings:
   1. Product technical data including:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. See Section 26 05 00 for additional requirements.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:

a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

D. Informational Submittals:
1. Ground fault protection system test reports signed by the projects supervising electrical foreman.
2. Reports:
a. As-left condition of all circuit breakers that have adjustable settings.

E. Refer to Section 01 81 33 – Cyber Security Requirements for required cyber security related submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Circuit breakers:
a. Eaton.
b. Or Equal.
2. Fuses:
a. Eaton Bussmann, Inc.
b. Or Equal.

2.2 CIRCUIT BREAKERS

A. Molded Case Type:
1. General:
a. Standards: UL 489.
b. Unit construction.
c. Over-center, toggle handle operated.
d. Quick-make, quick-break, independent of toggle handle operation.
e. Manual and automatic operation.
f. All poles open and close simultaneously.
g. Three position handle: On, off and tripped.
h. Molded-in ON and OFF markings on breaker cover.
i. One-, two- or three-pole as indicated on the Drawings.
j. Current and interrupting ratings as indicated on the Drawings.
2. Thermal magnetic type:
a. Inverse time overload and instantaneous short circuit protection by means of a thermal magnetic element.
b. Frame size 150 amp and below:
1) Non-interchangeable, non-adjustable thermal magnetic trip units.
c. Frame sizes 225 to 400 amp (trip settings less than 400A):
1) Interchangeable and adjustable instantaneous thermal magnetic trip units.
d. Ground Fault Circuit Interrupter (GFCI) Listed:
1) Standard: UL 943.
2) One- or two-pole as indicated on the Drawings.
3) Class A ground fault circuit.

4) Trip on 5 mA ground fault (4-6 mA range).
e. Ground Fault Equipment Protective Circuit Interrupter (GFEPCI) Listed:
1) Standard: UL 1053.
2) Trip on 30 mA ground fault (6-50 mA range).
f. Arc-Fault Circuit Interrupter (AFCI):
1) Standard: UL 1699.
g. Switching Duty (SWD) Listed:
1) 15 and 20 amp rated at 347 V and less.
2) Suitable for switching fluorescent lighting loads on a regular basis
h. Switching Duty (HID) Listed:
1) 50 amp maximum rated at 480 V and less.
2) Suitable for switching high intensity discharge lighting loads on a regular basis
3. Solid state trip type:
a. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and flux shunt trip mechanism.
b. Frame size 400 amp to 1200 amp (trip settings between 400 and 1200A):
1) Standard rating.
2) Interchangeable current sensor or rating plug.
3) Adjustable long time pick-up setting.
a) Adjustable from 50 to 100% of the current sensor or rating plug.
4) Adjustable short time pick-up setting.
5) Adjustable instantaneous pick-up.
6) Fixed ground fault pick-up, when indicated on the Drawings.
c. Adjustable arc energy-reducing maintenance system.
1) Frame size 1200A or when indicated on the Drawings for less than 1200A frame size.
2) Activate and deactivate without opening door and exposing operators to energized parts.
3) System status indicator adjacent to activation switch.
d. Frame size 1600 amp and above:
1) 100% rated.
2) Interchangeable current sensor or rating plug.
3) Adjustable long time pick-up setting.
a) Adjustable from 50 to 100% of the current sensor or rating plug.
4) Adjustable long time delay setting.
5) Adjustable short time pick-up setting.
6) Adjustable instantaneous pick-up setting.
7) Adjustable ground fault pick-up setting, when indicated on the Drawings.
8) Adjustable ground fault delay setting, when indicated on the Drawings.
e. Adjustable arc energy-reducing maintenance system.
1) Activate and deactivate without opening door and exposing operators to energized parts.
2) System status indicator adjacent to activation switch.
4. Motor circuit protector:
a. Adjustable instantaneous short circuit protection by means of a magnetic or solid state trip element.
b. Sized for the connected motor.

B. Low Voltage Power Type:
1. Inverse time overload, instantaneous short circuit and ground fault protection by means of a solid state trip element, associated current monitors and two-step stored energy trip mechanism.
2. Standards: IEEE C37.13, IEEE C37.16, IEEE C37.17, UL 1066.
3. 100% rated.
4. Electrically operated (EO) or manually operated (MO) as indicated on the Drawings.
5. Manually operated breakers:

a. Close/Open pushbuttons.
b. Red and green indicators to indicate breaker position.
c. Trip unit power: Internal CPT of the electrical gear.

6. Electrically operated breakers:
   a. Close/open pushbuttons.
   b. Red and green indicators to indicated breaker position.
   c. Trip unit power: Internal CPT of the electrical gear.
   d. Trip/close signal: External 120 VAC source.
   e. Charging motor power: Internal CPT of the electrical gear.
   f. Charge springs after a close.
7. Motor driven operator for charging mechanism with open, close and charge push button.
8. Stored energy mechanism position indicator.
9. Contact position indicator: Reversible 52a/52b contacts, quantity as indicated on the Drawings.
10. Truck operated cell switch (52TOC) when indicated on the Drawings.
11. Bell alarm with manual reset when indicated on the Drawings.
12. Draw out construction:
    a. Roll out type operated by removable crank handle and interlocked with the door.
    b. Four positions: Connected, test, disconnected and removed.
    c. Cell switches to short out ground fault relay when main or tie breaker is drawn out.
13. Current and interrupting ratings as indicated on the Drawings and a 30-cycle short-time withstand ratings equal to their symmetrical interrupting ratings, regardless of whether equipped with instantaneous trip protection or not.
14. Current limiters:
    a. Integrally mounted on 2000 amp frames and less and separate draw-out limiter on 3200 amp and larger.
    b. Coordinated with the trip unit to avoid unnecessary blowing of the current limiters.
    c. Anti-single-phasing device to trip breaker in the event of a blown limiter, indicator to indicate which limiter is blown and prevent breaker from being re-closed on a single-phase condition.
    d. Current limiting fuses: 200,000 amp RMS symmetrical interrupting capacity.
15. Frame size 800 amp and above:
    a. Interchangeable current sensor or rating plug:
    b. Adjustable long time pick-up setting.
       1) Adjustable from 50 to 100% of the current sensor or rating plug.
    c. Adjustable long time delay setting.
    d. Adjustable short time pick-up setting.
    e. Adjustable instantaneous pick-up setting.
    f. Adjustable ground fault pick-up setting, when indicated on the Drawings.
    g. Adjustable ground fault delay setting, when indicated on the Drawings.
    h. Adjustable arc energy-reducing maintenance system.
       1) Frame size 1200A or larger or when indicated on the Drawings for 800A frame size.
       2) Activate and deactivate without opening door and exposing operators to energized parts.
       3) System status indicator adjacent to activation switch.
    i. Unit status indicator.
    j. Cause of trip indicator.
    k. Current display.

2.3 GROUND FAULT RELAYS

2.4 FUSES

A. UL Class L fuses:
   1. Standard: UL 248-1 and UL 248-10.
   2. Dual-element time-delay and current limiting type.

3. Ratings: 600 V, 601-6000 amps and 200,000 RMS AIC symmetrical.

B. UL Class J fuses:
1. Standard: UL 248-1 and UL 248-8.
2. Dual-element time-delay and current limiting rejection type.
3. Ratings: 600 V, 0-600 amps and 200,000 RMS AIC symmetrical.

C. UL Class RK-1 fuses:
1. Standard: UL 248-1 and UL 248-12.
2. Single-element fast-acting and current limiting rejection type.
3. Dual-element time-delay and current limiting rejection type.
4. Ratings: 250 and 600 V, 1/10-600 amps and 200,000 RMS AIC symmetrical.

D. UL Class RK-5 fuses:
1. Standard: UL 248-1 and UL 248-12.
2. Dual-element time-delay and current limiting rejection type.
3. Ratings: 250 and 600 V, 1/10-600 amps and 200,000 RMS AIC symmetrical.

E. UL Class CC fuses:
1. Standard: UL 248-1 and UL 248-4.
2. Single-element fast-acting and current limiting rejection type.
3. Ratings: 250 and 600 V, 1/10-30 amps and 200,000 RMS AIC symmetrical.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Current and interrupting ratings as indicated on the Drawings.

B. Series rated systems not acceptable.

C. Devices shall be ambient temperature compensated.

D. Circuit Breakers:
1. Molded case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
a. Frame sizes 400 amp and less with trip setting less than 400A shall be thermal magnetic type.
b. Frame sizes 400 amp and larger shall be solid state trip type.
c. Motor circuit protectors sized for the connected motor.
2. Insulated case circuit breakers shall incorporate the following, unless indicated otherwise on the Drawings:
a. Set current sensor or rating plugs long time pick-up setting so that the indicated trip level is near the 75% trip point.

E. Fuses:
1. UL Class J: Use for feeder devices 600 amps and smaller.

3.2 FIELD QUALITY CONTROL

A. Adjustable Circuit Breakers:
1. Set all circuit breaker adjustable taps and other adjustable protective devices as recommended in the Coordinated Power System Protection Studies and approved by the Contracting Officer, except adjust motor circuit protectors per the motor nameplate and NFPA 70 requirements.

B. Fuses:
1. Install fuses (type rating, speed) as recommended in the Coordinated Power System Protection Studies and approved by the Contracting Officer. Provide recommended sizes for all fuses in each study.

C. Programmable Protective Devices:

1. Contractor shall program and configure all programmable protective devices with settings and parameters determined in the Coordinated Power System Protection Studies as approved by the Contracting Officer.

D. Ground Fault Protection System:
   1. Single source system:
      a. Main breaker using the residual sensing method system.
      b. Main and feeder breakers: Utilize four individual current sensors; the phase sensors are integral to the circuit breaker and the neutral sensor is external to the circuit breaker.

E. Testing:
   1. Acceptance testing: See Specification Section 26 08 13.
   2. Adjustable circuit breakers:
      a. Test and verify all circuit breaker trip functions using a test set provided by the manufacturer for that purpose for circuit breakers 1200 A and above.
   3. Ground fault protection system testing:
      a. Performance test installed ground fault protection system as required by the NFPA 70.
      b. Use high current injection method to test system.
      c. Test report shall indicate:
         1) Device settings.
         2) Tripping time in cycles for each device.
         3) Test current.
         4) Date of test.
         5) Name of certified testing firm that performed the test.
   4. Contracting Office shall have the option to witness the on-site commissioning and field testing at their own expense. Notice of testing shall be provided minimum 15 working days before the test is to be conducted.

3.3 CLOSEOUT ACTIVITIES

A. Refer to Section 01 81 33 – Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

SECTION 26 28 02
COORDINATED POWER SYSTEM PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Coordinated system protection studies for electrical systems in the Project:
      a. Short-circuit studies.
      b. Protective coordination studies.
      c. Arc-flash hazard studies.
      d. Circuit breaker and protective device settings.
      e. Associated reports.
      f. Separate studies and reports for:
         1) North Rim Temporary Waste Water Treatment Plant.

B. Related Sections include but are not necessarily limited to:
   1. Section 26 05 00 – Common Work Results for Electrical.
   2. Section 26 08 13 - Acceptance Testing.
   3. Section 26 28 00 – Overcurrent and Short Circuit Protective Devices.

C. Completely coordinate with work of other trades.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 242, Recommended Practice for Protection and Coordination of Industrial and Commercial Power Systems (Buff Book).
      b. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis (Brown Book).
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC)
      b. 70E, Standard for Electrical Safety in the Workplace

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

1.4 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Reports:
   a. Short circuit study report.
   b. Protective coordination study report.
   c. Arc-flash hazard study.
   d. As-left condition of all circuit breakers that have adjustable settings.
   e. Provide separate studies for each project site:
      1) North Rim Temporary Waste Water Treatment Plant.

PART 2 - PRODUCTS – NOT USED.

PART 3 - EXECUTION

3.1 COORDINATED POWER SYSTEM PROTECTION

A. Coordinated Power System Protection:
   1. Prepare studies to demonstrate that the equipment and system constructed meet the specified requirements for equipment ratings, coordination, and protection. Each study shall include a short circuit study report, system protective coordination study report, arc-flash study, and associated report(s) and protective device settings.
   2. Prepare a separate study for each project site, including:
      a. North Rim Temporary Waste Water Treatment Plant.
   3. The studies shall begin at the locations indicated and extend down the system through all buses.
      a. North Rim Temporary Waste Water Treatment Plant: Begin the study at the first overcurrent device upstream from the park transformer that feeds the plant. The study shall include all downstream buses, equipment, and devices.
   4. Perform the studies in accordance with IEEE 242 and IEEE 399.
   5. Include the name of the software developer, software package and software version number in the computer generated studies.
   6. System short circuit study report:
      a. Begin each study at the location indicated above and extend down the system through all buses. Perform a balanced three-phase fault, bolted line-to-line fault and line-to-ground fault study.
      b. Prepare a one-line diagram to show the electrical system buses, transformers and all sources of fault current including generators and motors.
      c. Utilize manufacturer's data for the actual proposed equipment (e.g., transformer impedance).
      d. Coordinate the available utility fault current and existing protective equipment settings with the power utility company and NPS staff. The power utility is Garkane Energy Cooperative(Garkane). Contact information for Garkane and NPS staff includes:
         1) Garkane Energy - Kanab:
            Neal.brown@garkane.com
            800-747-5403
         2) NPS North Rim Park Staff:
            Josiah Brown
            Josiah_Brown@nps.gov

      e. Preliminary short circuit information (provided by Garkane on 23 May 2024) includes:
         1) North Rim Entrance Station:
            a) Line-Line service voltage: 24.9kV
            b) Maximum 3-phase fault current: 236.8A
            c) Maximum 1-phase fault current: 182.6A
            d) Positive sequence X/R ratio: Contractor obtain from Garkane
            e) Zero-sequence X/R ratio: Contractor obtain from Garkane
            f) First overcurrent device upstream: Contractor obtain from Garkane.
            g) Confirm all electric information used in the studies with Garkane.
      f. Show input data in tabular form in the report and/or on the one-line diagram.
         1) Input data shall include but is not limited to:
            a) Utility fault current or MVA and X/R ratio.
            b) Bus voltages.
            c) Conductor sizes and type of conduit.
            d) Generator and motor sizes and contributions.
            e) Transformer sizes and impedances.

g. Show available fault current at each bus in tabular form in the report and/or on the one-line diagram.
h. Perform studies for both normal power and emergency/standby power scenarios.

7. System protective coordination study report:
   a. Begin each study at the location indicated above and extend down the system through all buses as required to ensure a coordinated power system.
   b. Include utility power and generator power scenarios.
   c. Demonstrate that the maximum possible degree of selectivity has been obtained between devices specified for the protection of equipment and conductors from damage from overloads and fault conditions.
      1) Where necessary, an appropriate compromise shall be made between system protection and service continuity.
      2) Consider system protection and service continuity to be of equal importance.
   d. Prepare a one-line diagram to show the electrical system buses, transformers and protective devices.
   e. Utilize manufacturer's data for the actual proposed protective devices.
   f. Summarize the coordination study, conclusions and recommendations.
      1) As a minimum, include the following:
         a) The manufacturer's information used to prepare the study.
         b) Assumptions made during the study.
         c) Recommended taps and settings of all adjustable devices in tabulated form.
         d) Composite coordination time-current curves on log-log paper showing:
            (1) That the settings for each protective device will provide protection and selectivity.
            (2) Identify each curve.
            (3) Cable and equipment damage points.
            (4) Circuit interrupting device operating and interrupting times.
            (5) One-line sketch of the part of the system being investigated.
            (6) Include as many curves as possible on a graph while maintaining readability.
         e) Ground fault curves shall be separated from the standard time-current curves but shall be on log-log paper showing:
            (1) That the settings for each protective device will provide protection and selectivity.
            (2) Identify each curve.
            (3) Cable and equipment damage points.
            (4) Circuit interrupting device operating and interrupting times.
            (5) One-line sketch of the part of the system being investigated.
            (6) Include as many curves as possible on a graph while maintaining readability.
         f) Position time-current curves for each device to provide for maximum selectivity to minimize system disturbances during fault clearing.
         g) Advise the Contracting Officer of potential coordination problems discovered during the study and include recommendations to resolve the problem.
         h) Submit the report for approval 90 days prior to equipment energization.

8. Arc Flash Study and Labeling
   a. Using the results of the short circuit study, prepare a detailed Arc Flash Study for each project location.
   b. The study shall include normal source and generator-powered scenarios.
   c. Analysis shall identify any areas with a hazard level above 2 (>8 Cal/cm^2). The study shall be re-run to ensure the software is looking at clearing times of upstream devices and mis-coordinated devices, use of ARM switches, etc.
   d. If there are remaining areas with a hazard level above 2 (>8 Cal/cm^2) after re-running the results, prepare a list of recommendations to address the problem. Some typical suggestions include:

1) Arc flash reduction maintenance (ARM) switches on breakers to reduce time delays or settings during maintenance.
2) Arc flash detection relays.
3) Multiple labels describing different arc flash hazards specific to the electrical configuration (i.e. on generator power).

e. Arc Flash shall be performed in accordance with latest AHJ approved versions of the NFPA 70 and 70E requirements.

f. Labeling Requirements:
1) Provide updated arc flash labels for all equipment at each project location. All labels shall include required information per NFPA 70 & 70E.
2) Labels shall be permanent machine printed labels that are rated for the environment the electrical is mounted in. Outdoor labels shall be sunlight and weatherproof.
3) Arc flash labels shall be affixed to all electrical switchgear, MCCs and other electrical equipment.

9. The final report and associated software files for all the Coordinated Power System shall be available to the Government for their use, without further royalty, usage fees or other compensation. The reports shall be transmitted via electronic media, CDROM or other typically acceptable electronic file transfer methods at the conclusion of the project.
10. All submittals, resubmittals and reports shall be signed and stamped by a Registered Professional Electrical Engineer in the state of Arizona.

B. Adjustable Circuit Breakers:
1. Provide recommended settings for all adjustable circuit breakers and other adjustable protective devices.

C. Fuses
1. Provide recommended sizes for all fuses in each study. Include recommendation for fuse type, rating, and speed.

D. Programmable Protective Devices.
1. Provide recommended settings for all programmable protective devices.

END OF SECTION

SECTION 26 28 16
SAFETY SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Safety switches.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 28 00 - Overcurrent and Short Circuit Protective Devices.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Heavy Duty Enclosed and Dead-Front Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Enclosed and Dead-Front Switches.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Provide a Summary Table or use Exhibit A that associates the safety switch features with connected equipment tag number. Exhibit A indicates minimum data required.
      c. See Section 26 05 00 for additional requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following safety switch manufacturers are acceptable:
   1. Eaton.
   2. Or Equal.

2.2 SAFETY SWITCHES

A. General:
   1. Non-fusible or fusible as indicated on the Drawings.
   2. Suitable for service entrance when required.
   3. NEMA Type HD heavy-duty construction.
   4. Switch blades will be fully visible in the OFF position with the enclosure door open.

5. Quick-make/quick-break operating mechanism.
6. Deionizating arc chutes.
7. Manufacture double-break rotary action shaft and switchblade as one common component.
8. Clear line shields to prevent accidental contact with line terminals.
9. Operating handle (except NEMA 7 and NEMA 9 rated enclosures):
    a. Red and easily recognizable.
    b. Padlockable in the OFF position.
    c. Interlocked to prevent door from opening when the switch is in the ON position with a defeater mechanism.

B. Ratings:
1. Horsepower rated of connected motor.
2. Voltage and amperage: As indicated on the Drawings.
3. Short circuit withstand:
    a. Non-fused: 10,000A.
    b. Fused: 200,000A.

C. Accessories, when indicated in PART 3 of this Specification Section or on the Drawings:
1. Neutral kits.
2. Ground lug kits.
3. Auxiliary contact kits:
    a. Opens before main switch.
    b. Rated 10A at 125/250 VAC.
    c. One N.O. and one N.C. contact.

D. Enclosures:
1. NEMA 1 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. With or without knockouts, hinged and lockable door.
2. NEMA 3R rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. With or without knockouts, hinged and lockable door.
3. NEMA 4 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
4. NEMA 4X rated (metallic):
    a. Body and cover: Type 304 or 316 stainless steel.
    b. No knockouts, external mounting flanges, hinged and gasketed door.
5. NEMA 4X rated (nonmetallic):
    a. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
    b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.
6. NEMA 7 and NEMA 9 rated:
    a. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
    b. Drilled and tapped openings or tapered threaded hub.
    c. Gasketed cover bolted-down with stainless steel bolts.
    d. External mounting flanges.
    e. Operating handle padlockable in the OFF position.
7. NEMA 12 rated:
    a. Body and cover: Sheet steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
    b. No knockouts, external mounting flanges, hinged and gasketed door.

E. Overcurrent and short circuit protective devices:
1. Fuses.

2. See Specification Section 26 28 00 for overcurrent and short circuit protective device requirements.

F. Standards: NEMA KS 1, UL 98.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's instructions and recommendations.

B. Install switches adjacent to the equipment they are intended to serve unless otherwise indicated on the Drawings.

C. Provide auxiliary contact kit on local safety switches for motors being controlled by a variable frequency drive.
1. The VFD is to be disabled when the switch is in the open position.

D. Permitted uses of NEMA 1 enclosure:
1. Surface or flush mounted in areas designated dry in architecturally finished areas.

E. Permitted uses of NEMA 3R enclosure:
1. Surface mounted in exterior location for HVAC equipment only.

F. Permitted uses of NEMA 4 enclosure:
1. Surface mounted in areas designated as wet.

G. Permitted uses of NEMA 4X metallic enclosure:
1. Surface mounted in areas designated as wet and/or corrosive.

H. Permitted uses of NEMA 4X nonmetallic enclosure:
1. Surface mounted in areas designated as corrosive.
2. Surface mounted in areas designated as highly corrosive.

I. Permitted uses of NEMA 7 enclosure:
1. Surface mounted in areas designated as Class I hazardous.

J. Permitted uses of NEMA 9 enclosure:
1. Surface mounted in areas designated as Class II hazardous.

K. Permitted uses of NEMA 12 enclosure:
1. Surface mounted in areas designated as dry in non-architecturally finished areas.

END OF SECTION

EXHIBIT A

Safety Switch Summary Table					
Equipment Tag	Switch Model Number	Rated Amps	Fused / Non-fused	Enclosure Type	Accessories
Example	Per MFR	60A	NF	NEMA 4X non-metallic	Ground lug, Aux Contact

SECTION 26 29 23
VARIABLE FREQUENCY DRIVES - LOW VOLTAGE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Variable frequency drives (VFDs) for operation of inverter duty motors.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.
   2. Section 26 05 00 - Common Work Results for Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI).
   2. ETL Testing Laboratories (ETL).
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 399, Recommended Practice for Industrial and Commercial Power Systems Analysis.
      b. 519, Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
      c. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
   4. National Electrical Manufacturer's Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. MG 1, Motors and Generators.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) Article 430, Motors Motor Circuits, and Controllers.
   6. Occupational Safety and Health Administration (OSHA).
   7. Underwriters Laboratory, Inc. (UL):
      a. 508, Standard for Industrial Control Equipment.
      b. 508A, Standard for Industrial Control Panels.

B. Qualifications:
   1. Provide drives that are listed and labeled by UL, ETL, or other Nationally Recognized Testing Laboratory (NRTL) as defined by OSHA regulations, or that have been inspected and subsequent field-labeled by such NRTL.
   2. Where listed drives and other components are installed in a common enclosure, the assembly shall be listed and labeled per UL 508 and UL 508A or equivalent NRTL standard.
      a. Entire assembly shall be affixed with a UL 508A label "Listed Enclosed Industrial Control Panel" or equivalent NRTL label prior to shipment to the jobsite.
   3. VFD Supplier shall maintain an authorized service organization within 300 miles of the Project Site.

C. Coordination:
   1. The intent of this Specification Section is to allow the VFD manufacturer to provide the best solution for the harmonic and motor protection outlined herein.
      a. This solution shall include, but not be limited to, all aspects of the distribution system including standby generation, motor feeder cable type and available floor space.
   2. Motor and VFD coordination: See Specification Section 01 61 03.
   3. VFD shall be supplied complete with all required control components.
      a. Provide control as indicated:
         1) On the electrical drawings.

2) As specified in this Specification Section.
3) As specified in the process control system loop descriptions.

b. VFD manufacturer shall review the application and provide, at no additional cost to the Contracting Officer, the hardware and software necessary to allow the VFD to control the driven equipment motor over its required operating range.
1) These may include, but are not limited to, analog and digital interface modules, communication interface modules, switches, lights and other devices.

c. Coordinate control devices with devices furnished with driven equipment such as vibration switches, thermal sensors, leak detectors, etc.

4. Verify plan dimensions with equipment space requirements as indicated on the Drawings.
a. Equipment which exceeds the allotted maximum dimensions may not be acceptable.
b. Equipment which reduces clear working space below the minimums established by the NFPA 70 will not be acceptable.

1.3 DEFINITIONS

A. Contracting Officer: Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

B. Variable Torque (VT):
1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as speed is reduced below full rated.
2. This type of load permits the VFD and the motor to operate at reduced output current at reduced speed.

C. Constant Torque (CT):
1. Defines a load characteristic in which the torque delivered from the motor to the load remains constant as speed is varied.
2. This type of load requires the VFD to be able to continuously deliver rated output current over the entire speed range.

D. Constant Horsepower:
1. Defines a load characteristic in which the torque delivered from the motor to the load is reduced as the speed is increased.
2. This characteristic is required for operation of the VFD and motor above rated frequency to maintain output current within the rated value.

E. Inverter Duty Motor: An AC induction motor complying with all requirements of NEMA MG 1 Part 31 for definite-purpose inverter-fed motors.

F. Standard Motor: An AC induction motor that fails to comply with one or more requirements of NEMA MG 1 Part 31.

G. Low Voltage: 600 VAC or less.

1.4 SUBMITTALS

A. Shop Drawings:
1. Provide a schedule for each VFD including the following information:
a. Equipment Tag Number.
b. VFD Complete Catalog Number.
c. VFD Amp Frame Size.
d. Variable or Constant Torque Rating Basis.
e. Rated Input Current.
f. Rated Continuous Output Current.
g. Rated Short Circuit Current.
h. VFD cable type specified (shielded or non-shielded).
i. VFD Maximum Motor Lead Length for the type of cable used.
j. Motor Manufacturer.
k. Motor Frame Size.

l. Motor Full Load Amps.
m. Motor Service Factor.
n. As installed motor Lead Length.
o. VFD options provided to meet harmonic or motor protection specifications.

2. Submit VFD Shop Drawings concurrently with driven equipment and motor Shop Drawings.
3. Product technical data:
   a. Complete electrical ratings and performance specifications confirming compliance with specified ratings and performance.
   b. Maximum rate of heat rejection from VFD and all related components and associated cooling requirements.
   c. Manufacturer's installation instructions.
   d. Manufacturer's programming and operating instructions.
   e. See Section 26 05 00 for additional requirements.
4. Fabrication and/or layout drawings:
   a. Top, front and side exterior views, with details showing maximum overall dimensions of enclosure, mounting provisions and conduit/cable entry provisions including top, bottom, and side-entry locations.
   b. Identify minimum clearances from other VFDs or electrical equipment required for proper cooling at top, bottom, side and back of enclosure.
   c. Three-line diagrams showing AC schematic of VFD, input, output and bypass devices including device ratings.
   d. Interior layout drawings showing location of all components within enclosure, field wiring terminal boards, and power and grounding connections.
   e. Field wiring diagrams showing locations and sizes of all electrical connections, ground terminations, and requirements for shielded wire usage or any other special installation considerations.
   f. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70, include any required calculations.
5. Certifications:
   a. Submit with Shop Drawings:
      1) Identification and location of closest authorized service organization.
      2) Harmonic analysis at each PCC per Harmonic Protection Requirements Article.
   b. Submit prior to shipment:
      1) Certified factory test reports confirming compliance with specified requirements.
   c. Submit after installation:
      1) Certified field service reports showing:
         a) Each VFD is operational.
         b) Each VFD and its driven equipment motor are compatible.
         c) Each VFD responds correctly to the input control signals.
         d) Critical frequencies of the drive system and that the VFD has been set to lockout these frequencies.
         e) Measured harmonic levels per Harmonic Protection Requirements Article.
         f) Measured motor terminal peak voltages per Motor Protection Requirements Article.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Approved copy of VFD schedule per Submittals Article.
3. Manufacturer's instruction manuals.
4. Troubleshooting procedures with a cross-reference between symptoms and corrective recommendations.
5. Connection data to permit removal and installation of recommended smallest field-replaceable parts.

6. Recommended spare parts list.
7. Commissioning sheets showing "as-left" values of all user-programmable or adjustable drive parameters.

C. Refer to Section 01 81 33 – Cyber Security Requirements for required cyber security related submittals.

1.5 WARRANTY

A. Full VFD warranty shall be provided by the manufacturer for a period of three (3) years following VFD commissioning.

B. See Specification Section 01 67 00 – Product Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Eaton.
   2. Or Equal.

2.2 GENERAL

A. VFDs shall consist of a rectifier-DC bus-inverter combination producing a sine-coded pulse-width-modulated (PWM) output voltage waveform.

B. VFDs, whether installed in motor control center (MCC) construction or separately mounted, shall constitute a complete combination motor controller per NFPA 70, Article 430 and shall provide the following per the requirements of that article without the addition of any external components or devices.
   1. Motor control.
   2. Motor overload protection.
   3. Motor and motor branch circuit short circuit and ground fault protection.
   4. Motor and controller disconnecting means.

C. It is the intent of this Specification that VFDs shall be an "engineered" or "configured" drive package in which the VFD chassis, all input, output and bypass power devices, VFD accessories, ancillary switches, contactors, relays, and related control devices are selected, furnished, factory-assembled and factory-tested by the VFD manufacturer in a single enclosure requiring only connection of the power supply circuit, motor branch circuit, and external control wiring in the field.

2.3 PERFORMANCE AND DESIGN REQUIREMENTS

A. Application:
   1. VFD(s) shall be of sufficient capacity and shall provide a quality of output waveform for stepless motor control from 10 to 100% of base speed of the driven equipment.
   2. VFDs shall be compatible with:
      a. Inverter duty induction motors.
      b. Standard induction motors.
      c. Special purpose submersible induction motor/pump.

3. VFDs shall be suitable for Constant Torque (CT) or Variable Torque (VT) applications.
    a. VFD manufacturer shall coordinate with the manufacturer of the driven equipment to identify CT and VT applications.
4. VFDs shall be designed to operate successfully under the following site conditions:
    a. Ambient:
        1) Temperature: 0-40 degrees C.
        2) 95% non-condensing relative humidity.
    b. Elevation:
        1) Temporary Wastewater Treatment Plant – 8900 feet above MSL
    c. Power supply characteristics:
        1) 480Vac, 3 PH, 60 Hz, 3 wire, (±10%).
        2) 208Vac, 3 PH, 60 Hz, 3 wire, (±10%).
        3) Effectively grounded.
        4) Ungrounded.

B. Ratings and Performance Specifications:
1. Voltage rating:
    a. Nominal: 460 or 480 VAC, 3 PH, 60 Hz.
    b. Range for continuous full load operation: ±10% of nominal.
    c. Voltage imbalance tolerance for full load operation: 3% minimum.
2. Current ratings:
    a. Continuous (including altitude derating for site elevations):
        1) Equal to or greater than the motor nameplate full load.
    b. Short-term overload:
        1) VT: 110% for 1 minute.
        2) CT: 150% for 1 minute.
        3) Permissible for 1 minute every 10 minutes continuously.
    c. Short circuit:
        1) 65,000 A RMS SYM, minimum.
        2) Where a short circuit rating is not indicated or specified for individual VFDs, each VFD shall have a rating not less than indicated on the Drawings for the MCC, switchboard or panelboard the VFD is supplied from.
        3) Where specified short circuit rating indicates additional input impedance is required to protect semiconductors, provide input AC line reactors, whether required to meet harmonic performance specifications or not.
3. Efficiency:
    a. 97%, minimum, at full speed and full load.
    b. 93%, minimum at 1/2 speed and full load.
4. Displacement power factor:
    a. 95%, minimum from 50% to 100% speed and load.
5. Efficiency and power factor criteria apply from the input terminals to the output terminals of the VFD alone, excluding losses of input and output power circuit accessories.
6. Frequency drift:
    a. +0.5% of set frequency.
7. Speed regulation (motor dependent): 3%.
8. Speed range: 10:1.
9. Control type:
    a. Volts/Hertz ratio; constant over the entire operating range of the VFD except:
        1) When operating under voltage boost.
        2) At frequencies over 60 Hz.
    b. Open Loop Sensorless vector.

C. Operational Features:
1. Insensitive to input phase sequence.
2. Continued operation with momentary voltage dips of 25% of rated voltage, or single phase condition: 4 seconds, minimum.

3. Controls power loss ride-through: 500 MSEC, minimum.
4. Electronic reversing.
5. DC injection braking.
6. Anti-windmilling: Synchronization of VFD starting frequency with spinning or coasting load, forward or reverse.
7. Critical frequency band lockout:
    a. Minimum of three settings.
    b. Adjustable bandwidth, 1 - 5 Hz.
8. Capable of operating without the motor connected for start-up and troubleshooting.
9. Provide drive protection as required to protect the drive components when the connected motor has become a generator by surges in the water lines forcing the pump to turn in the reverse direction.

D. The VFD shall be provided with the following minimum user-programmable parameters:
1. Carrier frequency.
2. Independent maximum and minimum speeds for forward and reverse operation.
3. Start frequency and hold time.
4. Independent linear acceleration and deceleration time.
5. Preset “jog” speed.
6. Three critical frequency bands.
7. One preset speed selectable by logic input.
8. Volts/Hertz ratio.
9. Voltage boost, magnitude and frequency range.
10. Process controller gain, offset and bias.
11. Current limit.
12. Overcurrent pickup.
13. Overcurrent delay.
14. Ground fault pickup.
15. DC injection level and time.

E. The VFD shall be designed such that the power circuit components are fully protected from line side disturbances and load side faults:
1. General:
    a. Shutdown conditions associated with supply circuit conditions which can be corrected external to the VFD-motor system shall be provided with automatic reset, with shutdown cause logged in memory:
        1) Input under voltage.
        2) Input over voltage.
        3) Input under frequency.
        4) Input over frequency.
        5) Input Phase loss.
        6) DC Bus under voltage.
    b. Shutdown conditions which indicate overload or fault within the VFD, the output circuit, or the motor shall require local manual reset at the VFD, requiring operator intervention.
        1) Over temperature.
        2) Blown fuse.
        3) Component failure.
        4) Overload.
        5) Short circuit.
        6) Ground fault.
        7) DC Bus over voltage.
        8) External safety input (e.g., motor thermal protection).
        9) Logic fault.
    c. When automatic shutdown occurs, VFD shall restart only when remote run signal is removed and reapplied.

d. VFD shall hold cause of trip data for a minimum of four shutdowns in memory.
    1) Data to be accessible through the keypad, local communication link and remotely.
2. Input protection:
    a. Input circuit breaker or current-limiting fuses with externally operable disconnect.
        1) Fault current interrupting rating equal to or greater than the specified withstand rating of the VFD.
        2) Handle padlockable in the OFF position.
    b. Provide full protection for semiconductors integral to the VFD; units requiring current-limiting fuses or circuit breakers in the supply circuit are not acceptable.
    c. Incoming line transient suppression.
        1) 6000V peak per IEEE C62.41.
        2) Phase-to-phase and phase-to-ground protection.
    d. Sustained over voltage trip.
3. Internal protection:
    a. Surge suppression and power device snubbers.
    b. Power devices rated at 2.5 times line voltage.
    c. Instantaneous over current trip.
    d. DC bus over voltage trip.
    e. Power device over temperature trip.
    f. Control logic circuit malfunction trip.
4. Output protection:
    a. Inverse-time overload trip:
        1) UL Class 10 characteristic.
    b. Over voltage trip.
    c. Over frequency trip.
    d. Short circuit trip.
        1) Line to line and line to ground.
    e. Ground fault trip.

2.4 OPERATOR AND REMOTE CONTROL INTERFACE

A. Drive controls shall be microprocessor-based with on-board human machine interface and both local and remote digital communications capability.
    1. All monitoring and control functions, other than those shutdowns specified to be manual reset only, shall be available both locally and remotely.

B. Control circuits shall be 120 VAC or 24 VAC or 24 VDC.
    1. 120 VAC supplied by CPT in the VFD.
        a. CPT shall have minimum additional capacity of 60 VA greater than that required by control devices.
        b. CPT shall have two fuses on the primary side and one fuse on the secondary side.
        c. CPT shall have surge protection on the primary side independent of any other surge protection in the VFD.
    2. 24 VAC or 24 VDC supplied by Class 2 power supply in the VFD.
        a. Power supply shall have minimum additional capacity of 33% greater than that required by control devices.
        b. Provide two current-limiting fuses on the AC supply to the power supply.
        c. Power supply shall have surge protection on the primary side independent of any other surge protection in the VFD.

C. Operator Interface:
    1. Door mounted sealed keypad, membrane type with LED or LCD display.
        a. Messages shall be in English and engineering units.
        b. Drive operating parameters shall be programmable.
        c. Menu driven.
        d. Password security.
        e. Display fault and diagnostic data.

f. Operating parameters, fault and diagnostic data maintained in non-volatile memory with historic log of fault and diagnostic data.
g. Gold plated plug-in contacts.

2. Provide indication and control interface, integral in the keypad, as required in the sequence of operation and Drawings.
   a. Minimum indications:
      1) Run.
      2) Stop.
      3) Ready.
      4) Alarm.
      5) Fault.
      6) Local control.
      7) Remote control.
      8) Control source local.
      9) Control source remote.
      10) Speed indication.
   b. Minimum control functions:
      1) Local/Remote switch.
      2) Stop button.
      3) Start button.
      4) Reset button.
      5) Speed control buttons.
3. Diagnostic indicators located externally on the face of the drive shall show the type of fault responsible for drive warning, shutdown or failure.
   a. On occurrence of more than one condition, each shall be recorded or indicated by the diagnostics.

D. Remote Control Interface:
1. Local portable computer interface via RS232/RS242 serial communications port:
   a. Capability to:
      1) Start-Stop VFD.
      2) Control VFD Speed.
      3) Access fault and diagnostic data.
2. Analog and discrete inputs:
   a. Speed reference (setpoint) signal 4-20 mA DC.
   b. Drive RUN command.
3. Analog and discrete outputs:
   a. 4-20 mA DC output for remote speed indication, as a function of frequency, calibrated 0 to 100%.
   b. Drive FAULT contacts.
   c. Drive RUNNING contacts.
   d. Drive selector switch in AUTO status contacts.
   e. Additional dry contacts to indicate status signals as indicated on the Drawings.
   f. All contacts for signaling external to the VFD shall be through auxiliary relays with contacts rated minimum 10A and shall be wired to field terminal blocks.
4. Contacts:
   a. Contacts shall be rated 2 A inductive at 120 VAC.
   b. All contacts shall be wired to field wiring terminal boards.
5. Drive shutdown on external fault input:
   a. Provide isolated input for dry contact from external motor or system safety devices to cause immediate shutdown of VFD.
   b. Safety shutdown to be operable in all operating modes of drive, including local operation from keypad.
   c. For submersible pump/motors incorporate the temperature/leak detection monitor and shut down.

d. Local safety switch, to driven equipment, auxiliary contact to lock-out VFD from running when safety switch is open.

6. Network communications capability:
   a. Provide VFD with communication card, protocol and required programming for digital communication of all VFD program and operational parameters to plant control system via:
      1) Modbus TCP/IP.
      2) Ethernet IP (if interfacing with an Allen Bradley PLC).
   b. Refer to Drawings for additional requirements.

2.5 HARMONIC PROTECTION REQUIREMENTS

A. All VFDs shall be capable of satisfactory operation from a source having voltage distortion and notch characteristics identified as acceptable for a "dedicated system" in IEEE 519 Table 10.2.

B. With all VFDs operating under worst-case harmonic current conditions, and the facility supplied from either or both the utility and generator sources, the VFDs shall not produce harmonic effects in excess of the following limits at any point of common coupling (PCC).
   1. Voltage distortion and notch characteristics: IEEE 519 Table 10.2 for General System.
   2. Current distortion: IEEE 519 Table 10.3 based on calculated I_{SC}/I_L at each PCC.

C. PCC shall be considered:
   1. Building service entrance switchgear, switchboard or MCC.

D. The minimum mitigation measures required to meet the specified harmonic criteria are one of the following topologies:
   1. All other volumes:
      a. 6-pulse rectifier topology with input line reactors or DC link reactors, minimum impedance 5% on drive kVA base.
      b. 18-pulse rectifier topology for each VFD with input current ratings in excess of 100 HP.

E. VFD manufacturer shall determine, for their proposed equipment, uncorrected harmonic distortion levels and mitigation techniques required to meet the specified limits and shall furnish the VFD types and all accessory items and equipment necessary to do so, whether specified herein or not.

F. VFD manufacturer shall provide a harmonic analysis of the distribution system based on their proposed specific equipment characteristics and mitigation techniques confirming that the specified levels are not exceeded.
   1. Analysis shall be based on the methodology of IEEE 519 and IEEE 399.
   2. Power system data for analysis shall be taken from the electrical drawings and approved equipment submittals.
      a. VFDs provided in a package with equipment specified elsewhere, shall be included in the analysis.

G. Following start-up, with facility at full load operation, provide measurement of harmonic voltage, current and notch characteristics at each PCC according to the requirements of IEEE 519 Section 9.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.6 MOTOR PROTECTION REQUIREMENTS

A. The VFD shall produce a quality of output waveform adequate to allow the motor to produce rated torque at rated RPM continuously without exceeding the temperature rise given in NEMA MG 1 Table 31-2.

B. Provide motor overload, short circuit and ground fault protection integral to drive electronics.

C. The VFD shall not produce voltage spikes in excess of the following values at the motor terminals when operated with the feeder types shown on the Drawings and the actual installed feeder lengths.
   1. If unmitigated voltage peaks exceed the specified limits, provide output line reactors, filters, or other devices as required to meet the specified limits:
      a. Inverter duty motors: 1280 V.
      b. Standard motors: 800 V.
      c. Rise time shall be greater than or equal to 0.1 microsecond.
      d. Motor lead length and data shall be determined by the Contractor based on the actual routing of the conductors.

D. Following start-up, provide measurement of peak voltage at the terminals of each motor, unless the lead lengths are 10% shorter than the manufacturers published literature for maximum lead length for the type of cable installed.
   1. Values in excess of specified limits require correction by contractor and re-measurement.
   2. Provide certification of compliant measurements as part of Field Service Engineer's final report.

2.7 EQUIPMENT CONSTRUCTION

A. Fabrication and Assembly:
   1. Each VFD system shall be factory-assembled for installation in an MCC or in an enclosure for remote mounting, and shall utilize interchangeable plug-in printed circuit boards and power conversion components wherever possible.
      a. Factory assembly shall be performed by the VFD manufacturer or authorized agent.
      b. Systems fabricated or assembled in whole or in part by parties other than the VFD manufacturer or authorized agent will not be acceptable.
      c. Indicated VFDs shall be mounted within standard motor control center sections, and included as part of the overall motor control center.
   2. Reactors and/or filters, where required, shall be mounted within or in an ancillary enclosure adjacent to the drive enclosure, or with the Contracting Officer's permission may be mounted in a separate enclosure.
   3. Cooling fans, as required, shall be provided to run when drive is running.
   4. Enclosures for separately mounted VFD's:
      a. NEMA Type 1 for installation in Electrical Rooms.
      b. NEMA Type 12 for installation in other unclassified areas.
      c. NEMA Type 4X stainless steel for installations in wet, damp or outdoor areas.
         1) Provide enclosure cooling required to not exceed drive temperature ratings.

B. Wiring:
   1. The wiring in the VFD shall be neatly installed in wire ways or with wire ties where wire ways are not practical.
      a. Where wire ties are used, the wire bundles are to be held at the back panel with a screw-mounted wire tie mounting base.
      b. Bases with a self-sticking back will not be allowed.
   2. All plug-in contacts shall be gold-plated.
   3. Provide terminal boards for all field wiring and inter-unit connections, including analog signals.
      a. Provide terminals for shield continuity where required.
   4. Terminal blocks shall be complete with marking strip, covers and pressure connectors.
      a. Non-brittle, interlocking, track-mounted type.
      b. Screw terminals will not be allowed.
      c. A terminal for each conductor of external circuits plus one ground for each shielded cable.
      d. For free-standing panels, 8 inches of clearance shall be provided between terminals and the panel base for conduit and wiring space.
      e. Not less than 25% spare terminals shall be provided.

f. Terminals shall be labeled to agree with identification indicated on the suppliers submittal drawings.
g. Individually fuse each control loop or system and all fuses or circuit breakers shall be clearly labeled and located for easy maintenance.

5. All grounding wires shall be attached to the enclosure sheet metal with a ring tongue terminal.
   a. The surface of the sheet metal shall be prepared to assure good conductivity and corrosion protection.
6. Wiring shall not be kinked or spliced and shall have markings on both ends or be color coded.
   a. Markings or color code shall match the manufacturer's drawings.
7. With the exception of electronic circuits, all interconnecting wiring and wiring to terminals for external connection shall be stranded **tinned copper**, type MTW or SIS, insulated for not less than 600 V, with a moisture-resistant and flame-retardant covering rated for not less than 90 DegC.

C. Nameplates:
1. All devices mounted on the face of the drive shall be provided with a suitable nameplate.
2. Push buttons, selector switches, and pilot lights shall have the device manufacturer's standard legend plate.
3. Relays, terminals and special devices inside the control enclosure shall have permanent markings to match identification used on manufacturer's wiring diagrams.

D. Painting: Enclosure, after being phosphate washed, shall be thoroughly cleaned and given at least one (1) coat of rust-inhibiting primer on all inner surfaces prior to fabrication.

2.8 COMPONENTS AND ACCESSORIES

A. Reactors:
1. For use on 6-pulse VFDs.
2. Impedance: 5%.
3. Continuous current: Not less than drive rating.
4. Current overload: 150% for 1 minute.
5. Insulation temperature rating: 180 degrees C.
6. Copper windings.
7. Saturation current rating: 3.5 to 5 times rated current.
8. Hi-potential rating: 2500 VAC line to ground and line to line, for 1 minute.
9. Noise reduction features:
   a. Epoxy over cast coil.
   b. Extra dips and bakes of varnish over continuous wound coil.

2.9 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Conduct all standard tests in accordance with NEMA and ANSI standards to ensure conformance to Specification requirements.

2.10 MAINTENANCE MATERIALS

A. Provide manufacturer's recommended renewable spare parts (e.g., power and control fuses).

B. Spare parts utilized during pre-start-up or start-up and demonstration testing shall be immediately restocked, at no cost to the Contracting Officer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and as indicated on the Drawings.

B. Provide separately mounted VFD enclosure with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
   1. Determine the SCCR rating by one of the following methods:
      a. Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
      b. Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
      c. Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.
   2. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the equipment or control panel circuit originates.
   3. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

C. Verify the installed motor nameplate electrical requirements do not exceed the VFD capacity.

D. Provide services of manufacturer's representative to perform start-up services.

E. The selection of input and output harmonic and voltage spike protection shall also be made on the available physical space.
   1. The space available on the Drawings shall not be exceeded.

3.2 START UP

A. Pre-start-up Services:
   1. Shall be completed a minimum of 30 days prior to the start-up and demonstration period.
   2. Shall consist of:
      a. Physical and electrical installation check.
      b. Final adjustments and calibration of drive parameters.
      c. VFD operation from simulated input signals.
   3. Shall be complete when VFD(s) are fully operational.

B. Field Quality Control:
   1. Perform field measurement of harmonics at each PCC per Harmonic Protection Requirements Article.
      a. For each individual VFD.
      b. For the maximum number of VFDs that will be operational at the same time.
      c. When all loads are at 75% load minimum.
      d. Duration: 1 hour minimum.
   2. Perform field measurement of the maximum voltage peak at the terminals of each motor fed from a VFD per Motor Protection Requirements Article.
      a. Use a high speed oscilloscope to produce a plot of Voltage (Y axis) versus Time (X axis).
         1) Time shall be measured in microseconds.
      b. Tests shall be performed at full:
         1) Full voltage and speed.
         2) Loaded to 75% minimum.
         3) Duration: 1 hour minimum.
   3. Record all data necessary for the preparation of required test reports.

C. Start-up and Demonstration Services:
   1. Supervise start-up of all units including recheck of settings made during the pre-start-up tests.
      a. Perform all work in the presence of the Contracting Officer's designated representatives.
   2. Setup all VFDs with carrier frequency at minimum value consistent with proper operation; inform Contracting Officer of carrier frequencies set in excess of 5 kHz and reason for setting.

3. Simulate operation of the VFD and its associated control and instrumentation system in both the manual and automatic modes.
    a. Ensure compatibility of VFD with associated control and instrumentation signals.
4. Simulate VFD failures and demonstrate troubleshooting aids.

D. Specific Commissioning Requirements
1. All startup and commissioning shall be performed by Manufacturer-certified technicians such tha tall warranty provisions remain in full effect.
2. Set the pump-starting ramp-rate for the pump VFDs at Roaring Springs Pumphouse to a "slow" ramp rate in order to slowly ramp up discharge pressure and mitigate water-hammer and effects on the electrical system.
    a. Coordinate ramp settings with Pump Manufacturer and Contracing Officer before startup and commissioning commences.

E. Instruct Contracting Officer's designated personnel:
1. Minimum of 8 hours at the jobsite.
    a. North Rim Temporary Wastewater Treatment Plant
2. Include both field and classroom instruction.
3. Instructions shall include proper operation and maintenance procedures including, but not limited to:
    a. Lubrication.
    b. Troubleshooting.
    c. Repair and replacement.
    d. Parts inventory.
    e. Maintenance records.
4. See Section 01 79 00 for Operator training requirements.

3.3 CLOSEOUT ACTIVITIES

A. Refer to Section 01 81 33 – Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

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SECTION 26 36 00
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Transfer switches.

B. Related Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. KS 1, Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum).
   2. Underwriters Laboratories, Inc. (UL):
      a. 98, Standard for Safety Enclosed and Dead-Front Switches.
      b. 1008, Standard for Safety Switch Equipment.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification:
      b. See Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout drawings.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Refer to Section 01 81 33 – Cyber Security Requirements for required cyber security related submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. See Section 26 05 00.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the listed manufacturers are acceptable:
   1. Transfer switches:
      a. Eaton

b. Or Equal.

2.2 TRANSFER SWITCH

A. Wiring configuration to allow single load to be supplied by a normal or alternate source.

B. Enclosure:
   1. NEMA 3R rated:
      a. Body and cover: Type 304 or 316 stainless steel.
      b. No knockouts, external mounting flanges, hinged, gasketed and lockable door.

C. Standards: NEMA KS 1, UL 98.

D. Construction:
   1. Electrically operated mechanically held, double throw, air-break type.
   2. Silver-surface main contacts and protect by arcing contacts.
   3. Switch shall have provisions for visual inspection of switch blades and contacts.
   4. Mechanical design will positively open all ungrounded conductors from normal source before connection is made to alternate source and will positively open alternate source before connection is made to normal source.
   5. Mechanical interlock to ensure the switch cannot be readily disabled, disconnected, improperly adjusted, removed or otherwise made inoperative.
   6. Make all contacts and coils readily accessible for replacement from front of panel without major disassembly.
   7. Internally mounted main circuit breaker on incoming normal source.
      a. See Drawings for size.
   8. Separate alternate source compartment that can be opened without accessing the main switchboard section.
      a. Equipped with CAM Lock type receptacles for quick connection to temporary roll-up generator.
   9. Ratings:
      a. Continuous duty in both normal and emergency.
      b. Three-phase, three-pole, four-wire.
      c. Voltage and current ratings as indicated on the Drawings.
      d. Short circuit withstand rating equal to or greater than the normal source electrical gear.
   10. Standards: UL 1008.

E. Operation:
   1. Non-automatic
      a. Manual initiation of transfer

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated and in accordance with manufacturer's recommendations and instructions.

B. Connect as indicated in one-line diagram.

C. Mounting of transfer switches:
   1. Floor mounted on concrete pad.

3.2 CLOSEOUT ACTIVITIES

A. Refer to Section 01 81 33 – Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

SECTION 26 41 13
LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Lightning protection systems using lightning rods, including lightning protection systems for:
      a. Buildings and Structures.

B. Scope:
   1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to provide lightning protection systems of the type indicated.
   2. Contractor shall furnish the services of individual possessing required qualifications, as indicated in this Section, to prepare the final design of the lightning protection systems required, in accordance with this Section and other Contract Documents. Such services are not delegated design.
   3. Provide lightning protection systems for the following buildings and structures associated with the following locations:
      a. North Rim Temporary Wastewater Treatment Plant.

C. Related Requirements include but are not necessarily limited to:
   1. Section 26 05 26 - Grounding and Bonding.

1.2 REFERENCES

A. Terminology: In this Section and relative to lightning protection system Work, the terminology indicated below has the following meaning, regardless of whether indicated with initial capital letters:
   1. Classification of Buildings in accordance with NFPA 780:
      a. Class I: Any commercial, industrial, or residential building less than 75 feet in height.
      b. Class II: Any commercial, industrial, or residential building 75 feet or taller.
      c. Heavy-duty stacks: Any smokestack or venting stack with a flue cross-section area greater than 500 square inches and stack height greater than 75 feet.

B. Reference Standards:
   1. ASTM International (ASTM):
      a. B8 - Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
   2. Lightning Protection Institute (LPI):
      a. 175 - Standard for the Design - Installation - Inspection of Lightning Protection Systems.
   3. National Fire Protection Association (NFPA):
      a. 780 - Standard for the Installation of Lightning Protection Systems.
   4. National Electrical Manufacturers Association (NEMA):
      a. TC 2 - Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
   5. Underwriters Laboratories, Inc. (UL):
      a. 96 - Standard for Safety Lightning Protection Components.
      b. 96A - Standard for Installation Requirements for Lightning Protection Systems.
      c. 651 - Standard for Schedule 40, 80, Type EB and A Rigid PVC Conduit and Fittings.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Coordination - General:

a. Contractor shall coordinate the services of lightning protection system designer with all other elements of the Work.
b. Contractor has full responsibility for scheduling lightning protection system designs and all related Work.
c. Allow sufficient time in Progress Schedule for performance of lightning protection system services, including requests for interpretation or clarification between lightning protection system designer and Contractor and between Contractor and Contracting Officer.

2. Coordination of Lightning Protection System Work's Connections to Other Work:
a. Where lightning protection system Work connects to other Work, existing construction, or both, the lightning protection system Work shall be consistent with the other Work and existing construction to which lightning protection system Work connects, and adjacent construction.
b. Submit details, loading, anchorage, and other coordinating information necessary for the lightning protection system Work to properly interface with other Work.
c. Changes in the Work or existing construction, necessary as a result of the lightning protection system, are ineligible for increase in Contract Price or Contract Times, unless: (1) otherwise agreed by both Contracting Officer and Government, or (2) expressly indicated otherwise elsewhere in the Contract Documents for the lightning protection system Work.
d. Changes requiring extra compensation, time, or both arising from lightning protection system design aspects needed for convenience of Contractor, Subcontractor, or Supplier, are not grounds for increase in Contract Price or Contract Times.

3. Coordination of Submittals, Fabrication, Production, and Shipment:
a. Do not release for raw materials procurement, fabrication, production, and shipment to the Site materials, equipment, or systems designed by lightning protection system designer until the associated lightning protection system designer has completed the design and Contracting Officer has reviewed and approved all associated Shop Drawings, product data Submittals, Samples, and such Submittals have been delivered to and accepted by Contracting Officer.
b. Allow sufficient time in the Progress Schedule for required Submittals and required actions by lightning protection system designer and Contracting Officer.

1.4 QUALITY ASSURANCE

A. Qualifications:
1. Lightning Protection System Designer:
a. One individual, acceptable to Contracting Officer, shall design or directly supervise preparation of the final design of all lightning protection systems required for the Work.
b. Individual preparing, or directly supervising preparation of, final design of lightning protection systems shall possess current, valid "Designer Inspector" (DI) certification from Lightning Protection Institute (LPI) or "Lightning Protection Master Certification" (LPMC) from Underwriters Laboratories (UL).
c. In addition, individual performing, or directly supervising preparation of, final design of lightning protection system shall be able to furnish documentation indicating possession of not less than ten years' experience personally designing or supervising the preparation of lightning protection systems similar to that required for the Work.
d. Designer may be employee of lightning protection system Supplier or individual or entity retained by lightning protection system Supplier.
e. Submit to Contracting Officer copy of current certification as LPI DI or UL LPMC and record documenting experience of lightning protection system designer. Indicate designer's current employer and employment history.
f. Upon Contracting Officer's request, submit information for not less than five prior lightning protection systems, similar in type, scope, and extent to that required for the Work. Construction of each lightning protection system on each such project shall have been substantially complete for not less than one year at the time such documentation is

submitted to Contracting Officer. Such information shall include, for each project, the following: project name and location (city, state or province, country); project owner; designer's employer and their role in the project (prime contractor, subcontractor, or supplier); name of project's design professional (company name) and location; year lightning protection system was completed; and general description of scope and extent of lightning protection system work. .

2. Installer:
   a. Installer of lightning protection system may be Contractor or Subcontractor.
   b. Throughout the Work, installer shall be a current, "UL Listed Lightning Protection Contractor".
   c. Installer's project manager or site superintendent shall possess a current, valid certification as "Master Installer" from LPI. Such individual shall be actively involved in managing and supervising installation of the lightning protection system Work.
   d. Installer shall furnish valid "UL Master Label" for the substantially completed lightning protection system Work.
   e. In addition, installer shall possess not less than five years' relevant experience performing lightning protection system construction and shall be able to document not less than five completed, prior projects or similar scope and complexity to the lightning protection system Work within the most-recent five-year period.
   f. Submit to Contracting Officer documentation of installer's current status as "UL Listed Lightning Protection Contractor" and copy of required LPI "Master Installer" certification.
   g. Upon Contracting Officer's request, submit documentation of required experience.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Drawings of entire lightning protection system for each building, container, and structure for which lightning protection system is required. Include plans, sections, schematics, and details as appropriate.
      b. Plan drawings showing type, size, and locations of all lightning protection materials and equipment.Roof penetration detail drawings.
      c. Submit schedules (tables) of materials and equipment as appropriate, indicating type, size, materials, and location of each, together with other pertinent information.
      d. "Certificate of Compliance" by lightning protection system designer, in accordance with this Section's Article, "Responsibilities of Lightning Protection System Designer".
   2. Product Data:
      a. Data for all materials and equipment required by "Part 2 – Products" of this Section. Submit material and equipment manufacturers' published product data such as catalog pages, standard drawings, expected performance data, specifications, and the like.
      b. Submit data sheets that include manufacturer's name and product model number. Clearly identify all optional accessories.
      c. Certification that materials and equipment proposed submitted are in accordance with applicable standards of LPI or UL.

B. Informational Submittals: Submit the following:
   1. Certifications and Notices:
      a. Roofing system manufacturer written consent to installer's proposed penetrations (if any) through roofing system.
   2. Roofing System Manufacturer's Instructions:
      a. When Contractor proposes mechanically fastening lightning protection system components to, or providing penetrations through, roofing, obtain and submit to Contracting Officer the roofing system manufacturer's:
      b. Written concurrence with proposed installation methods.
      c. Written instructions for sealing penetrations into or through roofing system.
   3. Supplier's Instructions:

a. Manufacturer's written instructions for handling, storage, and installation for all materials and equipment furnished.

4. Field Quality Control Results:
   a. Submit results of field quality control activities required in this Section.
5. Supplier's Reports:
   a. Submit written report of each visit to the Site by manufacturer's factory-trained representative.
   b. Submit written report of each visit to the Site by lightning protection system designer.
6. Qualifications Statements:
   a. Lightning protection system designer.
   b. Installer.

C. Closeout Submittals: Submit the following:
1. Post-Installation Certifications:
   a. Installer's written certification that the substantially completed lightning protection system Work complies with the Contract Documents.
   b. "UL Master Label" certificate.
2. Operation and Maintenance Data:
   a. Manufacturer's operation and maintenance manual for each building's or structure's lightning protection system provided or modified. Comply with Section 01 78 23 - Operation and Maintenance Data.
   b. Indicate requirements for, and frequency of, periodic inspections.
3. Record Documents:
   a. Prepare and submit drawings, including plans of roof or top of each building and structure for which lightning protection system was provided or modified, indicating as-constructed conditions. Include appropriate sections, details, and schematics.
   b. Record drawings shall expressly indicate their status as "as-constructed" drawings with an appropriate revision date.

1.6 RESPONSIBILITIES OF LIGHTNING PROTECTION SYSTEM DESIGNER

A. Responsibilities of lightning protection system designer employed on the Work include, but are not necessarily limited to, the following, unless specifically indicated otherwise in the associated elements of the Contract Documents where the lightning protection system is required:
1. Ethical Conduct and Professionalism: Comply with Laws and Regulations, and standards and guidelines regarding codes of ethics and codes of conduct published by relevant industry organizations, including LPI and UL.
2. Comply with Laws and Regulations and relevant design standards applicable to the subject lightning protection system Work.
3. Performance and Design Criteria Indicated in the Contract Documents and Other Information:
   a. Review performance and design criteria, indicated in the Contract Documents, that the lightning protection system Work must satisfy.
   b. Prepare written requests for interpretations or clarifications of performance or design criteria.
   c. Review existing information about the Site that constitutes Technical Data (if any, applicable to the subject lightning protection system Work), as indicated in the Supplementary Conditions.
4. Site Information and Investigations: With Contractor, obtaining all other necessary dimensions, field information, and other information necessary for preparing lightning protection system Shop Drawings.
5. Design Services: Personally, perform and prepare, or actively exercise direct, personal, supervisory control over others performing or preparing:
   a. Necessary design evaluations of conditions, materials, and equipment.
   b. Prepare the Shop Drawings and product data Submittals, and related design documents such as calculations, for the subject lightning protection system Work.

c. Assist Contractor with applying for and obtaining permits and approvals (not previously obtained by Contracting Officer or those for whom Contracting Officer is responsible) necessary for the lightning protection system Work.
d. Preparing modifications of the lightning protection system design documents as necessary.

6. Certification of Compliance by Lightning protection system designer:
   a. Through Contractor, submit to Contracting Officer, lightning protection system designer's written certification indicating:
   b. General Information: (1) Project name and designation, (2) Contractor name and Contract designation, (3) Subcontractor or Supplier name (when applicable), (4) full name of lightning protection system designer's business entity under which the lightning protection system services were performed, (5) full name and certification number of the individual responsible for the final design of the subject lightning protection system Work, (6) specific elements of lightning protection system Work to which the certification applies, and (7) lightning protection system designer's signature, and date of signature; apply lighting protection designer's seal when applicable.
   c. Explicit certification that the subject lightning protection system complies with:
      1) All applicable performance and design criteria indicated in the Contract Documents. Expressly indicate on certification of compliance the specific performance and design criteria used in the lightning protection system design.
      2) All Laws and Regulations.
      3) Applicable design standards commonly applicable to such types of construction. Expressly indicate such design standards on the certification of compliance.
7. Progress and Quality of Construction of Lightning protection system Work:
   a. Where appropriate for the subject lightning protection system Work, periodically visit the Site at appropriate intervals to observe the progress and quality of the subject lightning protection system Work.
   b. Where lightning protection system designer does not visit the Site during construction, keep informed of the progress and quality of the subject lightning protection system Work via discussions with Contractor, Subcontractor, and Suppliers, via photographic documentation, and other means acceptable to lightning protection system designer.
   c. Advise Contractor in writing when the subject lightning protection system Work is not in accordance with the lightning protection system designer's design documents (approved by Contracting Officer) and related Submittals approved by lightning protection system designer.
   d. Furnish to entity that retained lightning protection system designer copy of lightning protection system designer's written report of each visit to the Site.
8. Modifications to Design:
   a. Design appropriate modifications to the lightning protection system Work, including preparing new or revised certifications, reports, design drawings, sketches, design specifications, and calculations, as appropriate.
   b. Such design documents and calculations shall be submitted to Contracting Officer through Contractor to same extent original design documents Submittals and calculations, if any, where required by the Contract Documents for the subject lightning protection system Work.
9. Other services, as mutually agreed upon by lightning protection system designer and its client, or as required elsewhere in the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. A/C Lightning Protection, Inc.
   2. Or equal.

2.2 PERFORMANCE AND DESIGN CRITERIA.

A. Provide lightning protection systems Work in accordance with NFPA 780, UL 96A, and LPI 175.

B. Material for air terminals, main conductors and bonding conductors: Copper or aluminum.

C. Size of air terminals, main conductors, and bonding conductors shall be in accordance with NFPA 780.

2.3 MATERIALS

A. Unless otherwise expressly indicated in the Contract Documents, lightning protection system materials shall be compatible with materials of construction for the building or structure being protected and meet the requirements of UL 96.

B. Provide lightning protection system with Class I or Class II materials, in accordance with NFPA 780.

C. Ground Rods:
   1. 3/4-inch diameter by 10 feet long.
   2. Copper-clad:
      a. Uniform coating, not less than 10 mils thick, of electrolytic copper molecularly bonded to rigid steel core.
      b. Corrosion resistant bond between copper and steel.
      c. Hard drawn, scar-resistant surface.

D. Material for conductor fasteners, connector fittings, bonding fittings, conductor splicers and through-wall or through-roof assemblies shall be cast bronze, brass, or copper, with bolt pressure connectors.

E. Material for bolts, nuts, and screws shall be stainless steel.

F. Underground conductors shall be bare, soft-drawn, stranded copper in accordance with ASTM B8.

G. Raceways:
   1. Indicated as Schedules 40 (“PVC-40”) or Schedule 80 (“PVC-80”):
      a. PVC thermoplastic, with inert modifiers to improve weatherability and heat distribution.
      b. Rated for direct sunlight exposure.
      c. Fire retardant and low smoke emission.
      d. In accordance with NFPA 70 Type PVC, NEMA TC 2, UL 651.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. When lightning protection systems will be installed on new buildings or structures, coordinate such Work with other elements of the associated building or structure and provide complete system in accordance with the Contract Documents.

B. Installing the Work constitutes Contractor's approval of underlying work, substrates, and field conditions prevailing at the time of the Work.

3.2 INSTALLATION

A. Installation – General:
   1. Design and provide lightning protection system Work in accordance with LPI 175, NFPA 780, and UL 96A.
   2. Install lightning protection system in accordance with the Contract Documents and Shop Drawings approved by Contracting Officer.
   3. Roofing System and Installation of Lightning Protection System:
      a. Adhesively fasten lightning protection system components to roof system unless expressly shown or indicated otherwise in the Contract Documents.
      b. Do not mechanically fasten lightning protection system components to metal roof panels, metal coping or penetrate roof membrane without written consent of both roofing system manufacturer and Contracting Officer. Submit to Contracting Officer written consent of roofing system manufacturer.
      c. Seal all penetrations in accordance with roofing system manufacturer's written instructions and details. Obtain such instructions and details from roofing system manufacturer.
   4. Surge protective devices to be provided, by others, as shown on the Drawings.

B. Structures and Buildings:
   1. Lightning protection system shall include:
      a. Roof-mounted air terminals.
      b. Interconnecting conductors.
         1) Steel roof beams and trusses may be utilized as the main and secondary conductors.
      c. Downleads: Provide the following type(s) of conductor downleads:
         1) Conductors surface-mounted on the building's or structure's exterior wall . Route conductor in Schedule 80 PVC conduit for not less than one foot below finished grade and four feet above finished grade.
      d. Ground terminations.
      e. Bonding of other grounded systems of building or structure.
      f. Bonding to grounding electrode system.
   2. Connect downleads to the grounding electrode system ground ring.
   3. Underground connections shall be via exothermic weld.

3.3 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
   1. Perform fall-of-potential ground resistance test on each ground rod or ground ring.
      a. When resistance exceeds 25 ohms for individual ground rod:
         1) Provide additional ground rod so they are 20 feet apart, interconnect with no. 4/0 AWG and retest.
         2) If retest exceeds 25 ohms, contact Contracting Officer.
      b. When resistance exceeds 25 ohms for a ground ring, contact Contracting Officer.
   2. Perform continuity test for system elements concealed with in structure.
   3. Perform continuity test for system elements utilized structural steel as downconductors.
   4. Submit to Contracting Officer written results of required field quality control activities expressly indicating building or structure name, and Project, type of test or inspection performed, results obtained, problems observed or noted during the test or inspection, and whether results obtained indicate successful completion (i.e., acceptance). The Work will not be eligible for inspection for Substantial Completion until such results are submitted to and accepted by Contracting Officer.

3.4 CLOSEOUT

A. Documentation and Nameplates:

1. Prior to requesting inspection for Substantial Completion of lightning protection system Work, provide the following for each lightning protection system provided or modified:
   a. Nameplate, securely fastened to building or structure, indicating: “Lightning protection system provided by”, followed by company name and address of lightning protection system installer. Name plate shall be resistant to corrosion and deterioration (to which it may be subject at its installed location), including deterioration and fading due to exposure to sunlight.
   b. Submit “UL Master Label” certification.
   c. Deliver final operation and maintenance manuals for the lightning protection system.
2. Prior to requesting final payment, deliver to Contracting Officer the following for each lightning protection system provided or modified:

   As-constructed record drawings, in accordance with this Section’s “Submittals” Article. Such as-constructed drawings shall be developed from Shop Drawings approved by Contracting Officer and those of the Drawings showing the lightning protection system.

END OF SECTION

SECTION 26 43 13
SURGE PROTECTION DEVICES FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Type PC1 SPD - High exposure locations (switchgear, switchboard, panelboard or motor control center), integrally mounted.
   2. Type PC3 SPD - Medium exposure locations (switchboard, panelboard and motor control center), integrally mounted.
   3. Type PC5 SPD - Medium or low exposure locations at individual equipment locations, external, parallel connection.

B. Related Sections include but are not necessarily limited to:

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits.
      b. C62.41.1, Guide on the Surge Environment in Low-Voltage (1000V and Less) AC Power Circuits.
      c. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
      d. C62.45, Recommended Practice on Surge Testing For Equipment Connected to Low-Voltage (1000V and Less) AC Power Circuits.
   2. Military Standard:
      a. MIL-STD-220B, Method of Insertion Loss Measurement.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL):
      a. 1283, Standard for Electromagnetic Interference Filters.
      b. 1449, Standard for Surge Protective Devices.

B. Qualifications:
   1. Provide devices from a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
      a. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Contracting Officer:
   1. Includes the Contracting Officer (CO) and the Contracting Officer Representative (COR).

B. Clamping Voltage:
   1. The applied surge shall be induced at the 90 degrees phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 inches output leads of the SPD and from the zero voltage reference to the peak of the surge.

C. Let-Through Voltage:
   1. The applied surge shall be induced at the 90 degrees phase angle of the applied system frequency voltage.
   2. The voltage measured at the end of the 6 inches output leads of the SPD and from the system peak voltage to the peak of the surge.

D. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD device can operate and meet its specification within its rated temperature.

E. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD device is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10% deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may very by mode.

F. MCC: Motor Control Center.

G. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

H. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
      a. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      b. The N-G mode is not included in the per phase calculation.

I. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 480/277 V system the L-L peak voltage is 679V and the L-N peak voltage is 392 V).

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Manufacturer's qualifications.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Testing procedures and testing equipment data.
      e. Create a Product Data Sheet for each different model number of SPD provided (i.e., Model XYZ with disconnect and Model XYZ without disconnect, each require a Product Data Sheet).
         1) Data in the Product Data Sheet heading:
            a) SPD Type Number per PART 2 of the Specification.
            b) Manufacturer’s Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer’s certified value confirming the product meets the specified value/feature.
            c) Name of the nationally recognized testing laboratory that preformed the tests.
            d) Warranty information.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer’s official (printed and signed).
            b) Title of the official.
         4) Date of signature.

B. Operation and Maintenance Manuals:

1. See Specification Section 01 78 23 for requirements for:
    a. The mechanics and administration of submittal process.
    b. The content of the Operation and Maintenance Manuals.
2. Warranty.

1.5 WARRANTY

A. Minimum of a five year Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

A. Materials and equipment shall be the standard products of a manufacturer regularly engaged in the manufature of the products and shall be the manufacturer’s latest standard design that has been in satisfactory use for at least one year prior to installation.
    1. Materials and equipment shall conform to the respective publications and other requirements specified below and to the applicable requirements of NFPA 70.
    2. Components shall be UL or third-party certified.

2.2 GENERAL

A. Standards: IEEE C62.41.1, IEEE C62.41.2, IEEE C62.45, MIL-STD 220B, UL 1283, UL 1449.

2.3 TYPE PC1 SPD

A. Product:
    1. SPD tag number or electrical equipment tag number SPD is connected to.
    2. Integrally mounted in switchgear, switchboards or MCCs.
    3. Hybrid solid-state high performance suppression system.
        a. Do not use a suppression system with gas tubes, spark gaps or other components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
    4. Do not connect multiple SPD modules in series to achieve the specified performance.
    5. Designed for parallel connection.
    6. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
    7. Device monitor:
        a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitors the on-line status of each mode of the units suppression filter system and power loss in any of the phases.
        b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on Drawings.

C. Modes of Protection: All modes.
    1. Three phase (delta): L-L, L-G.
    2. Three phase (wye): L-N, L-L, L-G and N-G.
    3. Single phase (2-pole): L-L, L-N, L-G and N-G.
    4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130% of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 240,000 A per phase, 120,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High waveform impulses with no degradation greater than 10% deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE C High waveforms shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degree phase angle including 6 inches lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		C High V & I Wave	B Combination Wave	
L-L < 250 V **L-N < 150 V**	L-L	1470 V	1000 V	800 V
	L-N	850 V	600 V	500 V
	L-G	1150 V	800 V	600 V
	N-G	1150 V	800 V	600 V
L-L > 250 V **L-N > 150 V**	L-L	2700 V	2000 V	1800 V
	L-N	1500 V	1150 V	1000 V
	L-G	2000 V	1550 V	1200 V
	N-G	2000 V	1550 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.4 TYPE PC3 SPD

A. Product:
   1. Integrally mounted in a switchboard, panelboards or motor control centers.
   2. Hybrid solid state high performance suppression system.
      a. Do not use gas tubes, spark gaps or other components in suppression system which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   3. Do not connect multiple SPD modules in series to achieve the specified performance.
   4. Designed for parallel connection.
   5. Field connection: Use mechanical or compression lugs for each phase, neutral and ground that will accept bus bar or #10 through #1/0 conductors.
   6. Device monitor:
      a. Long-life, solid state, externally visible indicators and Form C contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phases.
      b. A fuse status only monitor system is not acceptable.

B. Operating Voltage: The nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
   1. Three phase (delta): L-L, L-G.
   2. Three phase (wye): L-N, L-L, L-G and N-G.
   3. Single phase (2 pole): L-L, L-N, L-G and N-G.
   4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130% of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 160,000 A per phase, 80,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10% deviation of the clamping voltage.

I. SPD Protection:
   1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
   2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degrees phase angle including 6 inches lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		B Comb. Wave	B3 Ring Wave	
L-L < 250 V **L-N < 150 V**	L-L	1000 V	700 V	800 V
	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V **L-N > 150 V**	L-L	2000 V	1400 V	1800 V
	L-N	1150 V	800 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.5 TYPE PC5 SPD

A. Product:
   1. SPD tag number or electrical equipment tag number SPD is connected to.
   2. Externally mounted next to equipment or internally to control panel for point-of-use loads.
   3. Hybrid solid state high performance suppression system.
      a. Do not use gas tubes, spark gaps or other suppression system components which might short or crowbar the line resulting in interruption of normal power flow to connected loads.
   4. Designed for parallel connection.
   5. Enclosure:
      a. Metallic NEMA 4 or 12 for interior locations.
      b. Metallic NEMA 4 or 4X for exterior locations.
   6. Field connection:
      a. Mechanical or compression lugs for each phase, neutral and ground that will accept #10 through #1/0 conductors. OR
      b. Preinstalled lead conductors: Size per manufacturer, length as required with a maximum of 2 feet.
   7. Device monitor:

a. Long-life, solid state, externally visible indicators and Form C dry contact(s) that monitor the on-line status of each mode of the units suppression filter system or power loss in any of the phase.
b. A fuse status only monitor system is not acceptable.

8. Accessories (when specifically specified): Unit mounted disconnect switch.

B. Operating Voltage: Nominal unit operating voltage and configuration as indicated on the Drawings.

C. Modes of Protection: All modes.
1. Three phase (delta): L-L, L-G.
2. Three phase (wye): L-N, L-L, L-G and N-G.
3. Single phase (2 pole): L-L, L-N, L-G and N-G.
4. Single phase: L-N, L-G and N-G.

D. Maximum Continuous Operating Voltage: Less than 130% of system peak voltage.

E. Operating Frequency: 45 to 65 Hz.

F. Short Circuit Rating: Equal to or greater than rating of equipment SPD is connected to.

G. Maximum Surge Current: 120,000 A per phase, 60,000 A per mode minimum.

H. Minimum Repetitive Surge Current Capacity: 4000 IEEE C High or B combination waveform impulses with no degradation of more than 10% deviation of the clamping voltage.

I. SPD Protection:
1. Integral unit level and/or component level overcurrent fuses and sustained overvoltage thermal cutout device.
2. An IEEE B combination wave shall not cause the fuse to open and render the SPD inoperable.

J. Maximum Clamping Voltages: Dynamic test at the 90 degrees phase angle including 6 inches lead length and measured from the zero voltage reference:

System Voltage	Test Mode	IEEE C62.41		UL 1449
		B Comb. Wave	B Ring Wave	
L-L < 250 V **L-N < 150 V**	L-L	1000 V	700 V	800 V
	L-N	600 V	400 V	500 V
	L-G	800 V	550 V	600 V
	N-G	800 V	550 V	600 V
L-L > 250 V **L-N > 150 V**	L-L	2000 V	1400 V	1800 V
	L-N	1150 V	8000 V	1000 V
	L-G	1550 V	1000 V	1200 V
	N-G	1550 V	1000 V	1200 V

K. EMI-RFI Noise Rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz.

2.6 SOURCE QUALITY CONTROL

A. SPD approvals and ratings shall be obtained by manufacturers from nationally recognized testing laboratories.

B. The SPD are to be tested as a complete SPD system including:
1. Integral unit level and/or component level fusing.

2. Neutral and ground shall not be bonded during testing.
3. 6 inches lead lengths.
4. Integral disconnect switch when provided.

C. The “as installed” SPD system including the manufacturers recommended circuit breaker, the SPD is connected to, will not open when tested with a IEEE C3 combination waveform.

D. Tests to be performed in accordance with IEEE C62.45:
1. Clamping voltage performance testing using IEEE C62.41 Category waveforms.
2. Single pulse surge current capacity test.
3. Repetitive surge current capacity testing.
4. Spectrum analysis for EMI-RFI noise rejection.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Type PC1 and PC3 SPD:
1. Connected in parallel to the equipment.
2. Install in dedicated electrical equipment compartment, bucket or panelboard box at the factory before shipment.
3. Provide leads that are as short and straight as possible.
4. Maximum lead length: 12 inches.
5. Minimum lead size: #2 stranded AWG or bus bar.
6. Connect leads to the equipment to be protected by one of the following means:
   a. Through a circuit breaker or molded case switch mounted in the equipment.
   b. Use manufacturer recommended circuit breaker size.
   c. Circuit breaker or switch to be operable from the equipment exterior or from behind a hinged door.

C. Type PC5 SPD:
1. Mounting options:
   a. On wall or support structure adjacent to the equipment to be protected with leads routed through conduit.
   b. Nipple connection directly to the equipment to be protected.
2. Install leads as short and straight as possible.
3. Maximum lead length: 5 feet.
4. Minimum lead size:
   a. Type PC5: #10 stranded AWG.
5. When conduit connection is used, provide a minimum of four twists per foot in the lead conductors and install in NFPA 70 sized conduit.
6. Connect leads to the equipment to be protected by one of the following means:
   a. Through a circuit breaker or molded case switch mounted in the equipment.
      1) Use manufacturer recommended circuit breaker size.
   b. Directly to the protected equipment bus, when SPD has integral disconnect switch.
   c. To the load side of field mounted equipment’s local disconnect switch.
      1) Provide taps or lugs as required to provide a UL and NFPA 70 compliant connection.

END OF SECTION

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SECTION 26 50 00
INTERIOR AND EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Material and installation requirements for:
      a. Interior building and exterior building mounted luminaires.
      b. Exterior luminaires.
      c. LEDs.
      d. Drivers.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Common Work Results for Electrical.
   2. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. C78.377, Specification for the Chromaticity of Solid State Lighting Products.
   2. Federal Communications Commission (FCC):
      a. Code of Federal Regulations (CFR), 47 CFR 18, Industrial, Scientific and Medical Equipment.
   3. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41, Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits.
   4. Illuminating Engineering Society of North America (IESNA):
      a. LM-79, Electrical and Photometric Measurements of Solid-State Lighting Products.
      b. LM-80, Measuring Luminous Flux and Color Maintenance of LED Packages, Arrays and Modules.
   5. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. 410, Performance Testing for Lighting Controls and Switching Devices with Electronic Drivers and Discharge Ballasts.
      c. LE 4, Recessed Luminaires, Ceiling Compatibility.
   6. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
      a. SSL 1, Electronic Drivers for LED Devices, Arrays or Systems.
   7. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 101, Life Safety Code.
   8. Underwriters Laboratories, Inc. (UL):
      a. 248-4, Low-Voltage Fuses - Part 4: Class CC Fuses.
      b. 844, Standard for Luminaires for Use in Hazardous (Classified) Locations.
      c. 924, Standard for Emergency Lighting and Power Equipment.
      d. 1012, Power Units Other Than Class 2.
      e. 1310, Standard for Class 2 Power Units.
      f. 1598, Luminaires.
      g. 8750, Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.
   9. United States Department of Energy (USDOE):
      a. EPAct, the National Energy Policy Act.

1.3 DEFINITIONS

A. Useful Life for LED luminaire light sources:
   1. The operating hours before reaching 70% of the initial rated lumen output (L70) with no catastrophic failures under normal operating conditions.
   2. This is also known as 70% "Rated Lumen Maintenance Life" as defined in IESNA LM-80.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Provide submittal data for all products specified in PART 2 of this Specification Section.
      b. Identify luminaire by Luminaire Schedule designation.
      c. Luminaire data sheet:
         1) Name of manufacturer.
         2) Complete order information (catalog number).
         3) Description of construction and optics.
         4) Total input wattage.
         5) Luminous efficacy (lumens/Watt).
         6) Photometric performance data including candlepower distribution and coefficient of utilization (CU) table.
         7) Dimensional size.
         8) Weight.
         9) UL nameplate data for luminaires used in Class 1, Division 1 and 2 areas.
         10) Effective Projected Areas (EPA) for pole mounted luminaires.
      d. Solid state Luminaire additional data:
         1) Voltage.
         2) Initial and IES L70 lumens.
         3) Luminous efficacy (lumens/Watt).
         4) Correlated Color Temperature (CCT).
         5) Color Rendering Index (CRI).
         6) Total Harmonic Distortion (THD).
         7) Lamp life.
         8) Driver manufacturer and model number.
         9) Driver life.
         10) Driver type (0-10V, constant voltage, constant current).
         11) Dimming range and control device compatibility.
         12) Remote driver: Maximum wire length to luminaire.
         13) Emergency battery driver:
            a) Compatibility with lighting module.
            b) Lumen output of lighting module in emergency operation.
            c) Battery life.
            d) Description of testing.
            e) Ambient operating temperature.
         14) Toxicity Characteristic Leaching Procedure (TCLP) compliance.
         15) DesignLights Consortium (DLC) Listing.
         16) Warranty information.
      e. Photometric calculation for manufacturers not listed in the Luminaire Schedule:
         1) Location: Per Photometric Performance Statistics Schedule on the Drawings.
            a) Calculation method: Point-to-Point.
            b) Required footcandle level: Per Photometric Performance Statistics Schedule on the Drawings.
            c) Light loss factor: Per Photometric Performance Statistics Schedule Table on the Drawings.
      f. See Section 26 05 00 for additional requirements.
   2. Test Reports:

a. IESNA LM-79 Test Report for Solid-State Luminaire.
b. IESNA LM-80 Test Report Solid-State Light Source.

3. Certifications: Solid-state Luminaire Useful Life Certificate.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
b. Submittal data for each component covered by warranty.
c. Warranty.

1.5 WARRANTY

A. Minimum of a five year Warranty from date of manufacture against failure for solid-state luminaire including LED arrays, LED drivers and integral control devices. The solid-state product is considered defective if more than 15% of the individual light emitting diodes fail to illuminate.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Luminaires:
a. Per Luminaire Schedule.
2. Solid State Light Sources:
a. Cree.
b. Luminaire manufacturer's proprietary system.
c. Or Equal.
3. LED Driver:
a. Luminaire manufacturer's standard.
b. Or Equal.
4. Emergency ballasts:
a. Iota Engineering.
b. Or Equal.
5. Emergency transfer devices:
a. Philips Bodine.
b. Or Equal.

2.2 GENERAL REQUIREMENTS

A. Luminaires complete with LED modules and drivers.

B. Rated for area classification as indicated on the Drawings.
1. In Class I, Division 1 and 2 areas, the temperature rating of the luminaires and LED combination shall not exceed the auto-ignition temperature of the atmosphere in which the Luminaire is used.

C. Provide all recessed luminaires with gaskets of rubber, fiberglass, or equivalent material to prevent light leaks around flush trim.
1. Provide recessed luminaires with trim gaskets cemented in proper position.

D. Provide standard plaster frame for all recessed luminaires installed in plaster walls or ceilings.
   1. Design, finish and fabricate material to preclude possibility of rust stain in plaster.

E. Coordinate luminaire mounting where recessed into building canopies prior to Submitting Shop Drawings. Confirm clearances and luminaire flange compatibility with construction.

F. Electrical components of recessed luminaires shall be accessible and removable through luminaire without having to remove luminaire from ceiling.

G. No live parts normally exposed to contact.

H. When intended for use in wet areas: Mark luminaire "Suitable for wet locations."

I. When intended for use in damp areas: Mark luminaire "Suitable for damp locations" or "Suitable for wet locations."

2.3 LUMINAIRES

A. Standards and Listings:
   1. DesignLights Consortium (DLC).
   2. UL 1598.
   3. UL 844 for hazardous locations.
   4. NEMA LE 4 for recessed locations.

B. Housings:
   1. As indicated in the Luminaire Schedule and the following:
      a. Troffer luminaires:
         1) Minimum 22 gage sheet steel.
         2) Integral end plates and trim flanges to suit ceiling construction.
         3) Wire way covers with captive retainers to allow access to electrical components without use of tools.
      b. Down Light luminaires:
         1) Minimum 22 gage sheet steel, or minimum 16 gage sheet aluminum, unless noted otherwise.
         2) Auxiliary junction box secured to mounting frame.
      c. Extruded aluminum housings, where scheduled, shall be at least 1/8 inches thick.
      d. Punch and form housings prior to finishing (post-paint).

C. Trim (Recessed Mounted):
   1. As indicated in the Luminaire Schedule and the following:
      a. For square and rectangular luminaires, miter and continuously weld corners.
      b. Miter perimeter inverted T-Bar angles at corners.
      c. Do not butt or overlap squared ends.
      d. Finish joints smooth.

D. Castings:
   1. As indicated in the Luminaire Schedule and the following:
      a. Uniform quality, free from imperfections affecting strength and appearance.
      b. Exterior surfaces, if not receiving a finish coat, shall be smooth and match adjacent surfaces. At least one coat of clear methacrylate lacquer shall be applied unless a painted finish is specified.

E. Fasteners:
   1. As indicated in the Luminaire Schedule and the following:
      a. Aluminum or steel luminaires: Zinc-Nickel plated, stainless steel, or equivalent.
      b. Stainless steel luminaires: Stainless steel.
      c. Bronze luminaires: Bronze or stainless steel.
      d. Non-metallic luminaires: Stainless steel.

F. Finishes:
   1. As indicated in the Luminaire Schedule and the following:

a. Painted surfaces:
1) Manufacturer's standard metal pretreatment and baked or air-dried, light-stabilized enamel finish, acrylic, alkyd, epoxy, polyester, or polyurethane.
2) White finishes shall have minimum 85% reflectance.
b. Unpainted surfaces:
1) Interior: Clear anodic coating, satin finish.
2) Exterior: Clear anodic coating.

G. Lens/Louver Frames:
1. As indicated in the Luminaire Schedule and the following:
a. Extruded aluminum with mitered corners.
b. Hinging or other normal motion shall not cause lens or louver to drop out.
c. No light leak between frame and housing.

H. Lenses:
1. As Indicated in the Luminaire Schedule and the Following:
a. 100% virgin, UV stabilized acrylic.
b. Held securely in place but must also be removable for cleaning and servicing.
c. Luminaires with directional lenses shall include a lens orientation device to ensure that lens installation provides light distribution as designed.
d. No light leaks between the lens and the luminaire.

I. Reflectors:
1. As Indicated in the Luminaire Schedule and the Following:
a. Down Light Reflector and Baffle Finishes: First-quality "Alzak" anodized specular finish.
b. Troffer reflector finish: Integral reflectors shall be painted white after fabrication with a minimum reflectance value of 90%.

J. Gaskets:
1. As Indicated in the Luminaire Schedule and the Following:
a. Gaskets at face plates or frames of recessed luminaires which serve as ceiling trim and allow interior access.
b. Moisture seal gaskets at exterior locations and in other designated wet areas.
c. Secure frames to luminaire bodies with screws or other means, to result in tight installation, without light leaks.

K. Ventilation:
1. Ventilation openings of adequate size and quantity to permit operation of driver without affecting rated output or life expectancy. Include wire mesh screens.

L. Wiring:
1. Factory-wired to be compatible with the project electrical and controls systems.

M. Mounting Accessories:
1. Provide appropriate mounting accessories for each luminaire, compatible with various structural conditions encountered.
2. All luminaires with adjustable beam angles shall have a locking device to ensure that the beam distribution is not effected during servicing or cleaning.
3. Recessed Luminaires:
a. Plaster Frames: Provide frames for luminaires installed in gypsum board and concealed suspension system ceiling tile. Make frames of non-ferrous metal or suitably rustproof after fabrication.
b. Baffles and Gaskets: As required to prevent light leakage.
c. Flanged luminaires are required in all ceiling systems except exposed grid lay-in panel type.
4. Luminaire Suspension Material:
a. Unfinished Spaces:
1) 1/2 inches minimum diameter swivel stem, unless otherwise noted.

2) Safety chain on high bay type.

b. Finished Spaces: Unless otherwise noted.
   1) Manufactured cable or stem and outlet box canopy.
      a) Contemporary design with swivel self-aligning features.
      b) Size canopy to cover outlet box, minimize size of canopy not associated with outlet box.
      c) Finish to match luminaire.
   2) Coordinate pendant location with ceiling tiles/ceiling grid.
      a) Submit coordinated mounting accessories as part of Shop Drawing submission.
   3) Luminaires mounted on suspended ceiling grids should be provided with outlet box designed for grid mounting with direct cord entry and supported by outlet box.

2.4 SOLID-STATE LUMINAIRES - ADDITIONAL REQUIREMENTS

A. Standards:
   1. IESNA LM-79, IESNA LM-80.
   2. NEMA SSL 1.
   3. UL 1012, 1310, and 8750.
   4. UL 844 for hazardous locations.

B. Solid state modules and driver to be provided and warrantied by luminaire manufacturer.

C. Solid-State Modules:
   1. Uniform color temperature of 4000K unless otherwise noted on the Luminaire schedule.
      a. Color temperature measurement shall have a maximum 3 SDCM on the MacAdam Ellipse for frosted lensed luminaires, and 2 SDCM for other luminaire types (ANSI C78.377).
   2. Minimum color rendering index (CRI) of 80 for indoor and 70 for outdoor applications.
   3. LED module light output and efficacy: Measured in accordance with IESNA LM-79 standards.
   4. LED useful life and lumen maintenance: Measured in accordance with IESNA LM-80 standards.
   5. Driver and LED module: Minimum useful life of 50,000 hours (L70).
   6. Individual LEDs connected such that a failure of one LED will not result in a light output loss of the entire luminaire.

D. Driver:
   1. Compatible with solid-state modules and control devices specified.
   2. Operate from 60 Hz input source of 120V through 277V with sustained variations of ±10% (voltage and frequency).
   3. Input current Total Harmonic Distortion (THD): Less than 20% when operated at nominal line voltage.
   4. Power Factor: Greater than 0.90.
   5. Avoid interference with infrared devices and eliminate visible flicker.
   6. Comply with ANSI C62.41 Category A for Transient protection.
   7. Comply with the requirements of the Federal Communications Commission (FCC) rules and regulations, Title 47 CFR part 18, Non-Consumer (Class A) for EMI/RFI (conducted and radiated).
   8. Dimmable drivers capable of continuous dimming over a range of 100% to 10% of rated lumen output, unless otherwise specified in Luminaire Schedule. Dimming controlled by a 0 - 10 VDC signal, unless otherwise specified in Luminaire Schedule.
   9. Control device must be compatible with type of driver and coordinated prior to submission of Shop Drawings. List of compatible dimming controllers must include the range of perceived brightness. No visible flicker throughout the dimming range.
   10. Remote-mounting:
      a. Provide maximum allowable distances for secondary wire runs to luminaires.
      b. Provide remote mounting hardware and enclosures as required.

11. Operating temperature range must be suitable for site temperature conditions within exterior and gasketed luminaires.

E. Emergency Battery Driver:
   1. UL 924.
   2. Confirm compatibility with LED modules utilized.
   3. Consist of a high temperature, maintenance-free nickel cadmium battery, charger, and electronic circuitry.
   4. A solid state charging indicator light to monitor the charger and battery.
   5. Single-pole test switch.
   6. The following product family shall be selected based on coordination with LED lamp type:
      a. Philips Bodine “BSL23C”: can operate up to 4.5W at 410mA.
      b. Philips Bodine “BSL26C”: can operate up to 5.1W at 265mA.
      c. Philips Bodine “BSL722 inches: can operate up to 23W at 770mA.
      d. Philips Bodine “BSL23C”: can operate up to 23W at 770mA in operating conditions ranging from -20 degrees C (-4 degrees F) to 60 degrees C (140 degrees F).
      e. Alternate manufacturer: Iota.

F. Luminaire properly heat sinked to assure LED junction temperature ratings are not exceeded.
   1. Provide ambient operating temperature range for which product is warrantied.

2.5 EXIT SIGNS AND EMERGENCY LIGHTING UNITS

A. Standards:
   1. UL 924.
   2. NFPA 101.
   3. Local State or City requirements.

B. Exit Signs:
   1. Housing and finish: As indicated in the Luminaire Schedule.
   2. LED illuminated with integral driver.
   3. AC powered or AC and battery powered: As indicated in the Luminaire Schedule.
   4. Battery powered units:
      a. Battery type: As indicated in the Luminaire Schedule.
      b. Self-testing/self-diagnostic.
         1) Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
      c. Consist of battery, charger, and electronic circuitry.
      d. Solid state charging indicator light to monitor the charger and battery.
      e. Single-pole test switch.
      f. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.

C. Emergency Lighting Units:
   1. Housing: As indicated in the Luminaire Schedule.
   2. Lamps: As indicated in the Luminaire Schedule.
   3. Battery type: As indicated in the Luminaire Schedule.
   4. Self-testing/self-diagnostic.
      a. Electronic circuitry automatically test emergency lighting for a minimum of 30 seconds every 30 days and 90 minutes once a year.
   5. Consist of battery, charger, and electronic circuitry.
   6. Solid state charging indicator light to monitor the charger and battery.
   7. Single-pole test switch.
   8. A user selectable audible alarm. The alarm shall be engaged unless noted otherwise on the Drawings.

2.6 MAINTENANCE MATERIALS

A. Furnish a minimum of 10% of total of each type and amperage of fuses for fixtures indicated to be fused.

B. Spare parts are to be stored in a box clearly labeled as to its contents.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Coordinate Luminaire Types with Ceiling Construction:
   1. Provide mounting hardware for the ceiling system in which the luminaire is to be installed.

B. Fasten luminaires supported by suspended ceiling systems to ceiling framing system with hold down clips.

C. Provide mounting brackets and/or structural mounting support for wall-mounted luminaires.
   1. Do not support luminaire from conduit system.
   2. When luminaire is supported from outlet boxes, install per NFPA 70.
   3. Supports for luminaire mounted on exterior walls shall not be attached to exterior face of the wall.

D. Support surface mounted luminaires from the building structure and not from the ceiling suspension system.
   1. Luminaires up to 4 feet wide and 4 feet long: A minimum of four supporting points, one at each corner.
   2. Luminaires 8 feet long: A minimum of five support points, one at center of luminaire and one at each corner.
   3. Luminaires smaller than 2 feet in length: A minimum of two supporting points.

E. Provide pendant luminaires with swivel hangers which will allow luminaire to swing in any direction but will not permit stem to rotate.
   1. Provide hangers with enclosure rating (NEMA 1, 4, or 7) equal to enclosure requirements of area in which they are installed.
   2. Swivel hangers for luminaires in mechanical equipment areas: Shock absorbing type.
   3. Secure low and high bay luminaires with safety chain or safety aircraft cable to the building structure.
      a. Chain or cable to prevent luminaire from falling more than 3 inches before the luminaire is caught by the chain or cable.

F. Pendant Mounted, Open, Industrial Luminaire:
   1. Not in continuous rows:
      a. Supported by conduit or by approved chains or cable:
      b. Hardwired to ceiling mounted junction box.
   2. In continuous rows:
      a. Supported rigidly with conduit and fasten luminaire to each other or mount on continuous metal channel per Section 26 05 00.
      b. Hardwired to ceiling mounted junction box.
      c. Provide reflector alignment clips.

G. Provide access panels for recessed luminaires that require access for maintenance when such access is not provided for in design of luminaire.
   1. Locate luminaires in accordance with reflected ceiling plans.

H. Locate luminaire in exact center of ceiling tile unless otherwise indicated.
   1. Relocate incorrectly installed luminaire and replace damaged ceiling materials.

I. Mount luminaire at heights indicated in Section 26 05 00 or per Luminaire Schedule or as indicted on the Drawings.

J. Install exterior luminaires so that water cannot enter or accumulate in the wiring compartment.

K. Luminaires with Emergency Battery:
   1. Where luminaires with emergency battery are shown controlled via switching device, connect the emergency battery to corresponding unswitched circuit so emergency battery will not operate when normal power is available and switching device turns lights off. Upon failure of normal power, luminaire will operate in emergency mode regardless of switch position.
   2. Luminaire manufacturer to supply the emergency battery with luminaire.

L. Ground luminaire.

3.2 LIGHTING CONTROL

A. Exterior wall mounted fixtures controlled as detailed on the Drawings.

3.3 ADJUST AND CLEAN

A. See Section 01 74 00.

B. Aim all emergency lighting units, so that, the path of egress is illuminated.

END OF SECTION

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SECTION 27 10 00
STRUCTURED CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes but is not necessarily limited to:
   a. Material and installation requirements for the structured cabling system.
   b. Fiber optic enclosures.
   c. Backbone cabling Outside Plant (OSP)
   d. Horizontal cabling.
   e. Patch cords.

B. Related Sections include but are not necessarily limited to:
   1. Section 07 84 00 - Firestopping.
   2. Section 26 05 00 - Common Work Results for Electrical.
   3. Section 26 05 26 - Grounding and Bonding.
   4. Section 26 05 43 - Electrical – Exterior Underground

1.2 REFERENCES

A. Definitions
   1. For the purpose of providing materials and installing electrical work, the following definitions shall be used.
      a. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, handholes and in-ground pump stations.
      b. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
      c. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.

B. Referenced Standards: Standards referenced in this section include, but are not necessarily limited to the following:
   1. Building Industry Consulting Service International (BICSI).
      a. Telecommunications Distribution Methods Manual. (TDMM).
      b. ICT Outside Plant Construction and Installation: Direct Buried Facilities
   2. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
   3. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
      a. 526-7, Measurement of Optical Power Loss of Installed Singlemode Fiber Cable Plant.
      b. 526-14, Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant.
      c. 568.0, Generic Telecommunications Cabling for Customer Premises.
      d. 568.1, Commercial Building Telecommunications Cabling Standard.
      e. 568.2-, Balanced Twisted-Pair Telecommunications Cabling and Components Standards.
      f. 568.3, Optical Fiber Cabling Components Standard.
      g. 568.4, Broadband Coaxial Cabling and Components Standard.
      h. 569, Telecommunications Pathways and Spaces.
      i. 606, Administration Standard for Telecommunications Infrastructure.
      j. 607, Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
      k. 1005, Telecommunications Infrastructure Standard for Industrial Premises
      l. 1152-A Requirements for Field Test Instruments for twisted pair cabling.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Telecommunications Contractor:
      a. Shall be regularly and professionally engaged in the business of the applications, installation, and testing of telecommunications systems and equipment.
      b. Include three references of similar scope jobs completed in the last two years.
      c. Supervisors and installers shall be Building Industry Consulting Services International (BICSI) Registered Cabling Installers, Technician Level.
      d. In lieu of BICSI certification, supervisors and installers assigned to the installation of this system or any of its components shall have:
         1) A minimum of five years of experience in the installation of the specified copper and fiber optic cable and components.
         2) Factory or factory approved certification from each equipment manufacturer indicating that they are qualified to install and test the provided products.
   2. Manufacturer:
      a. Company specializing in manufacturing products specified in this Section with minimum 10 years documented experience in the manufacturing, assembly, and factory testing of components which comply with TIA-568-0, TIA-568-1, TIA-568-2 and TIA-568-3.

1.4 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Fabrication and/or layout drawings, sealed and approved by a Registered Communications Distribution Designer (RCDD):
         1) Layout of complete building per floor:
            a) Building area boundaries, backbone systems and horizontal pathways.
         2) Building area drawings:
            a) Drop locations and cable identifications in accordance with TIA-606.
         3) Telecommunications space drawings:
            a) Telecommunication rooms plan views, pathway layout, mechanical/electrical layout, and cabinet, rack, backboard, and wall elevations.
         4) Typical detail drawings:
            a) Faceplate labeling, faceplate types, and firestopping.
   2. Product Data:
      a. Submittal data for all products specified in PART 2 of this Specification.

B. Informational Submittals:
   1. Certificates:
      a. Telecommunications Contractor and Installers qualifications.
      b. Key Personnel qualifications.
      c. Manufacturer qualifications.
      d. Manufacturer System Warranty.
   2. Test reports:
      a. Testing plan and procedures.
      b. Telecommunications cabling test results.

PART 2 - PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. All Materials and equipment shall be:
   1. Appropriate for the intended use.
   2. Recognized as such by a Nationally Recognized Testing Laboratory (NRTL) such as Underwriters Laboratories (UL), ETL SEMCO (ETL), the Canadian Standards Association (CSA) or the American National Standards Institute (ANSI).

3. NFPA 70 Compliant.
4. Permitted by the Authority Having Jurisdiction (AHJ).

B. All products shall be new, of the latest version at time of bid, and brought to the job site in original manufacturer's packaging. Used equipment and damaged materials will be rejected.

C. All copper products shall be from a single manufacturer so that a single performance warranty covers all applications on horizontal links/channel

2.2 FIBER OPTIC ENCLOSURES

A. Panel Mount Fiber Optic Enclosure:
1. Enclosure shall accommodate 2, 4 or 6 Fiber Adapter Panels.
2. Each Fiber Adapter Panel shall accommodate up to 6 duplex connectors (12 fibers).
3. Adapters shall be duplex LC style.
4. Adapters shall be unkeyed.
5. Provide dust covers for unused adapters.
6. Housing shall have incoming cable strain relief and cable management guides.

2.3 BACKBONE CABLING SYSTEM

A. Fiber Optic Outside Plant Cable (OSP)
1. Singlemode, 8 - 10um/125um OS2 rated cable,12-strand color coded groups..
2. Multimode, 50um/125um OM4 rated cable, 12-strand color coded groups.
3. Loose tube gel free.
4. Indoor / Outdoor plenum rated.
5. All dielectric construction.
6. Cable shall be label-verified, OFNP.
7. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.

2.4 HORIZONTAL CABLING SYSTEM

A. Horizontal Copper Cable: Industrial Ethernet.
1. Category 6.
2. Cable shall be label-verified.
3. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
4. Conductors shall be solid untinned copper 23 AWG
5. CMX-Outdoor wet location, 600 Volt AWM rated insulation where installed underground or in an area designated as a wet location.

B. Horizontal Fiber Cable:
1. Singlemode, 9um/125um OS2 rated cable.
2. Multimode, 50um/125um OM4 rated cable.
3. Cable shall be label-verified.
4. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
5. Cable shall be rated CMP per NFPA 70.

2.5 PATCH CORDS

A. Supply patch cords equal to 1.1 times the number of cables terminated in the communication room(s).
1. Provide for installed copper and fiber-optic systems.
2. Length: As required for connection without strain and ability to service equipment.

B. Patch Cords, Copper:
1. Assemblies consisting of flexible, twisted pair stranded wire with eight-position plugs at each end.
2. Shielded and/or Unshielded to match to horizontal link

3. Cable shall be label-verified.
4. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
5. Patch cords shall be wired straight through; pin numbers shall be identical at each end and shall be paired to match T568B patch panel jack wiring.
6. Patch cords shall be unkeyed.
7. Patch cords shall be factory assembled.
8. Patch cords shall match the color of the installed system.

C. Patch Cords, Fiber:
1. Singlemode assemblies consisting of flexible, 9um/125um OS2 rated cable with duplex LC connectors at each end.
2. Multimode assemblies consisting of flexible, 50um/125um OM4 rated cable with duplex LC connectors at each end.
3. Cable shall be label-verified.
4. Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.
5. Patch cords shall have crossover orientation.
6. Patch cords shall be unkeyed.
7. Patch cords shall be factory assembled.
8. Patch cords shall be yellow.

2.6 LABELING AND COLOR CODING

A. Labels shall be developed by the contractor and approved by the Contracting Officer.
1. Format labels in accordance with TIA 606.
2. Labels shall be machine printed on opaque or clear tape, stenciled onto adhesive labels.
3. Handwritten labeling is unacceptable.

B. Copper Cable and Jacks:
1. Business network (Data / Voice): Blue
2. Industrial network (Supervisory Control and Data Acquisition (SCADA)): Orange

2.7 FIBER OPTIC MICRODUCT

A. Manufacturers:
1. Dura-Line FuturePath
2. Or Equal

B. Specifications:
1. Armored.
2. 1.65 IN minimum nominal OD.
3. Minimum 0.51 IN nominal ID per microduct.
4. Minimum 4 ducts.
5. Unique color for each duct.
6. Rated for direct burial.
a. Exposed above-grade microduct shall be installed inside conduit.
7. Manufacturer markings every foot.
8. 20 gauge location wire.
9. Low-friction interior to aid in fiber pulling.
10. Rip cord to aid in opening of outer sheath.
11. Bend radius:
a. 25 IN supported.
b. 41 IN unsupported.

C. Materials:
1. Outer and inner sheaths: Polyethylene.
2. Armor: Steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. System cabling, components and appurtenances shall be installed in accordance with TIA/EIA/ANSI Standards, NFPA 70, manufacturer's instructions, and as shown.

B. Components shall be labeled in accordance with TIA/EIA/ANSI 606.

C. Penetrations in fire-rated construction shall be firestopped.

D. Cable installation:
   1. Cables shall not be installed in the same conduit, cable tray, utility pole compartment, or floor trench compartment with AC power cables.
   2. Cable lubricants specifically designed for installing communications cable may be used as needed to reduce pulling tension when pulling cable into conduit.

E. Pathway System:
   1. Provide in accordance with TIA 569 and NFPA 70.
   2. Provide grounding of raceways and cable tray in accordance with TIA 607 and NFPA 70.

F. Unshielded Twisted Pair Patch Panels:
   1. Patch panels shall be mounted in equipment racks with sufficient modular jacks to accommodate the installed cable plant plus 25% spares.
   2. Cable guides shall be provided above, below and between each panel.

G. Fiber Optic Patch Panels:
   1. Patch panels shall be mounted in equipment racks with sufficient connectors to accommodate the installed cable plant plus 25% spares.
   2. Cable guides shall be provided above, below and between each panel.

H. Backbone and Horizontal Distribution Cable:
   1. Cable pulling tension shall not be exceeded.
      a. 110N (25 pounds-force) for copper cabling.
   2. Cable shall not be stressed such that twisting, stretching or kinking occurs.
   3. Cable shall not be spliced.
   4. All backbone cable shall be installed in conduit or cable tray.
   5. All horizontal cable shall be installed in an appropriate telecommunications pathway.
   6. Cable shall not be run through structural members or in contact with conduits, pipes, ducts, or other potentially damaging items.
   7. Placement of cable parallel to power conductors shall be avoided, if possible; a minimum separation of 12 inches shall be maintained when such placement cannot be avoided.
   8. Cables shall be terminated; no cable shall contain unterminated elements.
   9. Minimum bending radius shall not be exceeded during installation or once installed.
   10. Only fabric hook and loop fasteners shall be used to wrap cables, 1/2 inches width minimum. Plastic or nylon cable ties shall not be used.

I. Fiber Optic Microduct
   1. Microduct shall be installed per manufacturers standards.
   2. Microducts must be connected to the same colors within microduct handholes. Push-Lock couplers must be utilized for all microduct connections within a handhole. End caps must be utilized for all non-connected microducts within a handhole.

3.2 TERMINATION

A. Cables and conductors shall sweep into termination areas; cables and conductors shall not bend at right angles.
   1. Manufacturer's minimum bending radius shall not be exceeded.
   2. When there are multiple system type drops to individual workstations, relative position for each system shall be maintained on each system termination block or patch panel.
   3. Unshielded Twisted Pair Cable:

a. Each pair shall be terminated on appropriate outlets, connectors, terminal blocks or patch panels.
b. No cable shall be unterminated or contain unterminated elements.
c. Pairs shall remain twisted together to within the proper distance from the termination as specified in the TIA/EIA/ANSI 568 Series.
d. Conductors shall not be damaged when removing insulation.
e. Wire insulation shall not be damaged when removing outer jacket.

4. Fiber Optic Cable:
   a. Each pair shall be terminated with appropriate connectors.
   b. No cable shall be unterminated or contain unterminated elements.

3.3 GROUNDING

A. Signal distribution system ground shall be installed in the telecommunications entrance facility and in each telecommunications closet in accordance with TIA/EIA/ANSI J-STD-607.
   1. Equipment racks shall be connected to the electrical safety ground.

3.4 LABELING

A. Label cables and outlet connectors using color labels on both ends per TIA/EIA/ANSI 606.

B. Label workstation, terminal blocks and patch panel connections using color coded labels per TIA/EIA/ANSI 606.

3.5 TESTING

A. Testing shall conform to the TIA/EIA/ANSI Standards for all test parameters.
   1. All test data sheets shall be downloaded from the tester, printed out and provided to the Government.
   2. Provide Government with all test results as Electronic Documents (in portable document format, PDF files) by Electronic Means.
   3. Tester shall be capable of testing parameters for the warranted system.

B. Materials and documentation to be furnished under this Specification are subject to inspections and tests.
   1. All components shall be terminated prior to testing.
   2. Equipment and systems will not be accepted until the required inspections and tests have been made, demonstrating that the signal distribution system conforms to the specified requirements, and that the required equipment, systems, and documentation have been provided.

C. Unshielded Twisted Pair Tests:
   1. All metallic cable pairs shall be tested for proper identification and continuity.
   2. All opens, shorts, crosses, grounds, and reversals shall be corrected.
   3. Correct color coding and termination of each pair shall be verified in the communications closet and at the outlet.
   4. Horizontal wiring shall be tested from and including the termination device in the communications closet to and including the modular jack in each room.
   5. These tests shall be completed and all errors corrected before any other tests are started.

D. Category 6 Horizontal Links:
   1. Perform copper Category permanent link tests in accordance with TIA-568 and TIA-568. Tests shall include wire map, length, insertion loss, NEXT, PSNEXT, ELFEXT, PSELFEXT, return loss, propagation delay, and delay skew.
   2. Perform copper Category link tests for Modular Plug Terminated Links (MPTL) in accordance with TIA-568.2 using a permanent Link Adapter and a Patch Cord Adapter following the test set manufacturer’s recommendations.
   3. Cables which contain failed circuits shall be replaced and retested to verify the standard is met.

E. Fiber Optic Cable:

1. Unless stated otherwise, tests shall be performed from both ends of each circuit.
2. All terminations shall be visually inspected for scratches, pits or chips and shall be reterminated if any of these conditions exist.
3. Each link shall be tested for insertion loss using a light source similar to that used for the intended communications equipment.
4. High-resolution optical time domain reflectometer (OTDR) tests shall be performed for each fiber.
5. Scale of the OTDR trace shall be such that the entire circuit appears over a minimum of 80% of the X-axis.

F. Fiber Optic Microduct
1. Pressure test each microduct to 100 PSI for a period of at least 15 minutes per microduct. Maximum pressure loss is limited to 10 PSI.
2. Mandrel test each microduct path with a mandrel to prove each path is clear, not kinked and able to blow fiber in the line. It is allowable to perform testing between handholes or terminations. If this option is chosen, the line must be reconnected and pressure tested after mandrel testing is successful to prove all connectors are reattached.

END OF SECTION

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SECTION 31 10 00
SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Site clearing Work, including:
      a. General provisions for site clearing Work.
      b. Preparation for site clearing Work.
      c. Clearing and grubbing.
      d. Tree protection, selective removals, and selective trimming.
      e. Disposal and cleaning.
      f. Stripping and stockpiling of topsoil.

B. Scope:
   1. The work under this Specification includes removal of existing vegetation within the limits of disturbance as shown on Project Plans.
   2. The contractor is advised that the recommended season for tree removal is August 15 to April 1.
      a. If tree removal is performed between April 1 and August 15, the contractor shall survey for active bird nests.
      b. If an active nest is discovered, work within one half mile of that nest will be prohibited until the birds have fledged.
      c. Survey work shall be performed by a qualified biologist.

C. Related Requirements: Include but are not necessarily limited to:
   1. Division 00 – Procurement and Contracting Requirements
   2. Division 01 – General Requirements
   3. Section 31 22 00 - Site Grading
   4. Section 31 23 00 - Earthwork
   5. Section 31 23 33 – Utilities - Trenching and Backfilling.

1.2 REFERENCES

A. Terminology:
   1. Terms indicated below are not defined terms indicated with initial capital letters but, when used in this Section, have the meanings indicated below:
      a. “Arborist” means Subcontractor retained to perform Work requiring a specialist in trees, shrubs, brush, other vegetation of the types existing at the Site, and possessing not less than the required qualifications indicated in this Section.
      b. “Clearing and grubbing” means removing and disposing of all: (1) trees, brush, and other vegetation, logs, and similar items (“clearing”); and (2) stumps, roots, logs, rubbish, and debris on or in the soil (“grubbing”) after Clearing. Clearing and grubbing includes grinding and removing of stumps. When clearing and grubbing, topsoil stripping and stockpiling, and required demolition Work is complete, the Site will be ready for grading and other new construction.
      c. “Demolition” means removal, whether in whole or in part, of existing human-made construction, such as removal of buildings, structures, and building systems; site work (such as pavement, curbs, sidewalks, gutters) and the like; Underground Facilities; and other existing construction.
      d. “Selective removal” means removal of specific trees, shrubs, brush, and other vegetation, whether as shown or indicated in the Contract Documents or as directed at the Site by Contracting Officer’s Representative.

e. "Selective trimming" means removal of selected parts of trees, shrubs, brush, and other vegetation, performed by arborist, for the purpose of either: (1) allowing installation of new construction adjacent to or through the tree, shrub, brush, or vegetation, or 2) removing damaged or unhealthy growth, to allow balance of the subject tree, shrub, brush, or vegetation to continue normal, healthy growth.
f. "Site clearing" means all the Work required by this Section and related Drawings.
g. "Topsoil" means existing material at the Site, visible after clearing and grubbing, to be stripped, when such material is friable, clay loam, surface soil present in depth of not less than four inches. Topsoil shall be free of subsoil, clay lumps, stones, and other objects over two-inch diameter and other objectionable material. Topsoil required for planting and landscaping Work in the Specifications of Division 32 may differ from the meaning indicated in this Section.

B. Reference Standards:
1. ASTM International (ASTM):
a. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength, and Perforated.
b. D448, Standard Classification for Sizes of Aggregate for Road and Bridge Construction.
2. American National Standards Institute (ANSI):.
a. A300, Standard for Tree Care Operations – Tree, Shrub, and Other Woody Plant Maintenance – Standard Practices.
3. International Society of Arboriculture (ISA):
a. Container Rootball Shaving.
b. Crown Correction.
c. Balled and Burlapped Root Correction.
d. Container Root Correction.
e. High Branched Crown Observation.
f. Low Branched Crown Observation.
g. Multiple Low Branches Crown Observation.
h. Balled and Burlapped Root Observation.
i. Container Root Observation - Tree.
j. Protection Maintenance.

1.3 ADMINISTRATIVE REQUIREMENTS

A. Pre-Clearing Conference:
1. Prior to commencing site clearing Work, actively participate in conference regarding site clearing Work. Date and time of conference will be mutually established by Contractor and Contracting Officer.
2. Location: Conference will be held at the Site in a location and time determined by the Contractor and the Contracting Officer or be by online video conference established by Contracting Officer.
3. Participants:
a. Required Participants: Contractor's project manager, Contractor's site superintendent, arborist, and the Contracting Officer Representative.
b. Potential Participants: Contracting Officer
4. Contracting Officer or Contracting Officer's Representative will chair the conference, prepare and distribute an agenda, and prepare and distribute a record of the conference.
5. Participants shall be prepared to discuss:
a. Project requirements and the Contract requirements for site clearing Work.
b. Submittals required for site clearing Work.
c. Schedule for site clearing Work and availability of resources.
d. Locations and types of site clearing Work, with specific attention to areas of selective removals, selective trimming, and notable species. Limits of clearing and grubbing. Proposed locations for stockpiles and temporary storage of cuttings and debris.
e. Environmental and other conditions at the Site.

f. Growth, vegetation, and existing construction requiring protection.
g. Required observations and field quality control for site clearing Work.

6. If additional information affecting site clearing Work subsequently comes to light, reconvene the conference at earliest opportunity.

1.4 QUALITY ASSURANCE

A. Qualifications:
1. Arborist:
a. Where selective removal, selective trimming, or both are required or necessary, retain the services of, and employ in the Work, accredited arborist, possessing qualifications acceptable to Contract Officer.
b. Arborist shall be skilled, trained, and possess documented experience in successfully protecting, trimming, and restorative care of trees and shrubs of the types necessary for the Work.
c. Certification: Arborist shall be certified by either International Society of Arboriculture (ISA) or American Society of Consulting Arborists (ASCA).
d. Arborist shall use in selective removal and selective trimming Work only workers with specific skill and successful experience in this type of Work required. Such workers shall work under the direct, personal supervision of arborist.
e. Submit to Contract Officer names, employer(s), certifications, other relevant qualifications and record of relevant experience, as indicated below, for not less than three successful projects involving same species of trees, shrubs, and vegetation as involved in the site clearing Work:
1) Names and telephone numbers of site owners, architects or engineers responsible for projects.
2) Approximate contract price of the selective removal and selective trimming of trees, shrubs, and vegetation.
3) Approximate time of year work was performed on each referenced project.
4) Approximate quantity and types of selective removal and selective trimming of performed.
5) General indication of species of trees, shrubs, and vegetation involved.

2. Biologists performing site survey as described above shall be qualified by U.S Fish and Wildlife Service for this purpose.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
a. Limits of Site Clearing Work: When limits of site clearing Work are not expressly shown on the Drawings, or where Contractor proposes alternative limits of site clearing Work, submit drawings, developed from the Drawings, clearly indicating proposed limits of site clearing Work, with dimensions indicated where appropriate.
b. Where proposed limits of clearing and grubbing, selective removals, and topsoil stripping are not identical with each other, clearly and expressly indicate limits of each on the Shop Drawings.

B. Informational Submittals: Submit the following:
1. Permits and Approvals:
a. Submit copy of each permit required and obtained for site clearing Work, issued by authority having jurisdiction.
b. Where Government permission or approval is required for selected site clearing activities, submit copy of Contract Officer’s written permission or approval for such activity.
c. When approval of Contracting Officer of property (other than Contracting Officer) is required for selected site clearing activity, submit to Contracting Officer written copy of such approval.
2. Certificates:

a. Arborist's certification that trees and shrubs shown or indicated to remain were protected during the site clearing Work in accordance with the Contract Documents.
b. Where trees or shrubs (shown or indicated to remain) were damaged during site clearing Work, submit arborist's certification that such trees and shrubs were promptly and properly treated or, where successful treatment was not feasible, were replaced.

3. Qualifications Statements:
   a. Arborist qualifications.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

2.1 MATERIALS

A. Tree Wound Dressing:
   1. Provide tree wound dressing, waterproof, adhesive and elastic with an antiseptic, free from kerosene, coal tar, creosote, and other material injurious to life of tree or other plant.

B. Filter Fabric:
   1. In accordance with requirements for temporary erosion and sediment controls indicated in Section 01 50 00 – Temporary Facilities and Controls.

C. Drainage Fill:
   1. Selected crushed stone, or crushed or uncrushed gravel, washed.
   2. Size 24 (in accordance with ASTM D448), with 90 to 100 percent passing 2.5-inch sieve and not more than 10 percent passing 3/4-inch sieve.

D. Burlap:
   1. Jute, not less than 7.2 ounces per square yard.

E. For other materials needed for site clearing Work, such as stone, topsoil, or other, comply with requirements of the Contract Documents.

PART 3 - EXECUTION

3.1 SITE CLEARING – GENERAL

A. Limits of Site Clearing Work:
   1. Limits of site clearing Work are shown and indicated on the Drawings.

B. General Provisions for Site Clearing:
   1. Contractor shall provide all labor, materials, equipment, tools, services, and incidentals necessary and required to perform site clearing Work in accordance with the Contract Documents.
   2. Perform site clearing Work to avoid creating nuisances, pollution, and preventable adverse effects on the environment.
   3. Comply with Section 01 73 40 - Execution, and this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".
   4. Excavation required for site clearing shall comply with Section 31 23 00 - Earthwork.
   5. Requirements of Authorities Having Jurisdiction:
      a. Perform site clearing Work in accordance with Laws and Regulations.
      b. Obtain, pay for, and comply with permits required for site clearing Work. Obtain from authorities having jurisdiction and furnish copy of each permit as a Submittal.
   6. Traffic Control:
      a. Where site clearing Work is along or adjacent to travelled ways subject to public traffic, comply with Section 01 50 00 – Temporary Facilities and Controls.
      b. Establish such controls prior to and maintain in place throughout site clearing Work that has potential to affect traffic.

7. Site clearing Work shall comply with ANSI A300 and applicable ISA standards indicated in this Section's "References" Article, unless the Contract Documents indicate more-stringent requirements.
8. Demolition Work is indicated in Section 02 41 00 - Demolition, including removal of site improvements and Underground Facilities.

3.2 PREPARATION

A. Permits and Approvals:
   1. Do not commence site clearing Work until necessary permits and approvals are obtained and copies furnished to Contracting Officer as Submittals.

B. Delineation of Limits of Site Clearing Work Areas:
   1. Locate and clearly flag at the Site:
      a. Limits of site clearing Work.
      b. Trees, shrubs, vegetation, and other materials to remain within limits of site clearing Work.
      c. Trees, shrubs, and other vegetation to be selectively trimmed.
      d. Trees, shrubs, and vegetation to be selectively removed.
      e. Salvageable trees, shrubs, and vegetation (to be relocated) within limits of site clearing Work.
   2. Flagging:
      a. Flagging shall be high-visibility type. Where necessary, provide lath or stakes driven into the ground, with flagging, to clearly delineate limits.
      b. Provide different-colored flagging for each type of delineation required by this Article.
      c. Promptly replace lost, moved, or destroyed flagging until Contracting Officer's Representative concurs that flagging is no longer needed.
   3. Review with Contracting Officer:
      a. Before starting site clearing Work, other than flagging, review at the Site with Contracting Officer or Contracting Officer's Representative.
      b. Make corrections as necessary.
      c. Review all trees, 5inch DBH (diameter at breast height) and larger, to be removed or selectively trimmed.
      d. Review with Contracting Officer's Representative at the Site trees and shrubs to be selectively trimmed, to reach mutual agreement on extent of selective trimming required.

C. Protection: Establish protection of trees, shrubs, and vegetation to remain, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming", and other applicable provisions of the Contract Documents.

D. Temporary Erosion and Sediment Controls:
   1. Provide applicable temporary erosion and sediment controls before commencing clearing and grubbing and topsoil stripping Work.
   2. Comply with temporary erosion and sediment control requirements of Section 01 57 23 - Temporary Stormwater Pollution Prevention and Section 31 25 00 Erosion and Sedimentation Controls.
   3. Continue providing temporary erosion and sediment controls as clearing and grubbing and topsoil stripping and stockpiling Work progresses into previously uncleared, ungrubbed areas of the Site...

3.3 CLEARING AND GRUBBING

A. Clearing and Grubbing – General:
   1. Prior to the contractor performing clearing operations, NPS staff will perform vegetation salvage activities within the limits of work including seed collection and ponderosa sapling harvesting. The NPS will transport and store salvaged vegetation.

a. Contractor to coordinate with the Contracting Officer Representative and confirm vegetation salvage work has been completed by the NPS prior to site clearing operations.

2. Following review and approval of limits of disturbance and installation of temporary fencing, contractor shall clear from within the approved limits of disturbance all vegetation not marked to remain.
   a. Include shrubs, brush, downed timber, rotten wood, heavy growth of grass and weeds, vines, rubbish, structures and debris.
3. Grub from within limits of disturbance all stumps, roots, root mats, logs, and debris encountered. Cavities resulting from the removal of stumps or other materials shall be backfilled with material approved by the Contracting Officer.

B. Trees and Shrubs Improperly Destroyed or Damaged:

C. Where, in the opinion of the Contracting Officer, vegetation to be preserved is significantly damaged by clearing and grubbing operations, the contractor shall be required to cute and remove from site damaged vegetation at no additional cost. Trees and Shrubs to Remain:
   1. Trees and shrubs to remain shall be protected, and trimmed where necessary or required, in accordance with this Section's Article, "Tree Protection, Selective Removals, and Selective Trimming".

3.4 TREE PROTECTION, SELECTIVE REMOVALS, AND SELECTIVE TRIMMING

A. General Provisions for Tree Protection, Selective Removals, and Selective Trimming:
   1. Provide temporary fencing, barricades, or guarding measures, as recommended by arborist, outside drip line of trees and shrubs to remain.
   2. Protect root systems from damage caused by noxious materials, storm water runoff, site clearing, planting and landscaping, other Work, and storage of materials and equipment. Protect root systems from flooding, erosion, and excessive wetting resulting from dewatering of excavations, drainage of tanks, and other construction activities.
   3. Do not store matter resulting from site clearing or demolition, topsoil, or other excavated material within drip line of trees and shrubs to remain. Vehicles are not allowed within drip line without authorization from the Contracting Officer. Restrict foot, vehicle and equipment traffic to prevent compaction of soil over root systems. Where such activities are unavoidable, and only as acceptable to Contracting Officer, provide temporary, continuous, heavy-duty wood planking effectively fastened together and capable of distributing loads from such activities. Temporary planking shall be underlaid by layer of filter fabric covered with two-inch layer of gravel.
   4. Cut branches and roots, when necessary, with sharp pruning instruments; do not break or chop. Fully paint cuts 1/2-inch and larger in size with tree wound dressing.

B. Excavation and Protection of Trees and Shrubs:
   1. Excavate within drip line of trees only where shown.
   2. Where trenching for utilities is required within drip line, tunnel under or around main lateral feeder roots by drilling, auger boring, pipe jacking, or digging by hand under supervision of arborist. Do not cut main lateral roots or tap roots; cut smaller roots, which interfere with installation of the Work.
   3. Where excavation for the Work is required within drip line of trees or shrubs, hand excavate to minimize damage to root systems. Perform excavation under supervision of arborist. Provide temporary shoring or other protective support systems at excavations, to minimize sloping and benching of excavations. Use narrow tine spading forks and comb excavated material to expose roots.
   4. Relocate roots in backfill areas wherever possible. If large, main lateral roots are encountered, expose beyond excavation limits as required to bend and relocate without breaking. If encountered immediately adjacent to location of construction and relocation is not practical, cut roots approximately three inches back from construction.

5. Do not allow exposed roots to dry out before permanent backfill is provided; provide temporary earth cover. Water and maintain in moist condition and temporarily support and protect from damage until permanently relocated and covered with earth.

C. Grade Adjustments and Tree Protection:
   1. Maintain existing grade within drip line of trees, unless otherwise shown or indicated.
   2. Lowering of Preconstruction Grade:
      a. Where required finish grade is below preconstruction grade around trees and shrubs, grade beyond drip line. Maintain preconstruction grade within drip line of trees and shrubs.
      b. Prune tree and shrub roots exposed during grade lowering, or provide permanent protections as recommended by arborist. Do not cut main or lateral roots or tap-roots; cut only smaller roots.
      c. Compensate for loss of roots and prune branches to stimulate root growth.
      d. Provide extended service through completion of the Contract correction period as recommended by arborist.
   3. Minor Fills:
      a. Where preconstruction grade is six inches or less below elevation of finish grade shown, fill with topsoil complying with quality requirements of Specifications for finish grading and landscaping.
      b. Place in single layer and do not compact.
      c. Hand-grade to required finish elevations.
   4. Moderate Fills:
      a. Where preconstruction grade is more than six inches, but less than 16 inches, below finish grade elevation, provide layer of drainage fill and filter fabric on preconstruction grade prior to placing topsoil that complies with quality requirements of Specifications on finish grading and landscaping.
      b. Carefully place drainage fill against trunk of tree or shrub approximately two inches above elevation of finish grade and extend not less than 1.5 feet from tree or shrub trunk on all sides.
      c. Provide filter fabric with edges overlapping by 6 inches, minimum.
      d. Place fill layer of topsoil to finish grade elevation.
      e. Do not compact stone, gravel or topsoil layers. Hand-grade to required finish elevations.
   5. Deep Fills:
      a. Provide an open dry circular well of durable, unmortared stone, located not less than two feet s from trunk of associated tree or shrub.
      b. To facilitate proper drainage, provide eight to 10 continuous runs of four-inch drain tiles horizontally on the preconstruction ground surface under the complete spread of branches in radial pattern around the tree or shrub.
      c. Slope drain tiles away from tree or shrub.
      d. Provide drainage fill on preconstruction ground surface in depth of two inches under and six inches over drain tiles.
      e. Provide filter fabric over entire top surface of drainage fill.
      f. Provide eight to 10 drainage tiles, each four-inch diameter, vertically in radial pattern around tree or shrub, located five feet from trunk of tree or shrub. Extend vertical drainage tiles from the filter fabric layer above the horizontal drainage tiles to postconstruction finished grade
      g. Hold drainage tiles in place with drainage fill.
      h. Hand-grade to required finish grade elevation.

D. Tree and Shrub Pruning (Selective Trimming):
   1. Pruning necessary for the project and future periodic maintenance in the area, will adhere to the Park's pruning guidelines with the goal of retaining health and integrity of trees and shrubs treated. Damage to trees or roots in or adjacent to project areas during construction will be avoided as much as possible

2. Tree pruning shall be conducted in accordance with *Grand Canyon National Park Pruning Protocols* available from the Contracting Officer's Representative.
    a. Pruning shall occur at the branch collar and the branch collar shall remain intact.
    b. No more than 20% of the total tree canopy will be pruned (the green leaf or needle-bearing area of branches).
    c. Tree roots shall be pruned if they are exposed during the project. No more than 33% of the tree's roots shall be removed and not more than 20% from one side shall be removed.

3.5 DISPOSAL AND CLEANING

A. Disposal – General:
    1. Do not use cleared, grubbed, or trimmed material as fill, backfill, or in embankments.
    2. Dispose of cleared, grubbed, and trimmed material, and other materials, rubbish, and debris, in accordance with Laws and Regulations.
    3. Pay all costs associated with transporting and disposing of materials and debris resulting from site clearing Work.
    4. Do not sell removed materials at the site. If materials, equipment or debris will be sold by contractor, remove the items from the park boundary and perform the sale or transaction elsewhere, in accordance with Laws and Regulations.

B. Tree Removal
    1. Contractor shall salvage all 6 IN diameter trees or larger. These trees shall be limbed and cut into 4 FT logs.
        a. Contactor shall transport all logs to a final off-site location as indicated in Section 01 11 00. Slash and limbs shall be removed from the Park by the Contractor.
    2. Stumps not removed due to construction shall be flush cut, not to exceed 6 IN in height above the ground.

C. Cleaning:
    1. Perform progress cleaning and other cleaning Work, and disposal of resulting materials and debris, in accordance with Section –01 73 40 - Execution.

D. Burning:
    1. Burning of trees, shrubs, brush, other vegetation, and other materials at or adjacent to the Park is not allowed.
    2. Do not burn combustible materials on site.

3.6 TOPSOIL STRIPPING AND STOCKPILING

A. Topsoil Removal:
    1. Remove required topsoil prior to all other soil disturbing operations
    2. Remove the topsoil in one pass, do not mix topsoil with subsoil, and do not compact or drive upon topsoil during removal.
    3. Extents of topsoil removal shall be approved by Contracting Officer's Representative prior to all other soil disturbing operations.

B. Stripping:
    1. Before commencing topsoil stripping:
        a. Perform clearing and grubbing and selective removals.
        b. Remove grass and other vegetation that may remain following clearing and grubbing.
        c. Provide necessary and required temporary erosion and sediment controls.
    2. Strip topsoil to depths encountered or as specified within the geotechnical report, 4 IN minimum.
    3. Before stockpiling, separate objectionable material from topsoil.
    4. Live vegetation less than 3 FT in height and limbs less than 1 IN in diameter shall be incorporated as topsoil in the stockpiles.

5. Do not strip topsoil from within drip line of trees and shrubs to remain as part of the completed Project.

C. Stockpiling:
   1. Construct and maintain topsoil stockpiles in accordance with Section 01 67 00 - Product Requirements, at locations in accordance with Section 01 11 00 - Summary of Work.

D. Reuse of Stripped Topsoil:
   1. Reuse in the finish grading and landscaping Work topsoil that complies with the Contract Documents for such Work.
   2. Where topsoil stripped from the Site does not comply with the Contract Documents relative to quality required for use in finish grading and landscaping Work, provide appropriate soil amendment material, properly and fully mixed into topsoil stripped from the Site, so that amended material complies with quality requirements for topsoil required for finish grading and landscaping Work.

E. Disposal of Excess Topsoil:
   1. Topsoil in excess of quantity required for the finished Project is Government's property and shall be stockpiled onsite at location designated by Government, in accordance with stockpiling requirements of Section 01 67 00 - Product Requirements.

END OF SECTION

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SECTION 31 22 00
SITE GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Earthwork - site excavation, grading, compaction, and other Earthwork related work.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 31 23 00 - Earthwork
   3. Section 32 15 40 - Crushed Stone Surfacing.
   4. Section 31 25 00 – Soil Erosion and Sediment Controls

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33, Standard Specification for Concrete Aggregates.
      b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/CUFT).
      c. D1241, Standard Specification for Material for Soil-Aggregate Subbase, Base, and Surface Courses.
      d. D1557, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 FT-LBF/CUFT (2,700 kN-M/M)).
      e. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      f. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
      g. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      h. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
      i. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   2. American Association of State Highway and Transportation Officials (AASHTO)
      a. M 43, Standard Specification for Sizes of Aggregate for Road and Bridge Construction.
      b. M 57, Standard Specification for Materials for Embankment and Subgrades.
      c. M 147, Standard Specification for Materials for Aggregate and Soil-Aggregate Subbase, Base, and Surface Courses.
   3. Federal Regulations:
      a. Occupational Safety and Health Administration (OSHA):
         1) 29 CFR Part 1926.650, Occupational Safety and Health Standards, referred to herein as OSHA Standards.

1.3 DEFINITIONS

A. Geotechnical Engineer: Independent geotechnical specialist, hired by the Contractor, providing field quality control for the project.

B. Finish Grade: The earth or soil layer immediately below the surfacing material of the site.

C. Rough Grade: The earth or soil layer immediately below the finish grade surface.

D. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.

E. Unauthorized Excavation:
   1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Contracting Officer.
      a. Unauthorized excavation, as well as associated remedial work as directed by Contracting Officer or Geotechnical Engineer, shall be at Contractor's expense.
   2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Geotechnical Engineer.

1.4 SUBMITTALS

A. Product Data:
   1. Acknowledgement that products submitted meet requirements of standards referenced.
   2. Manufacturer's installation instructions.
   3. Certifications.

B. Samples:
   1. Coordinate samples and testing for approval of off-site materials with the Geotechnical Engineer.

1.5 PROJECT CONDITIONS

A. Salvageable Items: Carefully remove items to be salvaged, and store on Contracting Officer's premises unless otherwise directed.

B. Dispose of waste materials, legally, off site.
   1. Burning, as a means of waste disposal, is not permitted.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Fill:
   1. Selected on-site material from site excavation or from off-site borrow approved by the Contracting officer or Geotechnical Engineer.

B. Aggregate Base:
   1. Granular Fill Material:
      a. Clean, Granular material.
      b. Minimum of 100% passing the ¾ inch (19 mm) sieve.
      c. Less than 25% passing the No. 50 (0.297 mm) sieve.
      d. Less than 5% fines passing the No. 200 sieve.
      e. ASTM D1241/AASHTO M147 Grading "B" or other material acceptable to the Contracting Officer or Geotechnical Engineer, hired by the Contractor.

PART 3 - EXECUTION

3.1 PROTECTION

A. Erosion Control:
   1. See Specification Section 31 25 00.
   2. See Specification Section 01 35 05.
   3. See Specification Section 31 23 00.

3.2 SITE GRADING

A. Excavation and Grading:
   1. See Specification 31 23 00

B. Grading Tolerances: As shown on Drawings.

C. Disposition:

Remove excess material and dispose of at the temporary material stockpile location shown in the Contract Documents.

1.

3.3 COMPACTION DENSITY REQUIREMENTS

A. Obtain approval from Contracting Officer with regard to suitability of soils and acceptable subgrade prior to subsequent operations.

B. Remove frozen, loose, wet, or soft material and replace with approved material as directed by the Contracting Officer.

C. Assure by results of testing that compaction densities comply with the following requirements:
   1. Sitework:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Rough Grade:		
Cohesive soils	95% of ASTM D698	-2 to +2% of optimum
Cohesionless soils	75% relative density per ASTM D4253 and ASTM D4254	
Finish Grade:		
Cohesive soils	95% of ASTM D698	-2 to +2% of optimum
Cohesionless soils	75% relative density per ASTM D4253 and ASTM D4254	

3.4 FIELD QUALITY CONTROL

A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA standards 29 CFR Part 1926.650 Subpart P, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.

B. Special Inspection and testing:
   1. See Section 01 40 00.

C. Responsibilities of Special Inspector:
   1. Review proposed materials for rough grade and finish grade around the site and structures.
   2. All testing, observation and work indicated as being performed by the Geotechnical Engineer, hired by the Contractor, in this Specification Section.
   3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
   4. Moisture density relations, to be established by the Geotechnical Engineer required for all materials to be compacted.
   5. Extent of compaction testing will be as necessary to assure compliance with specifications.
   6. Prepare and submit inspection and test reports to Contracting Officer.
      a. Coordinate such work with other Special Inspectors.
   7. Test reports to include the following:
      a. Report and certification of aggregate fill and drainage fill.
      b. Test reports on borrow material.
      c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
      d. Field reports; in-place soil density and moisture tests.
      e. One optimum moisture-maximum density curve for each type of soil encountered.
      f. Other documentation necessary for the Contracting Officer to approve earthwork.

g. Assist Contracting Officer to determine corrective measures necessary for defective work.

D. Responsibilities of Testing Agency for Site Rough Grading and Finish Grading:
   1. All testing, observation and work indicated as being performed by the Contractor's Geotechnical Engineer in other than Article 3.4 of this Specification Section.
   2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
   3. Moisture density relations, to be established by the Contractor's Geotechnical Engineer required for all materials to be compacted.
   4. Extent of compaction testing will be as necessary to assure compliance with specifications.

END OF SECTION

SECTION 31 23 00
EARTHWORK

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Earthwork - excavation, backfilling, grading, placement of fill, compaction, preparation of subgrade below pavements, disposal of waste and surplus materials, placing crushed stone, construction of berms, sheeting, bracing, dewatering, placing structural fill and other Earthwork related work.
   2. Rock Removal – removal of rock boulders using mechanical methods, including drilling, or by expansive demolition grout application, disposal of waste and surplus materials, and other Rock Removal related work.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 31 23 33 – Utilities – Trenching and Backfilling.
   4. Section 31 25 00 - Soil Erosion and Sediment Controls.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C33/C33M, Standard Specification for Concrete Aggregates.
      b. D698, Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 FT-LBF/FT^3).
      c. 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)).
      d. D2487, Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
      e. D3786, Standard Test Method for Bursting Strength of Textile Fabrics--Diaphragm Bursting Strength Tester Method.
      f. D4253, Standard Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
      g. D4254, Standard Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
      h. D4632, Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
   2. Occupational Safety and Health Administration (OSHA):
      a. 29 CFR Part 1926.650, Safety and Health Regulations for Construction - Excavations, referred to herein as OSHA Standards.

1.3 DEFINITIONS

A. Excavation:
   1. Consists of removal of material encountered to subgrade elevations required or indicated.
   2. Includes excavation of soils; pavements and other obstructions visible on surface; underground structures, utilities, and other items indicated to be demolished and removed; boulders; and rock.

B. Rock Removal:
   1. Classification of rock removal shall include solid ledge rock in its natural location that requires systematic quarrying, drilling, and/or expansive grout application for its removal and also large boulders that cannot be easily dislodged as described in the conditions below.
   2. Rock removal:

a. Rock removal includes any material which cannot be dislodged by a D-8 Caterpillar tractor, or equivalent, equipped with a hydraulically operated power ripper, or by a Caterpillar 330 hydraulic excavator, or equivalent, without the use of drilling.

C. Foundations: Footings, base slabs, foundation walls, mat foundations, grade beams, piers and any other support placed directly on soil or rock.

D. Geotechnical Engineer: Independent geotechnical specialist, hired by the Contractor, providing field quality control for the project.

E. Non-Structural Fill/Backfill: Soil materials placed and compacted to achieve finish grade elevations that do NOT support foundations, slabs, paving, or other flatwork.

F. Structure: Buildings, foundations, slabs, tanks, curbs, or other man-made stationary features occurring above or below ground surface.

G. Subgrade: The earth or soil layer immediately below foundation bearing elevation, subbase material, fill material, backfill material, or topsoil materials.

H. Unauthorized Excavation:
1. Consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of Contracting Officer.
a. Unauthorized excavation, as well as associated remedial work as directed by the Contracting Officer or Contractor’s Geotechnical Engineer, shall be at Contractor’s expense.
2. Unsuitable Soil Materials: Soil materials encountered at or below subgrade elevation of insufficient strength and stiffness to support construction as determined by the Contractor’s Geotechnical Engineer.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's installation instructions.
3. Certifications.
a. Contractor shall submit certification, to the Contracting Officer, that sources of rock, sand, earth and other natural materials imported into the project construction limits are noxious weed free.

B. Samples:
1. Coordinate samples and testing for approval of off-site materials with the Contractor’s Geotechnical Engineer and with the Contracting Officer.

1.5 PROJECT CONDITIONS

A. See Geotechnical Investigation Reports referenced in Section 01 11 00.

B. Salvageable Items: Carefully remove items to be salvaged, and store on Contracting Officer’s premises unless otherwise directed.

C. Dispose of waste materials, legally, off site.
1. Burning, as a means of waste disposal, is not permitted.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

2.1 MATERIALS

A. General
   1. Do not import into the project limits rock, sand, gravel, earth, subsoil, or other natural materials from a Contractor-selected non-commercial materials source that have not been certified free of noxious weeds.
   2. Materials imported into the project limits, which do not include a noxious weed free certification may be rejected and ordered by the Contracting Officer to be removed from the project limits. Any fill material coming from off-site shall be inspected to reduce the chance for introduction of exotic plant species. Offsite source for any fill material shall be also inspected prior to material coming into the Park.
   3. The Contracting Officer has the discretion of requesting inspection of certified materials by a third party and rejecting the use of the source if noxious weeds or seeds thereof are found to be present.
   4. Only Clean fill, preferably from a site within the Park, shall be used. Any fill coming from off-site shall be certified weed seed-free soil and The source of the material shall be inspected and/or approved by GRCA's Vegetation Program Manager (NPS) prior to use.
   5. The source of fill for this project is from project-related excavations. There are no other borrow pits available on-site for Contractor sourcing of fill material.

B. Select Fill and Backfill, to be used under Building foundations, slabs, equipment pads, and for wall backfill and trench backfill:
   1. Native soil and/ or excavated material to be used as Select fill:
      a. Native soil and/or excavated fill material encountered during excavation that is desired to be reused as backfill shall not contain unsuitable material as determined by a qualified Geotechnical Engineer, hired by the Contractor.
      b. Processing onsite material shall include removing frozen soil, wood, trash, organic material, cobbles and boulders larger than 3 inches in longest dimension, and other deleterious materials.
      c. If other fill materials are preferred for any of the presented applications, Contractor shall present to Contracting Officer for review.
      d. Excavated bedrock should not be used as backfill.
   2. Selected material approved by Contractor's Geotechnical Engineer and submitted to the Contracting Officer from off-site borrow.
   3. Select Fill:
      a. May be low volume change cohesive or granular soil at Contractor's option.
      b. Free of organic matter, frozen material and debris, or other deleterious materials.
      c. Free of cobbles and boulders greater than 3-inches diameter
      d. Low volume change cohesive soil:
         1) ASTM D2487 classification: CL-ML or CL.
         2) Liquid limit: Less than 40.
         3) Maximum plasticity index: 20.
      e. Granular soil:
         1) ASTM D2487 classification: GW, GP, GM, GC, SW, SP, SM or SC.
   4. Alternate Select fill, to be used for wall backfill only:
      a. Arizona Department of Transportation (ADOT) Class 4 aggregate
      b. Maximum plasticity index: 5
   5. Non-Structural Fill:
      a. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
      b. Liquid limit: Less than 40.
      c. Maximum plasticity index: 15.

C. Granular Fill Under Slabs-On-Grade, Electrical Equipment Pads, Manholes and Handholes:
   1. Clean, granular material.
   2. Less than 5 PCT fines passing the No. 200 sieve.
   3. ASTM C33/C33M gradation size No. 67, 3/4 IN to No. 4 or other material acceptable to Contractor's Geotechnical Engineer.

D. Geotextile Filter Fabric:
   1. Nonwoven type.
   2. Equivalent opening size: 50 - 100 (U.S. Standard Sieve).
   3. Permeability coefficient (cm/second): 0.07 minimum, 0.30 maximum.
   4. Grab strength: 157 LBS minimum in either direction in accordance with ADOT Standards, 1014-9.
   5. Mullen burst strength: 125 PSI minimum in accordance with ASTM D3786 requirements.

E. Flowable Fill: See Section 03 31 30.

PART 3 - EXECUTION

3.1 PROTECTION

A. Protect existing vegetation that is to be preserved as noted in Section 02 41 00. Protect surface and subsurface features on-site and adjacent to site as follows:
   1. Provide barricades, coverings, or other types of protection necessary to prevent damage to existing items indicated to remain in place.
   2. Protect and maintain bench marks, monuments or other established reference points and property corners.
      a. If disturbed or destroyed, replace at own expense to full satisfaction of Contracting Officer and controlling agency.
   3. Verify location of utilities.
      a. Omission or inclusion of utility items does not constitute nonexistence or definite location.
      b. Take necessary precautions to protect existing utilities from damage due to any construction activity.
         1) If utilities are indicated to remain in place, provide adequate means of support and protection during earthwork operations.
         2) Do not interrupt existing utilities serving facilities occupied by Contracting Officer or others, or otherwise in use by the Park during occupied hours, except when permitted in writing by Contracting Officer and then only after acceptable temporary utility services have been provided.
         3) Obtain Contracting Officer's approval prior to disconnecting any utility service.
      c. Repair damages to utility items at own expense.
      d. In case of damage, notify Contracting Officer at once so required protective measures may be taken.
   4. Maintain free of damage, existing fences, sidewalks, structures, and pavement, not indicated to be removed.
      a. Protect new and existing structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.
      b. Any item known or unknown or not properly located that is inadvertently damaged shall be repaired to original condition.
      c. All repairs to be made and paid for by Contractor.
   5. Provide full access to public and private premises, fire hydrants, street crossings, sidewalks and other points as designated by Contracting Officer.
   6. Maintain stockpiles and excavations in such a manner to prevent inconvenience or damage to structures on-site or on adjoining property.
   7. Avoid surcharge or excavation procedures which can result in heaving, caving, or slides.
      a. Contractor shall note recommendations provided in Section 6.1, Temporary Excavations, of Geotechnical Report.

B. Protection of trees to remain:
   1. Where trees are near the outside of the limit of disturbance and have been determined to be preserved in place during clearing and grubbing operations, place temporary fencing as noted on Project Plans.

3.2 SITE EXCAVATION AND GRADING

A. Excavation and Grading:
   1. Prepare subgrades under asphaltic concrete pavement, concrete pavement and those areas where aggregate base course and crushed aggregate are used as finish grade materials.
   2. Perform as required for construction of storm water drainage improvements. Project Plans indicate both existing grade and finished grade required for construction of Project.
      a. Stake all units, structures, piping, roads, parking areas and walks and establish their elevations.
      b. Perform other layout work required.
      c. Replace property corner markers to original location if disturbed or destroyed.
   3. Preparation of ground surface for embankments or fills:
      a. Before fill is started, scarify to a minimum depth of 8 IN in all proposed embankment and fill areas.
      b. Where ground surface is steeper than one vertical to four horizontal, plow surface in a manner to bench and break up surface so that fill material will bind with existing surface. Benching shall be in accordance with OSHA recommendations.
   4. Where trees are near the outside of the limit of disturbance and have been determined to be preserved in place during clearing and grubbing operations, perform excavation by hand within dripline of these trees.
      a. Remove organic matter and unconsolidated soils with rakes and shovels within dripline where pavement is to be placed.
      b. Compact subgrade with a hand tamper.
      c. Do not use machinery.
   5. Protection of finish grade:
      a. During construction, shape and drain embankment and excavations.
      b. Maintain ditches and drains to provide drainage at all times.
      c. Protect graded areas against action of elements prior to acceptance of work.
      d. Reestablish grade where settlement or erosion occurs.

B. Borrow:
   1. Provide necessary amount of approved fill compacted to density equal to that indicated in this Specification.
   2. Include cost of all borrow material in original proposal.

C. Construct embankments and fills as required by the Project Plans:
   1. Construct embankments and fills at locations and to lines of grade indicated.
      a. Completed fill shall correspond to shape of typical cross section or contour indicated regardless of method used to show shape, size, and extent of line and grade of completed work.
   2. Provide approved fill material which is free from unsuitable soil materials including roots, organic matter, trash, frozen material, and stones having maximum dimension greater than 6 IN.
      a. Ensure that stones larger than 4 IN are not placed in upper 6 IN of fill or embankment.
      b. Do not place material in layers greater than 8 IN loose thickness.
      c. Place layers horizontally and compact each layer prior to placing additional fill.
   3. Compact soils as required to obtain specified density. Selection of appropriate equipment is the Contractor's responsibility.
      a. In general, compact cohesive soils by sheepsfoot, and granular soils by pneumatic rollers, vibrators, or by other equipment as required to obtain specified density.
      b. Control moisture for each layer necessary to meet requirements of compaction as defined herein.

D. Grading Tolerances: ±2 IN

E. Topsoil Placement
   1. Prior to placing the topsoil, the Contractor will disk or scarify all disturbed areas to a depth of 8 IN in a direction perpendicular to the natural flow of water.

a. Prior to topsoil placement, if the Contracting Officer determines that subsoil is excessively compacted by the Contractor's operations, the Contractor will scarify the subsoils to a depth of 24 IN to de-compact and break the interface between particles.
2. When applying topsoil, the Contractor will avoid mixing the topsoil with subsoil material.
3. The Contractor will spread conserved topsoil to a depth of 4 IN over all disturbed soil areas.
4. Topsoil will be spread using the lightest weight equipment applicable.
5. If the Contractor's Geotechnical Engineer determines that topsoil is excessively compacted by the Contractor's operations, the Contractor will scarify the topsoil to a depth of 8 IN to de-compact and break the interface between particles.
6. Under no circumstances should placed topsoil be allowed to remain without erosion protection (i.e., hydromulch, erosion wattles, log erosion barriers) for more than seven days or when heavy rain is predicted prior to erosion protection placement.
7. In areas where proposed grades are not shown within the contract documents, the Contractor shall scarify compacted soils and reestablish original grades if disturbed by construction activities.

F. Disposition:
1. North Rim: Stockpile per drawing sheet C104.

3.3 BEDROCK EXCAVATION

A. Bedrock excavation will be necessary.
1. Bedrock is anticipated to be difficult to excavate with increasing resistance with depth.
2. Based on this range, rippability per the Caterpillar Handbook of Ripping is between Rippable to Marginally Rippable using a D11 dozer.
3. Additional methods for excavation of rock include an impact hammer attachment to an excavator and specialized rock trenching equipment.
4. Refer to Geotechnical Report for depth to bedrock encountered during soils testing.

3.4 ROCK REMOVAL

A. General:
1. Contractor is solely responsible for method of rock removal employed, safety of all persons, and protection of property in accordance with Contract Documents.
2. Avoid damaging or weakening foundations, buildings, structures, Underground Facilities, wells, sheeting, bracing, and other facilities.
3. Coordinate rock removal with other Work to avoid damage to new construction and possible decrease in concrete strength placed less than 28-days prior to rock removal operations.
4. Perform rock removal adjacent to Underground Facilities and above-ground utilities, life-safety facilities, and facilities that may pose hazards to health and safety, with utmost care, after properly notifying and coordinating with Contracting Officer.
5. Contractor shall promptly remedy property damaged during or as a result of rock removal operations, in manner acceptable to Contracting Officer at no additional cost to Government.
6. Where conditions of hazard exist, or clearances with existing facilities, piping, or structures are very small, or where the potential for damage to persons or property is strong.

B. When rock is encountered:
1. Strip free of earth.
2. Employ an independent surveyor to determine rock quantities before operations begin.
3. In computing the volumetric content of rock excavation for payment, the pay lines shall be taken as follows:
a. For Structures: 3 FT outside the exterior limits of foundation and from rock surface to 6 IN below bottom of foundations.
b. For piping and utilities: A width 18 IN wider that the outside diameter of the pipe or conduit and from rock surface to 6 IN below bottom exterior surface of the pipe or conduit.

c. For rough or finish grading: 2 FT outside the exterior limits of excavation and rock surface to 6 IN below bottom of finish grade surface.

C. Disposition:
1. Do not use rock removed by Contractor as fill or backfill.

3.5 USE OF EXPLOSIVES

A. Not authorized

3.6 COMPACTION DENSITY REQUIREMENTS

A. See also Geotechnical Report.

B. Backfill placement shall occur in maximum 8-IN. loose lifts. Each lift shall be tested for proper compaction.

C. CO shall be consulted as to the adequacy of whether onsite soils are suitable as fill material.

D. Provide dewatering system necessary to successfully complete compaction and construction requirements.

E. Remove frozen, loose, wet, or soft material and replace with approved material as directed by Contractor's Geotechnical Engineer.

F. Stabilize subgrade with well graded granular materials as directed by Contractor's Geotechnical Engineer.

G. Assure by results of testing that compaction densities comply with the following requirements:
1. Sitework:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Under Paved Areas, Sidewalks and Piping:		
Cohesive soils	95 PCT per ASTM D698	-1 to +3 PCT of optimum
Cohesionless soils	95 PCT relative density per ASTM D698	-2 to +2 PCT of optimum
Pipe Bedding	65 PCT relative density per ASTM D4253 and ASTM D4254	
Unpaved Areas:		
Cohesive soils	95 PCT of ASTM D698	-1 to +3 PCT of optimum
Cohesionless soils	95 PCT per ASTM D698	-2 to +2 PCT of optimum

2. Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Inside of structures under foundations, under equipment support pads, under slabs-on-grade and scarified existing subgrade under fill material	98 PCT per ASTM D698	-1 to +3 PCT of optimum
Outside structures next to walls, piers, columns and any other structure exterior member	95 PCT per ASTM D698	-2 to +2 PCT of optimum

3. Specific areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside structures under equipment support foundations	98 PCT per ASTM D698	-1 to +3 PCT of optimum
Under void	85 PCT per ASTM D698	-1 to +3 PCT of optimum
Granular fill under manholes	65 PCT relative density per ASTM D4253 and ASTM D4254 or 98 PCT of ASTM D698	

3.7 EXCAVATION, FILLING, AND BACKFILLING FOR STRUCTURES

A. General:
   1. In general, work includes, but is not necessarily limited to, excavation structures and retaining walls, removal of underground obstructions and undesirable material, backfilling, filling, and fill, backfill, and subgrade compaction.
   2. Obtain fill and backfill material necessary to produce grades required.
      a. Materials and source to be approved by Contractor's Geotechnical Engineer.
      b. Excavated material approved by Contractor's Geotechnical Engineer may also be used for fill and backfill.
   3. In the paragraphs of this Specification Section, the word "soil" also includes any type of rock subgrade that may be present at or below existing subgrade levels.

B. Excavation Requirements for Structures:
   1. General:
      a. Do not commence excavation for foundations for structures until:
         1) The removal of topsoil and other unsuitable and undesirable material from existing subgrade.
         2) Density and moisture content of site area compacted fill material meets requirements of specifications.
         3) Site surcharge or mass fill material can be removed from entire construction site or portion thereof.
         4) Contractor's Geotechnical Engineer grants approval to begin excavations.
   2. Dimensions:
      a. Excavate to elevations and dimensions indicated or specified.
      b. Allow additional space as required for construction operations and inspection of foundations.
      c. Slope sides of excavations to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
      d. Maintain sides and slopes of excavations in safe condition until completion of backfilling.
   3. Removal of obstructions and undesirable materials in excavation includes, but is not necessarily limited to, removal of old foundations, existing construction, unsuitable subgrade soils, expansive type soils, and any other materials which may be concealed beneath present grade, as required to execute work indicated on Project Plans.
      a. If undesirable material and obstructions are encountered during excavation, remove material and replace as directed by Contractor's Geotechnical Engineer.
      b. Remove unsuitable subgrade soils located below foundations. The bottom of the over excavation shall be located outside the exterior limits of foundations around the perimeter of structure the following horizontal distance, whichever is greater:
         1) Distance equal to depth of over excavation below bottom of foundations. See Geotechnical Report.
      c. When excavation has reached required subgrade elevations, notify Contractor's Geotechnical Engineer, who shall make an inspection of conditions.

1) If Contractor's Geotechnical Engineer determines that bearing materials at required subgrade elevations are unsuitable, provide Subgrade Stabilization as specified herein.

4. Level off bottoms of excavations to receive foundations, floor slabs, equipment support pads, or compacted fill.
   a. Remove loose materials and bring excavations into approved condition to receive concrete or fill material.
   b. Where compacted fill material must be placed to bring subgrade elevation up to underside of construction, scarify existing subgrade upon which fill material is to be placed to a depth of 8 IN and then compact to density stated in this Specification Section before fill material can be placed thereon.
   c. Do not carry excavations lower than shown for foundations except as directed by Contractors' Geotechnical Engineer.
   d. If any part of excavations is carried below required depth without authorization, notify Contractor's Geotechnical Engineer and correct unauthorized excavation as directed. Corrections may include:
      1) Under soil supported footings, foundation bases, or retaining walls, fill unauthorized excavation by extending indicated bottom elevation of footing or base to excavation bottom, without altering required top elevation.
         a) Concrete fill may be used to bring elevations to proper position.
      2) In locations other than those above, including slabs on grade and pile supported foundations, backfill and compact unauthorized excavations as specified for authorized excavations of same classification, unless otherwise directed by Contractor's Geotechnical Engineer.
      3) No extra compensation will be made to Contractor for correcting unauthorized excavations.
5. Make excavations large enough for working space, forms, dampproofing, waterproofing, and inspection.
6. Notify Contractor's Geotechnical Engineer and Contracting Officer as soon as excavation is completed in order that subgrades may be inspected.
   a. Do not commence further construction until subgrade under compacted fill material, under foundations, under floor slabs-on-grade, under equipment support pads, and under retaining wall footings has been inspected and approved by the Contractors' Geotechnical Engineer as being free of undesirable material, being of compaction density required by this specification, and being capable of supporting the allowable foundation design bearing pressures and superimposed foundation, fill, and building loads to be placed thereon.
   b. Contractor's Geotechnical Engineer shall be given the opportunity to inspect subgrade below fill material both prior to and after subgrade compaction.
   c. Place fill material, foundations, retaining wall footings, floor slabs-on-grade, and equipment support pads as soon as weather conditions permit after excavation is completed, inspected, and approved and after forms and reinforcing are inspected and approved.
   d. Before concrete or fill material is placed, protect approved subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
7. Subgrade stabilization:
   a. If subgrade under foundations, fill material, floor slabs-on-grade, or equipment support pads is in a frozen, loose, wet, or soft condition before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Contractor's Geotechnical Engineer.
   b. Provide compaction density of replacement material as stated in this Specification Section.
   c. Loose, wet, or soft materials, when approved by Contractor's Geotechnical Engineer, may be stabilized by a compacted working mat of well graded crushed stone meeting the requirements defined in this specification section. If the base of the excavation is

still loose, wet, or soft, place geotextile fabric meeting the requirements defined in this specification section at the base of the excavation prior to placement of crushed stone. Compact stone mat thoroughly into subgrade to avoid future migration of fines into the stone voids.

d. Remove and replace frozen materials as directed by Contractor's Geotechnical Engineer.
e. Method of stabilization shall be performed as directed by Contractor's Geotechnical Engineer.
f. Do not place further construction on the repaired subgrades, until the subgrades have been approved by the Contractor's Geotechnical Engineer.

8. Do not place floor slabs-on-grade including equipment support pads until subgrade below has been approved, piping has been tested and approved, reinforcement placement has been approved, and Contractor receives approval to commence slab construction.
   a. Do not place building floor slabs-on-grade including equipment support pads when temperature of air surrounding the slab and pads is or is expected to be below 40 DEGF before structure is completed and heated to a temperature of at least 50 DEGF.
9. Protection of structures:
   a. Prevent new and existing structures from becoming damaged due to construction operations or other reasons.
   b. Prevent subgrade under new and existing foundations from becoming wet and undermined during construction due to presence of surface or subsurface water or due to construction operations.
10. Shoring:
    a. Shore, slope, or brace excavations as required to prevent them from collapsing.
    b. Remove shoring as backfilling progresses but only when banks are stable and safe from caving or collapse.
    c. Construct shoring that is required to retain water as part of the dewatering system, using non-permeable details such as interlock sealant for sheet piles.
11. Drainage:
    a. Control grading around structures so that ground is pitched to prevent water from running into excavated areas or damaging structures.
    b. Maintain excavations where foundations, floor slabs, equipment support pads or fill material are to be placed free of water.
    c. Provide pumping required to keep excavated spaces clear of water during construction.
    d. Should any water be encountered in the excavation, notify Contracting Officer and Contractor's Geotechnical Engineer.
    e. Provide free discharge of water by trenches, pumps, wells, well points, or other means as necessary and drain to point of disposal that will not damage existing or new construction or interfere with construction operations.
12. Frost protection:
    a. Do not place foundations, slabs-on-grade, equipment support pads, or fill material on frozen ground.
    b. When freezing temperatures may be expected, do not excavate to full depth indicated, unless foundations, floor slabs, equipment support pads, or fill material can be placed immediately after excavation has been completed and approved.
    c. Protect excavation from frost if placing of concrete or fill is delayed.
    d. Where a concrete slab is a base slab-on-grade located under and within a structure that will not be heated, protect subgrade under the slab from becoming frozen until final acceptance of the Project by the Contracting Officer.
    e. Protect subgrade under foundations of a structure from becoming frozen until structure is completed and heated to a temperature of at least 50 DEGF.

C. Fill and Backfill Inside of Structure and Below Foundations, Base Slabs, Floor Slabs, Equipment Support Pads and Piping:
   1. General:

a. Subgrade to receive fill or backfill shall be free of undesirable material as determined by Contractor's Geotechnical Engineer and scarified to a depth of 8 IN and compacted to density specified herein.
b. Surface may be stepped by at not more than 12 IN per step or may be sloped at not more than 2 PCT.
c. Do not place any fill or backfill material until subgrade under fill or backfill has been inspected and approved by Contractor's Geotechnical Engineer as being free of undesirable material and compacted to specified density.

2. Obtain approval of fill and backfill material and source from Contractor's Geotechnical Engineer prior to placing the material.
3. Vapor barrier: Install a continuous vapor barrier under floor slabs-on-grade as shown on Contract Drawings.
4. Fill and backfill placement:
   a. Prior to placing fill and backfill material, optimum moisture and maximum density properties for proposed material shall be obtained from Contractor's Geotechnical Engineer.
   b. Place fill and backfill material in maximum 8IN lifts.
   c. Compact material by means of equipment of sufficient size and proper type to obtain specified density.
   d. Use hand operated equipment for compacting fill within 5 FT of walls and less than 3 FT above pipes.
      1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
      2) Contractor is responsible for method of compaction so as not to damage wall.
   e. Do not place fill and backfill when the temperature is less than 40 DEGF and when subgrade to receive fill and backfill material is frozen, wet, loose, or soft.
   f. Use vibratory equipment to compact granular material; do not use water to compact soil by flooding or jetting. Moisture conditioning for compaction by vibratory equipment is allowed.
5. Where fill material is required below foundations, place fill material, conforming to the required density and moisture content as required to fill the specified overexcavation to bottom of foundation.

D. Filling and Backfilling Outside of Structures:
1. This paragraph of this Specification applies to fill and backfill placed outside of structures above bottom level of both foundations and piping but not under paving.
2. Provide material as approved by Contractor's Geotechnical for filling and backfilling outside of structures.
3. Fill and backfill placement:
   a. Prior to placing fill and backfill material, obtain optimum moisture and maximum density properties for proposed material from Contractor's Geotechnical Engineer.
   b. Place fill and backfill material to maximum allowable lift thickness indicated in this Section.
   c. Compact material with equipment of proper type and size to obtain density specified.
   d. Use hand operated equipment for compacting fill within 5 FT of walls and less than 3 FT above pipes.
      1) Compaction equipment exceeding 3000 LBS dead weight shall not be used within 5 FT of the wall as a minimum
      2) Contractor is responsible for method of compaction so as not to damage wall.
   e. Do not place fill or backfill material when temperature is less than 40 DEGF and when subgrade to receive material is frozen, wet, loose, or soft.
4. Backfilling against walls:
   a. Do not backfill around any part of structures until each part has reached specified 28-day compressive strength and backfill material has been approved.

b. Do not start backfilling until concrete forms have been removed, trash removed from excavations, pointing of masonry work, concrete finishing, dampproofing and waterproofing have been completed.
c. Do not place fills against walls until floor slabs at top, bottom, and at intermediate levels of walls are in place and have reached 28-day required compressive strength to prevent wall movement.
    1) See Contract Drawings for specific exceptions.
d. Bring backfill and fill up uniformly around the structures and individual walls, piers, or columns.

E. Backfilling Outside of Structures Under Piping or Paving:
1. Preparation of subgrade under pavements:
    a. Concrete pavement shall be constructed atop a minimum 8 IN. thick zone of moisture-conditioned and compacted subgrade.
    b. Aggregate base course as used as subgrade for asphaltic concrete pavement shall be installed atop a minimum 8 IN. thick zone of moisture-conditioned and compacted subgrade.
    c. Aggregate base course as used as finish surface for the contractor access road shall be constructed atop a minimum 8 IN. thick zone of moisture-conditioned and compacted subgrade.
    d. Aggregate base course as used as finish surface for the construction trailers and staging area at the South Rim Water Treatment Facilities shall be constructed atop a minimum 8 IN. thick zone of moisture-conditioned and compacted subgrade.
2. When backfilling outside of structures requires placing backfill material under piping or paving, the material shall be placed from bottom of excavation to underside of piping or paving at the density required for fill under piping or paving as indicated in this Specification Section.
3. This compacted material shall extend transversely to the centerline of piping or paving a horizontal distance each side of the exterior edges of piping or paving equal to the depth of backfill measured from bottom of excavation to underside of piping or paving.
4. Provide special compacted bedding or compacted subgrade material under piping or paving as required by other Specification Sections for the Project.

F. Mechanical compaction is required for all materials placed as fill during construction.
1. Compaction of cohesive materials is best accomplished with equipment such as a jumping jack or padfoot roller.
2. Noncohesive soils are best compacted with a vibratory plate or vibratory smooth-drum roller.
3. Compaction utilizing any flooding type technique is not recommended. The resulting subgrades shall be proof-rolled to verify stability.
4. If the proof-roll reveals soft or loose soils, the subgrade shall be stabilized.
    a. Stabilization shall be accomplished by over excavating existing soil to bedrock and replacing with compacted, moisture conditioned Engineered Fill or by using geotextile stabilization under 12 IN. of Engineered Fill.

3.8 FIELD QUALITY CONTROL

A. All excavation, trenching, and related sheeting, bracing, etc. shall comply with the requirements of OSHA Standards, and state requirements. Where conflict between OSHA and state regulations exists, the more stringent requirements shall apply.

B. Special Inspection and Testing:
1. See Section 01 40 00.

C. Responsibilities of Special Inspector:
1. Review proposed materials for fill and backfill around structures.
2. All testing, observation and work indicated as being performed by the Contractor's Geotechnical Engineer inArticle 3.5 of this Specification Section .

3. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
4. Moisture density relations, to be established by the Contractor's Geotechnical Engineer required for all materials to be compacted.
5. Extent of compaction testing will be as necessary to assure compliance with specifications. Minimum test requirement is equal to 1 test per 2000 sf per lift.
6. Prepare and submit inspection and test reports to Contracting Officer.
    a. Coordinate such work with other Special Inspectors.
7. Test reports to include the following:
    a. Report and certification of aggregate fill and drainage fill.
    b. Test reports on borrow material.
    c. Verification of suitability of each footing subgrade material, in accordance with specified requirements.
    d. Field reports; in-place soil density and moisture tests.
    e. One optimum moisture-maximum density curve for each type of soil encountered.
    f. Report of actual unconfined compressive strength and/or results of bearing tests of each strata tested.
    g. Other documentation necessary for Contractor's Geotechnical Engineer to approve earthwork.
    h. Assist Contracting Officer to determine corrective measures necessary for defective work.

D. Responsibilities of Testing Agency for Site Excavation and Grading:
1. All testing, observation and work indicated as being performed by the Contractor's Geotechnical Engineer.
2. Services will include verification and documentation of satisfactory soil materials, subgrade quality, sampling, placement, moisture conditioning, compaction and testing of proposed soil materials, and field testing for quality control.
3. Moisture density relations, to be established by the Contractor's Geotechnical Engineer required for all materials to be compacted.
4. Extent of compaction testing will be as necessary to assure compliance with specifications.

END OF SECTION

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SECTION 31 23 33
UTILITIES - TRENCHING AND BACKFILLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Requirements for excavating, filling, and other earthwork for linear, buried utility projects, including:
      a. Field conditions.
      b. Soil and aggregate materials.
      c. Test pits.
      d. Excavation.
      e. Preparation of subgrades.
      f. Filling and compacting.
      g. Rough grading.
      h. Disposal of excavated spoil materials.

B. Related Requirements Include, but are not necessarily limited to, the following:
   1. Section 31 10 00 - Site Clearing.
   2. Section 32 91 13 - Finish Grading.
   3. Section 31 23 00 – Earthwork.

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement:
   1. Contractor shall provide all labor, materials, construction equipment and machinery, tools, and incidentals required or necessary for performing all trenching, backfilling, and related earthwork for the Contract, including all work related to excavating, preparing subgrades, providing and stockpiling materials, filling with required materials, compacting, grading, proper disposal of excess spoil materials, and all other work required by this Section. This Section includes trenching, backfilling, and related earthwork required for constructing: buried utilities, including piping and, where applicable, other Underground Facilities; site improvements (including pavement, sidewalks, curbs, and the like); subgrade preparation for other work; and all other trenching, backfilling, and related earthwork required by the Contract Documents and not addressed under other Specifications sections.
   2. Unless expressly indicated otherwise in the Contract Documents, such as Section 01 27 00 - Definition of Contract Line Items, the Work of this Section is included in the various lump sum and unit price bid/pay items for the Contract.
   3. All Work under this Section is unclassified and covered by this Section and the associated bid/payment item(s). No separate payment will be made for removing, handling, or disposing of rock (unless the Contract includes a separate bid/pay item specifically for rock excavation or rock removal), stones, concrete (whether or not reinforced), debris, stumps, and other material, regardless of moisture content, unless such material constitutes an unforeseen Hazardous Environmental Condition and Work associated with such Hazardous Environmental Condition is not included in the Contract.

1.3 REFERENCES

A. Terminology:
   1. The following terms are not defined and are not indicated with initial capital letters but, when used in this Section, have the following meaning:
      a. “Borrow” means material required for trenching, backfilling, and related earthwork in excess of quantity of suitable material available from required grading, cuts, and excavations at the Site. Borrow may be necessary even though not otherwise expressly required by the Contract Documents.

b. “Cohesive soil” means clay (fine grained soil), or soil with a high clay content, which has cohesive strength. Cohesive soil does not crumble, can be excavated with vertical or near-vertical sideslopes, and is plastic when moist. Cohesive soil is difficult to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.
c. “Cohesionless soil” means fill material that does not clump together; its grains remain separate and apart from each other. Cohesionless soils typically have a low proportion of fine (no. 200 mesh size and less) particles and may be soil material or granular material. The terms “cohesionless soils”, “cohesionless materials”, “non-cohesive soils”, and the like have the same meaning.
d. “Fill” means soil material, granular material, or other material indicated in this Section required for backfilling excavations or as material for achieving required rough grading. Unless indicated otherwise in the context of a specific provision, the terms “fill” and “backfill” have the same meaning, as do derivative terms such as, “filling” and “backfilling”. When used by itself, the term “backfill” means material required for refilling an excavation.
e. “Foundations” means bottoms of manholes, chambers, vaults, and similar structures; base slabs (slabs-on-grade); bearing directly on soil, granular material, or rock.
f. “Granular material” means gravel, sand, or silt, (coarse grained soil) with little or no clay content. Granular soil has no cohesive strength. Some moist granular soils exhibit apparent cohesion. Granular soil cannot be molded when moist and crumbles easily when dry. The terms “granular material”, “aggregate material”, and “granular soil” have the same meaning. Detailed requirements for specific types of granular material are indicated in Article 2.1 of this Section.
g. “Subgrade” means the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.
h. “Trenching” means excavating for buried utilities, other Underground Facilities, and related excavation work. In this Section, the words, “trenching” and “excavating” have the same meaning. In this Section, the word “excavation”, whether singular or plural, is general and includes trenching.
i. “Unauthorized excavation” means removing materials beyond limits shown or indicated in the Contract Documents or otherwise directed by Contracting Officer’s Representative.
j. “Unclassified”, when used in referring to trenching, excavating, or excavations, means excavation and disposal of all materials, of any description whatsoever, encountered in performing the Work, unless otherwise shown or indicated in the Contract Documents.
k. “Unsuitable soil materials” means soil or other materials encountered at or below subgrade elevation of insufficient strength, stiffness, or characteristics to support the Work in accordance with the Contract Documents or as determined by Contracting Officer’s Representative. The terms “unsuitable soil material”, “unsuitable soil”, and “unsuitable material” have the same meaning.

B. Reference Standards: Standards referenced in this section include, but are not necessarily limited to, the following:
1. American Association of State Highway and Transportation Officials (AASHTO):
a. AMRL R18 - AASHTO Accreditation Procedure Manual.
2. ASTM International (ASTM):
a. C33/C33M - Standard Specification for Concrete Aggregates.
b. D698 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft^3 (600 kN-m/m^3)).
c. D1556 - Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
d. 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)).
e. D2166 - Standard Test Method for Unconfined Compressive Strength of Cohesive Soil.

f. D2216 - Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
g. D2434 - Standard Test Methods for Measurement of Hydraulic Conductivity of Coarse-Grained Soils.
h. D2487 - Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
i. D2850 - Standard Test Method for Unconsolidated-Undrained Triaxial Compression Test on Cohesive Soils.
j. D3740 - Minimum Requirements for Agencies Engaged in Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
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. D6913 - Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
o. D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
p. D7928 - Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.
q. E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Areas requiring concrete or asphalt paving work are owned and under the jurisdiction of the Government, unless indicated otherwise elsewhere in the Contract Documents.

B. Qualifications:
1. Contractor's Testing Laboratory:
a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of materials specified in this Section.
b. When Contractor is expressly required, by this Section's "Field Quality Control" Article or elsewhere in the Contract Documents, to retain testing laboratory for tests required under this Section's "Field Quality Control" Article, retain one testing laboratory for quality assurance testing and field quality control testing.
c. Testing laboratory shall possess current, valid accreditation from the AASHTO Materials Reference Laboratory (AMRL), in accordance with AASHTO AMRL R18, for ASTM D3740, for tests required for quality assurance testing indicated in this Article and field quality control testing indicated to be Contractor's responsibility.
d. Testing laboratory shall comply with ASTM E329.
e. Testing laboratory shall be experienced in the types of testing required.
f. Selection of testing laboratory is subject to Contracting Officer's acceptance. Upon Contracting Officer's request, submit qualifications statement for testing laboratory, including name of entity, location, copies of applicable certifications, summary of entity's experience, and names and qualifications of personnel who will perform the subject sampling and testing.

C. Quality Assurance Testing:
1. Quality assurance testing, which may also be regarded as source quality control testing, is in addition to field quality control testing required by this Section's "Field Quality Control" Article.

2. Materials used in the Work may require testing and retesting, as directed by Contracting Officer's Representative, during the Project. Allow free access to onsite material stockpiles, borrow sources, and other sources of aggregate and soil materials at all times. Tests not specifically indicated to be performed at Government's expense (if any), including retesting of defective materials and defective work, shall be at Contractor's cost.
3. Contractor's Testing Laboratory Scope for Quality Assurance Sampling and Testing:
    a. Obtain samples and perform testing of proposed fill materials in the laboratory, at the Site, and at borrow locations (if any) to provide assurance that the Work will comply with the Contract Documents.
    b. Testing laboratory shall perform testing required to obtain data for selecting moisture content for placing and compacting fill materials.
    c. Submit to Contracting Officer's Representative, via Contractor, written results of each test.
4. Required Quality Assurance Material Testing by Contractor's Testing Laboratory:
    a. Perform the following quality assurance tests on materials to be incorporated into the Work. Submit results of such tests to Contracting Officer's Representative and obtain Contracting Officer's Representative's acceptance thereof prior to incorporating the subject materials into the Work.
    b. Gradation in accordance with ASTM D6913 and ASTM D7928. Perform one test for every 1,000 cubic yards of each material to be incorporated into the Work.
    c. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials to be incorporated into the Work: suitable soil material, and soil structural fill.
    d. Moisture/density relations for fill in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 1,000 cubic yards of each material to be incorporated into the Work.
    e. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of each material to be incorporated into the Work.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
    1. Shop Drawings:
        a. Schedule (table or written narrative) indicating, for each specific area of the Work, type of fill materials proposed, together with indication of whether source of materials is onsite or borrow source. Identification of each type of material shall employ material names/designations identical to those in the Contract Documents.
    2. Product Data:
        a. Borrow Soil Materials: Name and address of Supplier of borrow soil materials, gradation, and Supplier's certification that materials are sufficiently free of Constituents of Concern so that a Hazardous Environmental Condition will not be created or exacerbated. If no soil materials will be obtained from any borrow location, expressly so indicate to Contracting Officer's Representative in writing.
        b. Aggregate: Supplier's published description of aggregate materials, including name and address of Supplier, certification of material's compliance with AASHTO and state department of transportation standards, and gradation.

B. Informational Submittals: Submit the following:
    1. Procedure Submittals:
        a. Excavation plan indicating:
            1) Excavation Method(s): Indicate high-level methods to be used for excavating, such as use of backhoe or other earth moving construction equipment, trenchless excavating methods, micro-trenching, hydro-excavating (when allowed), air vacuum excavating (when allowed), or other (use of explosives is not allowed). Where different methods will be used, indicate locations of each in the Work. Purpose of indicating high-level excavating methods is for Contracting Officer's

information regarding effect of excavating method on Government property and operations.

b. Compaction procedure and compaction equipment proposed for use. Where different procedures or equipment will be used for compacting different types of material or at different locations at the Site, indicate where each procedure and equipment item will be used.

c. Contracting Officer's acceptance of excavation plan does not, in any way, modify Contractor's sole responsibility for complying with the Contract Documents, construction means, methods, procedures, techniques, or sequences, and safety and protection measures incident thereto.

2. Quality Assurance Test Results Submittals:
   a. Submit results of quality assurance testing performed in accordance with this Section's "Quality Assurance" Article, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
      1) Tests on materials from onsite and borrow sources.
      2) Optimum moisture – maximum dry density curve for each type of fill material.
3. Field Quality Control Submittals:
   a. Submit results of testing and inspection performed in accordance with the field quality control Article in Part 3 of this Section, including:
      1) Indication of soil classification in accordance with ASTM D2487.
      2) Field density testing.
      3) Proctor Compaction Test to determine optimum moisture for soil and maximum dry density.
4. Qualifications Statements:
   a. Quality assurance testing laboratory, when requested by Contracting Officer.

1.6 FIELD CONDITIONS

A. Existing Conditions:
   1. Subsurface Conditions:
      a. Subsurface Information: The Supplementary Conditions indicate information (if any) that is Technical Data on subsurface conditions at the Site. Such information and data are not intended as a representation or warranty of continuity of conditions between soil borings or test pits, nor of groundwater levels at dates and times other than date and time when measured, nor that purpose of obtaining the information and data were appropriate for use by Contractor. Contracting Officer and Government are not responsible for interpretations or conclusions drawn therefrom by Contractor.
      b. Contractor's Explorations: Soil borings and other exploratory operations may be made by Contractor, at no additional cost to Government. Coordinate Contractor-performed test borings and other exploratory operations with Contracting Officer. Perform such explorations without disrupting or otherwise adversely affecting operations of Government and others.
   2. Where subsurface conditions or locations of Underground Facilities and structures are unforeseen or differ substantively from that shown or indicated in the Contract Documents, comply with Contract requirements for giving notice and other actions.
   3. Existing Structures and Underground Facilities:
      a. The Contract Documents show or indicate certain structures and Underground Facilities adjacent to the Work. Such information was obtained from existing records and is not guaranteed to be correct or complete. Contractor shall explore ahead of the excavation to determine the exact location of all existing structures and Underground Facilities. Existing structures and Underground Facilities shall be supported and protected from damage by Contractor. Immediately repair and restore existing structures and Underground Facilities damaged by Contractor without additional cost to Government.
      b. Movement or operation of construction equipment and machinery over Underground Facilities shall be at Contractor's sole risk. When required by owner of the Underground Facility, prepare and submit to owner of such Underground Facility, and

obtain their acceptance, of Contractor's plan presenting Contractor's analysis of the loads to be imparted during construction (including transient loading by construction equipment, machinery, and vehicles) and Contractor's proposed measures to protect structures and Underground Facilities during the Work.

c. Acceptance of or approval by Contracting Officer of Contractor's proposed evaluation and method(s) for protecting Underground Facilities in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, means, methods, procedures, techniques, and sequences of construction, and the safety and protection measures incident thereto.

d. Coordinate with utility owners for shut off of services in active piping and conduits. When required by utility owner, Government will assist Contractor with utility owner notifications. Completely remove buried piping and conduits indicated for removal and not otherwise indicated as being abandoned or to remain in place.

e. In general, service lines and laterals to individual residences, businesses, buildings, and structures, are not shown; however, Contractor shall assume that a service exists for each utility owner to each residence, business, building, structure, and property.

f. Do not interrupt existing utilities serving facilities occupied and used by Government or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by Contracting Officer after acceptable temporary utility services are provided by Contractor for the affected structure or property.

PART 2 - PRODUCTS

2.1 MATERIALS

1. Provide granular under-slab fill under foundations, manholes, chambers, vaults, handholes, and similar work unless other under-slab material is required by the Contract Documents.
2. ASTM C33/C33M gradation size no. 67, or other material acceptable to Contracting Officer's Representative.
3. Material shall be uniformly-graded, washed, evenly graded mixture of crushed stone, or crushed or uncrushed gravel, free of organic and deleterious material, complying with the following:
   a. 100 percent passing a 1.5-inch sieve.
   b. Not more than five percent passing a no. 4 sieve.

B. Granular Structural Fill:

1. Granular structural fill, sometimes called "select granular fill", is required for improving subgrade (after removal of unsuitable material), as backfill for excavations in areas that, after restoration, will be subject to vehicular traffic, and at other locations shown or indicated for such material in the Contract Documents.
2. Material shall be well-graded, crushed aggregate, free of organic and deleterious material, complying with ADOT Class 4 Aggregate, with a maximum PI of 5.
3. For unstable subgrade conditions backfill shall consist of coarse granular material, free of organic and deleterious material, complying with ADOT Class 1 or 2 base course.

C. Soil Structural Fill:

1. At Contractor's option, soil structural fill may be low-volume change cohesive soil material or granular soil material.
2. Free of organic and deleterious matter, frozen material and debris.
3. Low-volume change cohesive soil material:
   a. ASTM D2487 classification: CL-ML or CL.
   b. Liquid limit: Less than40.
   c. Maximum plasticity index: 20.
4. Granular soil material:
   a. ASTM D2487 classification:.
5. Previously excavated materials complying with the Contract Documents requirements for soil structural fill may be used for soil structural fill.

6. When onsite materials are unsuitable for use as soil structural fill, provide granular structural fill or approved borrow material as soil structural fill. Prior to using borrow material as soil structural fill, furnish product data Submittal and quality assurance Submittal for proposed material and obtain Contract Officer's approval and acceptance (as applicable) of the proposed material.

D. Suitable Soil Material as Non-Structural Fill:
   1. Provide suitable soil material as fill for the Work, unless other material is required.
   2. Material shall be:
      a. Free of rock larger than three inches in any dimension, debris, waste, frozen materials, organic material, and other deleterious material.
      b. ASTM D2487 classification: GW, GP, GM, GC, SC, SW, SP, SM, CL-ML or CL.
      c. Liquid limit: Not greater than 40.
      d. Plasticity index: not greater than 20.
   3. Previously-excavated materials complying with the Contract Documents requirements for suitable soil material may be used for suitable soil material.
   4. When onsite materials are unsuitable for use as suitable soil material, provide or approved borrow material as suitable soil material. Prior to using borrow material as suitable soil material, furnish product data Submittal and quality assurance Submittal for proposed material and obtain Contracting Officer's approval and acceptance (as applicable) of the proposed material.

E. Subbase Material:
   1. Subbase material is granular material underlying pavement, sidewalks, and other surfaces expressly indicated in the Contract Documents.
   2. Material shall be naturally- or artificially-graded mixture of natural or crushed gravel, crushed stone, or natural or crushed sand. Slag is unacceptable.
   3. Material shall be ADOT Class 4 Aggregate, with a maximum PI of 5.

F. Pipe Bedding Material:
   1. Materials: Unless otherwise expressly required in the Contract Documents, pipe bedding material shall be crushed stone and gravel, free of: rock or gravel larger than one-inch in any dimension, debris, waste, frozen materials, organic material and other deleterious matter.
      a. Materials shall be ASTM C33 No. 67 coarse aggregate with less than 5 percent fines.

G. Flowable Fill, also known as Controlled Low Strength Material (CLSM):
   1. Unless expressly required otherwise by the Contract Documents, flowable fill may be used, at Contractor's option (following Contracting Officer's approval), for backfilling in lieu of the following materials:, pipe bedding material, soil structural fill, and suitable soil material used as non-structural fill.
   2. Comply with Section 03 31 30- Concrete Materials and Proportioning.
   3. Material provided shall be excavatable by ordinary mechanical excavation equipment, such as backhoes.

H. Trench Plugs:
   1. Materials: Trench plugs shall be constructed from compacted clay soils with an USCS classification of CL or with at least 60 percent fines and a plasticity index of 15 or greater. Trench plugs may also be constructed from reinforced concrete, lean concrete, controlled low-strength material (CLSM), or site soils processed with bentonite.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions:
   1. Provide Contracting Officer's Representative with sufficient notice and with means to examine areas and conditions under which trenching, backfilling, other related earthwork, and grading will be performed. Contracting Officer will advise Contractor in writing when

Contracting Officer's Representative is aware of conditions that may be detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

2. This Article, however, in no way modifies or reduces Contractor's sole responsibility for complying with the Contract Documents, for construction means, methods, procedures, techniques, and sequences, and for the safety and protection measures incident thereto.
3. Nothing in this Article, including action by Contracting Officer (if any), is for benefit of Contractor.

B. Installing the Work constitutes Contractor's approval of underlying work, subgrades, and field conditions prevailing at the time of the Work.

3.2 TEST PITS

A. Test Pits - General:
   1. Test Pit Locations Not Shown or Indicated in the Contract Documents and Test Pits Not Part of a Dedicated Bid/Pay Item:
      a. In advance of other construction, excavate test pits, make observations and measurements, and promptly fill test pits.
      b. Purpose of test pits is to determine existing subsurface conditions and locations of Underground Facilities and structures.
      c. Perform all work required in connection with excavating, stockpiling, maintaining, temporarily supporting excavations, filling, and replacing pavement for test pits. Contractor is responsible for the definite location of each existing Underground Facility involved within the area of excavation for the Work. Exercise care during such location work to avoid damaging and disrupting affected Underground Facility or structure. Contractor is responsible for repairing, at Contractor's cost, damage to Underground Facilities or structure caused during the Work.

B. Payment for Test Pits:
   1. All payment for test pits shown or indicated in the Contract Documents will be part of the bid/pay item Contract Price.

C. Results of Test Pits:
   1. Document results of all test pits excavated by Contractor.
   2. Submit to Contracting Officer's Representative written results of test pits expressly required by the Contract Documents or directed by Contracting Officer's Representative. Furnish such Submittal within three days of excavation of associated test pit, unless Contracting Officer's Representative allows more time. When Contracting Officer's Representative requests written results of test pits performed for Contractor's own use, promptly furnish such information as Informational Submittal.
   3. Required documentation of test pits shall include:
      a. Identification of Project, Site, and Contractor.
      b. Date and time of test pit excavation, indication of weather conditions, and names of personnel present and employer of each.
      c. Detailed description of location of test pit, including, where necessary, measurements to landmarks shown on the Drawings. Where appropriate, include sketch of location from the Drawings.
      d. Indication of approximate dimensions of test pit, including length, width, and depth.
      e. Verbal (written) description of observed subsurface conditions, including apparent strata, rock (if any), groundwater conditions, and approximate depth at which each was observed.
      f. Verbal (written) description of unusual conditions observed, including potential existence of Hazardous Environmental Condition, if any. Include pertinent data, such as readings from instrumentation used.
      g. Description and sketch, with appropriate dimensions, of Underground Facilities and structures in the test pit. Sketches shall be clearly legible with clear, well-written annotations and dimensions.

h. Other pertinent information and data from observations made while test pit was open.
i. Brief written description of backfilling and restoration of test pit, including time operations were completed.

3.3 PREPARATION

A. Site Preparation:
1. Comply with Section 31 10 00 - Site Clearing.
2. Comply with this Section's "Erosion and Sediment Control During Construction" Article.

B. Dust Control:
1. Relative to controlling dust during construction, comply with Section 01 50 00 – Temporary Facilities and Controls and Section –01 73 40 - Execution.

C. Maintenance and Protection of Traffic:
1. Comply with Section 01 50 00 – Temporary Facilities and Controls.

3.4 EROSION AND SEDIMENT CONTROLS DURING CONSTRUCTION

A. Temporary Erosion and Sediment Controls – General:
1. Provide temporary erosion and sediment controls in accordance with Section 01 57 23 – Temporary Stormwater Pollution Prevention, Section 31 25 00 – Soil Erosion and Sediment Control, and other requirements of the Contract Documents.

3.5 EXCAVATION

A. Excavation – General:
1. Perform all excavation work, including trenching and backfilling, required to complete the Work as shown, specified, and required. Excavating work includes removing, handling, and proper disposal of earth, sand, clay, expansive-type soils, other unsuitable soil materials, gravel, hardpan, soft, weathered or decomposed rock, concrete and masonry (reinforced or unreinforced), pavements, rubbish, debris, stumps, and other materials, regardless of moisture content, within the excavation limits.
2. Trenching and backfilling work shall comply with the Contract Documents, including required grades, elevations, general dimensions, and alignment shown or indicated on the Drawings including cuts and fills, as applicable.
3. Protect existing buildings and structures against undermining and destabilization. If adjacent trenching affects foundations of one or more buildings or structures, promptly advise Contracting Officer in writing.
4. Where excavation includes rock or other material that requires drilling or specialized equipment for removal, remove rock in accordance with Section 31 23 00 - Earthwork.
5. If unsuitable material and obstructions are encountered during excavation, remove material and replace as directed by Contracting Officer.

B. Excavation Methods:
1. Traditional Excavation Methods: Excavation via traditional methods, such as backhoe, bulldozer, other earth moving construction equipment or machinery, or excavation using hand tools, is acceptable for all excavating work on the North Rim.
2. Use of Explosives:
a. Use of explosives is not allowed.
3. Micro-trenching: Installation of buried utilities using micro-trenching equipment and techniques is acceptable when the associated Underground Facility is of a size and depth appropriate for such construction method. Submit to Contracting Officer request for interpretation or clarification for requirements for resin backfilling of micro-trenches. Contracting Officer will issue such requirements via Field Order.
4. Trenchless: Where Contractor proposes trenchless construction techniques, such as directional drilling, micro-tunneling, or others, comply with the Contract Documents regarding such construction methods. When the Contract Documents do not include requirements for the proposed trenchless construction method, submit to Contracting Officer

request for interpretation or clarification to obtain appropriate requirements, which will be issued via appropriate Contract modification.

5. Hydro-excavating (also known as Hydro-Vacuum Excavating):
   a. Hydro-excavating is acceptable only for excavating test pits.
   b. Avoid creating nuisances, unsafe conditions, and inconvenience to Government, owners and occupants of adjacent property, and the public when hydro-excavating is allowed and used.
6. Air Vacuum Excavating:
   a. Air vacuum excavating is acceptable only for excavating test pits.
   b. Avoid creating sandblasting outside of excavations, dust emissions, other nuisances, unsafe conditions, and inconvenience to Government, owners and occupants of adjacent property, and the public when air vacuum excavating is allowed and used.

C. Excavation Protection:
   1. Provide excavation protection system(s) in accordance with Laws and Regulations to prevent injury to persons and property, including Underground Facilities.
   2. Provide safe access to excavations, including emergency exit, and safe access for construction equipment and machinery, where applicable, in accordance with laws and Regulations.

D. Excavations for Manholes, Chambers, and Vaults:
   1. Refer to this Section, Section 01 27 00 - Definition of Contract Line Items, and applicable details (if any) on the Drawings for requirements on excavation pay limits for manholes, chambers, vaults, and similar items.
   2. Elevation of bottom of manholes, chambers, and vaults may be changed only via duly issued Contract modification. Such modifications may be directed by Contracting Officer to ensure a stable bearing surface. Elevations of piping, conduit, and similar other Underground Facilities shall be as shown or indicated on the Contract Documents.
   3. Extend excavations sufficiently on each side of manholes, chambers, vaults, or similar construction only as necessary for installing precast concrete structures and appurtenances, including temporary supports of excavations, observation and inspection of the Work, and safe sloping of sides of excavations, as necessary.

E. Subgrades – General:
   1. Provide firm, dense, thoroughly compacted, consolidated subgrades, free of mud, muck, and other soft and unsuitable materials. Subgrades shall remain firm and intact under all construction operations. Reinforce subgrade by providing granular structural fill on subgrades that are otherwise solid but become soft or muddy on top due to construction operations. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown on the Drawings.
   2. If, in Contracting Officer's Representative's opinion, subgrade becomes soft, muddy, or both, because of construction delays, failure to dewater properly, or other cause within Contractor's control, excavate subgrade to firm material, trim the subgrade, and backfill with granular structural fill material at Contractor's cost.
   3. Remove unsuitable subgrade materials below foundations. Limits of required removal of unsuitable material, when not otherwise expressly shown or indicated in the Contract Documents, shall be outside exterior limits of foundations around perimeter of manhole, chamber, vault, or similar item, by not less than the greater of the following horizontal distances:
      a. Distance equal to depth of required removal of unsuitable material, below bottom of foundations.
      b. Three feet.
      c. As directed by Contracting Officer's Representative, in consultation with Contractor's geotechnical engineering consultant (if any).
   4. Preparation of Subgrades for Subsequent Work:
      a. Level off subgrades to receive foundations or compacted fill.

b. Where subgrades are to receive subsequent fill or manholes, chambers, vaults, or similar items, remove loose materials and bring subgrades into compliance with the Contract Documents.
c. Where compacted fill material is required to bring subgrade up to underside of construction, scarify existing subgrade upon which fill material will be placed to depth of six inches and then compact to density required in this Section before fill material is placed thereon.
d. Do not excavate lower than required for buried piping or foundations, unless directed otherwise by Contracting Officer's Representative.
e. Where excavation extends below required elevation without authorization, promptly advise Contracting Officer's Representative and remedy unauthorized excavation in accordance with the Contract Documents. Corrections may include:
1) Under soil-supported foundations or soil-supported retaining walls:
a) Filling entire vertical distance between excavated subgrade and material required under foundation or other structure with compacted granular structural fill.
b) Concrete fill is acceptable for bringing elevations to proper position.
2) For locations other than those indicated above including slabs-on-grade:
a) Backfill and compact unauthorized excavations as indicated for authorized excavations of same classification, unless otherwise directed by Contracting Officer's Representative.
3) Contractor is not eligible for change in Contract Price or Contract Times for remedying unauthorized excavations.

5. Evaluation and Protection of Subgrade:
a. Advise Contracting Officer's Representative as soon as excavation is completed for Contracting Officer's Representative's observation of subgrades and, where necessary or required, inspection and testing of subgrades.
b. If Contracting Officer's Representative determines that bearing materials at required subgrade elevations are unsuitable, provide subgrade stabilization as indicated in this Article.
c. Do not commence further construction until subgrade under compacted fill material, under foundations and retaining walls is acceptable (in accordance with the Contract Documents) to Contracting Officer's Representative, who may consider results of required testing, and who may elect to consult with geotechnical consultant (if any).
d. Contracting Officer's Representative shall have sufficient opportunity to observe subgrade, after successful completion of tests and inspections required by the Contract Documents.
e. Place fill material and perform subsequent construction after subgrade is acceptable in accordance with the Contract Documents.
f. Protect subgrade from becoming loose, wet, frozen, or soft due to weather, construction operations, or other reasons.
6. Subgrade stabilization:
a. If subgrade under foundations or fill material, is frozen, loose, wet, or soft before construction is placed thereon, remove frozen, loose, wet, or soft material and replace with approved compacted material as directed by Contracting Officer's Representative, who may consult with the Contractor's geotechnical consultant.
b. Loose, wet, or soft materials, when approved by Contracting Officer's Representative, may be stabilized by a compacted working mat of well graded crushed stone.
c. Stabilization shall be in accordance with the Contract Documents. Where the Contract Documents do not address subgrade stabilization, promptly submit to Contracting Officer written request for clarification or interpretation, or other written instrument in accordance with the Contract Documents. In such event, do not proceed until response is obtained from Contracting Officer.

F. Pipe Trench Preparation:
1. Not more than 150 feet of trench may be opened in advance of installing pipe in trench.

2. Trench width shall be minimized to greatest extent practical, and shall comply with the following:
    a. Trench width shall be sufficient to provide space for installing, jointing and inspecting piping. The Drawings show additional requirements for trenches. In no case shall trench be wider at top of pipe than pipe barrel's outside diameter (OD) plus one foot, unless otherwise shown or indicated.
    b. Enlargement of trench width at pipe joints may be made when required and approved by Contracting Officer's Representative.
    c. For excavating and backfilling for manholes, chambers, and vaults associated with buried piping, excavation at widest point of manhole, chamber, or vault shall be not wider than two feet greater than widest outside dimension (including bottom footings or flanges, if any, of precast concrete structures) of the associated manhole, chamber, or vault.
    d. Trench width shall be sufficient for Contractor's means of temporarily supporting the excavation and dewatering.
    e. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.
    f. Do not use construction equipment or machinery that necessitates trench to be excavated to excessive width.
3. Depth of trench shall be as shown or indicated in the Contract Documents. If required and approved by Contracting Officer in writing (such as a duly issued Contract modification), depths may be revised.
4. Where Contracting Officer's Representative considers existing subgrade (beneath intended bedding material) unsuitable, remove and replace such unsuitable material with granular structural fill material for full width of trench, down to suitable material.

G. Freeze Protection:
1. Do not place foundations or fill material on frozen subgrade.
2. When freezing temperatures are expected, based on widely recognized, reputable source for weather forecasts at or near the Site, do not excavate to full depth indicated, unless foundations or fill material can be placed immediately after excavation has been completed and is acceptable in accordance with the Contract Documents.
3. Protect from freezing excavation, subgrade, and fill materials when subsequent Work thereon is delayed.

H. Construction Traffic on Soils:
1. Furnish and use appropriate backhoe or other low-contact pressure equipment to remove existing materials.
2. Minimize construction traffic on existing materials and saturated soils and avoid soil disturbance.
3. Repair disturbed subgrade materials prior to performing subsequent Work. Remedial work shall be in accordance with the Contract Documents. When not addressed in the Contract Documents, remedial Work shall be as directed by Contracting Officer via appropriate Contract modification.
4. Allow only minimal foot traffic on bearing soils prepared for subsequent installation of fill or foundations.

3.6 FILLING AND COMPACTING

A. Filling and Compacting – General:
1. Provide and compact all fill required for the finished grades as shown and as indicated in this Section.

B. Place fill as promptly as progress of the Work allows, but not until completing the following:
1. Obtaining Contracting Officer's Representative's concurrence, after observation by Contracting Officer's Representative of construction below finish grade, including removal of trash and debris from excavations, waterproofing (where required), and related work.

2. Successful completion of required field quality control activities for work that will be covered or concealed by filling, including field quality control testing of buried piping, conduits that will convey fluid or gas, and exfiltration testing (where performed or required) of manholes, chambers, vaults, and similar items. For manholes, chambers, and vaults, where infiltration testing or vacuum testing is performed or required, such testing may be performed following backfilling.
3. Completion of proper documentation of as-constructed conditions and existing conditions (such as locations of Underground Facilities) in accordance with Section 01 77 00 – Closeout Procedures.
4. Removal of temporary supports of excavations.
5. Remove fill that includes organic materials or other unacceptable material and replace with fill material complying with the Contract Documents.

C. Placement – General:
1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around manholes, chambers, vaults, and similar items, and Underground Facilities.
2. Management of Moisture Content:
   a. Place fill materials at moisture content and density as indicated in this Article's requirements on compaction density. Prior to placing fill material, optimum moisture and maximum density properties for proposed material shall be obtained from Contracting Officer's Representative, who may consult with Contractor's geotechnical consultant, if any. Furnish and use construction equipment and machinery capable of adding measured amounts of water to fill materials to bring fill materials to a condition within required moisture content range. Control moisture for each lift necessary for required compaction.
   b. Furnish and use construction equipment and machinery capable of discing, aerating, and mixing fill materials to ensure reasonable uniformity of moisture content throughout fill materials, and to reduce moisture content of borrow materials by air drying, when necessary.
   c. When subgrade or fill materials requires moisture-conditioning before compaction, fill material shall be sufficiently mixed or worked on the subgrade to ensure uniform moisture content throughout the lift of material to be compacted.
   d. Materials at moisture content in excess of specified limit shall be dried by appropriate means, such as aeration or stockpiling for gravity drainage and air drying.
3. Compaction:
   a. Compaction Equipment:
      1) Perform compaction with construction equipment and machinery suitable for the type of fill material placed. Unless otherwise required, compact cohesive soils using sheepsfoot compactor, and compact granular materials using pneumatic rollers, vibrators, or other construction equipment or machinery to obtain required density.
      2) Select and use equipment capable of providing the minimum density required in the Contract Documents.
      3) Use light compaction equipment and machinery, with equipment or machinery gross weight not exceeding 7,000 pounds within horizontal distance of 10 feet from the wall of completed, below-grade manholes, chambers, vaults, and similar items, and walls of adjacent buildings or structures.
      4) Furnish and use construction equipment and machinery capable of compacting in restricted areas next to structures and around piping and Underground Facilities.
   b. Compaction Test Area:
      1) Effectiveness of construction equipment and machinery selected by Contractor for compacting, shall be tested at start of compacted fill work by constructing a small section of fill within the area where fill will be placed.
      2) If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the quantity of coverages, decrease the lift thicknesses, or use different compactor equipment or machinery.

4. Placement of Lifts and Compaction:
    a. Place fill materials in horizontal, loose lifts, not exceeding specified thickness prior to compacting.
    b. Place fill in manner ensuring uniform lift thickness after placing.
    c. Preparation of surfaces for placement of fill:
        1) Before commencing placing of fill, scarify underlying material to depth of six inches.
        2) Where ground surface is steeper than one vertical to four horizontal ("1V:4H"), plow surface to bench and break up surface so that fill material will bind with existing surface. For slopes steeper than 1V:4H and less than 1V:1.5H, bench shall be six feet wide. For slopes steeper than or equal to 1V:1.5H and less than 1V:0.5H, bench shall be four feet wide.
    d. Mechanically compact each lift, by not less than two complete coverages of compactor. One coverage is defined as the conditions reached when all portions of the fill lift have been subjected to the direct contact of compactor's compacting surface.
    e. Compaction of fill materials by inundation with water is unacceptable.
5. Restrictions:
    a. Do not place fill materials when standing water is present on surface of area where fill will be placed.
    b. Do not compact fill when standing water is present on the fill to be compacted.
    c. Do not place or compact fill in frozen condition or on top of frozen material.
    d. Fill containing organic or deleterious materials or other unacceptable material previously described shall be removed and replaced prior to compaction.
6. If required densities are not obtained because of improper control of placement or compaction procedures, or because of inadequate or improperly functioning compaction equipment or machinery, perform all work necessary to provide required densities. Such work shall include, at no additional cost to Government, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
7. Repair, at Contractor's cost, observed or measured settlement. Make repairs and replacements as necessary and required within 30 days after being so advised by Contracting Officer's Representative, unless more-timely action is necessary to avoid or reduce the potential for safety hazards or damage to property.

D. Fill Placed in Pipe Trenches:
1. Piping trenches may be backfilled prior to testing of piping, unless nature of test requires observation of pipe or manholes, chambers, vaults, or similar items during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
2. Pipe Bedding: Pipe bedding material shall be as follows:
    a. Unless otherwise shown or indicated, install buried piping on not less than six-inch layer of aggregate pipe bedding material underneath piping.
    b. Pipe bedding material shall extend upward from elevation required immediately above to 6 inches above crown of associated buried piping.
    c. Pipe bedding material shall be spread and the surface graded to provide a uniform and continuous support beneath piping at all points between bell holes or pipe joints.
    d. Install initial layer of pipe bedding material on prepared subgrade and compact as required. Provide appropriate divot in the bedding material to accommodate each pipe bell or joint. Install piping so that pipe barrel carries the weight of each pipe segment, rather than pipe bells or joints bearing the pipe's weight.
    e. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
    f. After each pipe's bedding material has been graded, and the piping has been aligned, joined in accordance with the Contract Documents, and placed in final position on bedding material, provide and compact sufficient pipe trench fill material under and around each side of pipe and back of bell or end thereof to hold piping in proper

position and maintain alignment during subsequent pipe jointing and embedment operations.

g. Subsequent to forming pipe joint, place additional pipe bedding material, in required lifts, to required top elevation of pipe bedding material. Ensure bedding material is properly and fully placed under pipe "haunches" for proper support of piping. Compact lifts of pipe bedding material in accordance with this Article prior to placing subsequent backfill material.

3. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placing and compacting of pipe trench fill materials shall comply with the following:
   a. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping.
   b. Each layer of pipe trench fill material shall be compacted by not less than two complete coverages of all portions of surface of each lift using appropriate compaction equipment or machinery.
   c. Method of compaction and compaction equipment and machinery used shall be appropriate for material to be compacted and shall not transmit damaging shocks to piping.

E. Installation of Flowable Fill, also known as Controlled Low Strength Material (CLSM):
   1. Discharge flowable fill from ready-mix delivery vehicle into excavation, or other space to be backfilled with such material, via chutes, pumping, or hand-carried in buckets, in accordance with the Contract Documents (including the Specifications of Division 03 - Concrete) and requirements of flowable fill ready-mix Supplier.
   2. Subgrade on which flowable fill is placed shall be free of disturbed or softened material and water.
   3. Place flowable fill in lifts not greater than four feet depth.
   4. Placing of each lift of flowable fill shall be a continuous operation, to the extent practicable.
   5. Place flowable fill in manner that prevents flotation of piping or other damage to the Work, other Underground Facilities, and adjacent property.
   6. Cold Weather Placing:
      a. Do not place flowable fill on frozen subgrade.
      b. Flowable fill batching, mixing, and placing may be performed when weather conditions are favorable, and ambient air temperature is 34 degrees F and rising.
      c. At the time of placing, flowable fill must have a temperature of not less than 40 degrees F.
      d. Discontinue placing flowable fill when ambient air temperature is 38 degrees F or less and falling.
   7. After placing flowable fill, allow not less than 12 hours before placing subsequent lift or approved otherwise by Contracting Officer's Representative.
   8. Prevent contact with flowable fill by construction vehicles and equipment, or other traffic, for not less than 24 hours after placing, or until flowable fill is sufficiently hard to prevent rutting or other damage by vehicles and construction equipment.

F. Fill Required Under Subbase for Pavement and Other Traveled Ways:
   1. Where bottom of pavement or surfacing of other traveled way will be at elevation equal to or less than preconstruction ground surface, after required excavation and preparation of subgrade, provide required subbase material to required depth. At underside of pavement or other surfacing of traveled way, subbase material shall extend horizontally six inches beyond edges of pavement or other surfacing. Exterior edges of subbase material shall be placed and compacted at uniform slope of one foot vertical-to-one foot horizontal away from top edge of subbase down to subgrade.
   2. Where bottom of pavement or surfacing of other traveled way will be at elevation greater than preconstruction ground surface, after required preparation of subgrade, provide required fill material and subbase material to required depth. At underside of pavement or other surfacing of traveled way, subbase material shall extend horizontally six inches beyond edges of pavement or other surfacing. Exterior edges of subbase material and fill

material shall be placed and compacted at uniform slope of one foot vertical-to-one foot horizontal away from top edge of subbase down to subgrade.

G. Temporary Pavement:
   1. Provide not less than 1.5 inches of temporary bituminous pavement immediately after filling excavations in paved roads and other pavement subject to vehicular traffic, where such pavement will remain permanently.
   2. Maintain surface of paved area over the fill in good and safe condition during progress of the Work, and promptly fill depressions over and adjacent to the fill area caused by settlement of fill.
   3. Permanent replacement pavement shall be equal to that of the existing roadways plus one inch, unless otherwise shown or specified.

H. Compaction Density Requirements:
   1. Compaction Requirements for Sitework (including civil, grading, and Underground Facilities):

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Under Pavement, Other Traveled Ways, Curbs, Gutters, Sidewalks, and Buried Utilities (including manholes, chambers, vaults, and similar items):		
Cohesive soils	95% per ASTM D698	-2 to +2% of optimum
Cohesionless soils	75% relative density per ASTM D4253 and ASTM D4254	
Sitework Not Covered by the Above Category or Classification:		
Cohesive soils	90% of ASTM D698	-2 to +2% of optimum
Cohesionless soils	65% relative density per ASTM D4253 and ASTM D4254	

   2. Compaction Requirements for Materials Supporting Foundations and Adjacent to Buildings and Structures:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Fill supporting foundations and fill adjacent to exterior of buildings and structures, adjacent to walls, piers, and columns	95% per ASTM D698	-2 to +2% of optimum

   3. Compaction Density and Moisture Requirements for Specific Areas:

LOCATION	COMPACTION DENSITY	MOISTURE CONTENT
Outside buildings and structures, under slabs-on-grade	98% per ASTM D698	-2 to +2% of optimum

   4. Fill Lift Thickness:
      a. Unless expressly shown or indicated otherwise, place fill in trenches, below piping, below foundations, or under paved areas in horizontal uncompacted layers not exceeding eight inches deep, and thoroughly compact each before next layer is placed.
      b. In pipe trenches, above elevation of bottom of pipe, horizontal uncompacted layers shall be six inches deep.
   5. Fill Moisture Content: Fill shall be wetted and thoroughly mixed to achieve moisture content to within the required range indicated in the applicable table, above, with the following exception(s):

a. On-site clayey soils: Optimum to plus two percent (moisture less than optimum is unacceptable).

6. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated.
7. Field quality control testing for density; to verify that specified density was obtained, will be performed during each day of compaction work. Responsibility for field quality control testing is indicated in this Section's "Field Quality Control" Article.
8. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the required compaction. Perform additional compaction work at no additional cost to Government until required compaction is achieved. Such work includes complete removal of unacceptable (as determined by Contracting Officer's Representative) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

I. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with granular structural fill material and thoroughly compact in accordance with applicable table in this provision. Slope the sides of excavation in accordance with the maximum allowable inclinations specified for each element of the Work.

3.7 UNAUTHORIZED EXCAVATION

A. Unauthorized Excavation – General:
1. Excavations outside lines and grades shown or indicated and that are not approved by Contracting Officer's Representative (including excavations below required subgrade elevation, unless Contracting Officer's Representative directs removal of unsuitable subgrade material), together with removing and disposing of the associated material, shall be at Contractor's cost and risk.
2. Fill unauthorized excavations with properly compacted granular structural fill material at Contractor's cost.

3.8 PAVEMENT SUBBASE COURSE

A. Pavement Subbase – General:
1. Place subbase material, in layers of specified thickness, over subgrade to support pavement base course.
2. Prepare subgrade underlying subbase course in accordance with this Section's general requirements for subgrades.

B. Grade Control:
1. During construction, maintain lines and grades including crown and cross-slope of subbase course.
2. Comply with Section 01 73 40 - Execution, regarding staking and elevation controls.

C. Placing of Pavement Subbase Course:
1. Provide subbase material where required to the limits shown or indicated.
2. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. If the Contract Documents do not show or indicate required section of replacement paving, replacement subbase course shall be of thickness equal to existing subbase course.
3. Maintain optimum moisture content for compacting subbase material during placing operations.
4. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over compacted subbase.
5. To prevent softening of subgrade, do not install pavement subbase in excess of 500 feet in length without compacting.
6. If subgrade material becomes churned up into or mixed with subbase material, remove the mixed material and replace with clean, compacted subbase material.

3.9 GRADING

A. Grading – General:
   1. Uniformly grade areas within limits of grading under this Section, including adjacent transition areas.
   2. Smooth subgrade surfaces within specified tolerances, compact with uniform levels or slopes between points where elevations are shown, or between such points and existing grades.

B. Grading Outside Building Lines:
   1. Grade areas adjacent to building lines to drain away from buildings and structures.
   2. Grade to prevent ponding of water. Provide grades and slopes as shown on the Drawings and to allow effective drainage to proper drainage routes, such as catch basins, ditches or swales intended to convey storm water, and other storm water drainage routes. Where intended grade for effective drainage is unclear, promptly submit to Contracting Officer request for interpretation and obtain Contracting Officer's Representative's interpretation or clarification before proceeding,
   3. Provide final surfaces free of irregular surface changes, in accordance with the following:
      a. Grassed Areas and Areas Covered with Gravel, Stone, Wood Chips, or Other Special Cover: Finish areas to receive topsoil or special cover to within not more than one inch above or below required subgrade elevations. Requirements for topsoil and finish grading are in Section 32 91 13 - Finish Grading.
      b. Sidewalks: Shape surface of areas under sidewalks to line, grade, and cross section, with finish surface not more than one inch above or below required subgrade elevation.
      c. Pavement (including hard-surfaced pavement and areas with stone surfacing): Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 0.5-inch above or below required subgrade elevation.

C. Grading Surface of Fill Under Concrete Slabs-on-Grade:
   1. Grade smooth and even, free of voids, compacted as specified, and to required elevation.
   2. Provide final grades within tolerance of 0.5-inch when tested with a ten-foot straight edge.

3.10 DISPOSAL OF EXCAVATED SPOIL MATERIALS

A. Spoil Disposal - General:
   1. Contractor shall stockpile spoils onsite per drawing sheet C104.
   2. Disposal of materials shall comply with Laws and Regulations, at no additional cost to Government.

3.11 FIELD QUALITY CONTROL

A. Site Tests and Inspections:
   1. Testing Laboratory:
      a. Employ a testing laboratory to perform field quality control testing.
      b. Testing Laboratory Scope:
         1) Perform field moisture content tests (in accordance with ASTM D2216 or ASTM D6938) and density tests (in accordance with ASTM D1556 or ASTM D6938) to verify that required compaction of fill materials was provided.
         2) Tests of actual unconfined compressive strength or bearing tests (in accordance with ASTM D2850 or ASTM D2166) on each stratum.
         3) Furnish to Contracting Officer's Representative and Contractor written results of each test.
      c. Authority and Duties of Testing Laboratory:
         1) Testing laboratory representatives ("technician") shall inspect the materials in the field, perform testing, and report findings to Contracting Officer's Representative and Contractor. When the Work is defective, technician will direct attention of Contracting Officer's Representative and Contractor to such defective work.
         2) Technician shall not supervise performance of any of Contractor's Work. Technician shall not perform other duties for Contractor.

3) Work will be tested and inspected by testing laboratory as the Work progresses, but failure to detect defective work (including defective materials) shall not, in any way, prevent later rejection when defect is discovered, nor shall it obligate Contracting Officer for Substantial Completion or final acceptance. Technicians are not authorized to revoke, alter, relax, enlarge, or release requirements of the Contract Documents, or to approve or accept any portion of the Work.

2. Responsibilities and Duties of Contractor:
   a. Use of testing laboratory or geotechnical consultant in no way relieves Contractor of responsibility to provide work in compliance with the Contract Documents.
   b. When Government furnishes services of testing laboratory, geotechnical consultant, or any combination thereof, for trenching, backfilling, and related earthwork, Government and Contracting Officer's Representative do not represent that the sampling and testing performed by Government-hired testing laboratory or observations by Government-hired geotechnical consultants, is sufficient for Contractor's purposes, or to monitor all aspects of the trenching, backfilling, and related earthwork. If additional quality control is needed to verify that the work performed and materials delivered to the Site are in accordance with the Contract Documents, Contractor may retain its own, independent testing laboratory to perform additional sampling and testing for Contractor's purposes.
   c. To facilitate testing laboratory and geotechnical consultant, Contractor shall advise testing laboratory and geotechnical consultant not less than two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
   d. Contractor shall be responsible for providing required compaction for fill and other earthwork. Contractor shall control construction operations by performing confirming tests to verify that Contractor has complied with the Contract Documents relative to compaction and moisture content.
   e. Contractor shall demonstrate adequacy of compaction equipment and procedures before exceeding one or more of the following quantities of earthwork. Each test location shall include tests for each layer, type, or class of fill to finish grade.
      1) 200 linear feet of trench fill.
      2) 10 cubic yards of granular structural fill.
      3) 100 cubic yards of suitable soil material.
      4) 50 cubic yards of subbase material.
3. Testing laboratory will inspect and indicate acceptable subgrades and fill layers before construction work is performed thereon. Testing of subgrades and fill layers shall be as follows:
   a. Trenches for Underground Facilities (including buried ductbanks):
      1) In Open Fields: Two locations every 1,000 linear feet.
      2) Along Dirt or Gravel Roads or Off Traveled Right-of-Way: Two locations every 500 linear feet.
      3) Crossing Paved Roads: Two locations along each crossing.
      4) Under Pavement Cuts or Within Two Feet of Pavement Edges: One location every 400 linear feet.
   b. For granular structural fill: Once per lift for each 1,000 square feet placed and compacted.
   c. For soil structural fill:
      1) For backfilling trenches directly adjacent to buildings or structures, on 30-foot intervals on all sides of the building or structure for every compacted lift, but not less than one per lift on each side of the building or structure for buildings or structures less than 60 feet long on a side.
      2) For material not used as fill against buildings or structures, once per lift for each 1,000 square feet placed and compacted.
   d. For Suitable Soil Material: One per 1,000 square feet on every compacted lift.
   e. Subbase Material: One per 1,000 square feet on every compacted lift.

4. Periodic compliance tests will be made by Contracting Officer's Representative to verify that compaction is in accordance with the Contract Documents, at no cost to Contractor. Contractor shall remove overburden above the level at which Contracting Officer's Representative wishes to test and shall fill and re-compact the material after testing is complete.

B. Defective Work:
   1. If testing laboratory reports or inspections indicate subgrade, fill, or bedding compaction less than specified density, Contractor shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at Contractor's cost until subgrades, bedding, and fill are acceptable.
   2. Costs for retesting of subgrade, fill, or bedding materials that did not originally comply with the Contract Documents, including required density, shall be paid by Contractor.

3.12 RESTORATION

A. Restoration – General:
   1. Perform finish grading, including providing topsoil, in accordance with Section 32 91 13 - Finish Grading.
   2. Provide replacement paving, sidewalks, curbs, gutters, and similar items in accordance with the Contract Documents including the Specifications of Division 32 - Exterior Improvements.
   3. Restore landscaping including lawn and meadow areas, in accordance with the Contract Documents including the Specifications of Division 32 - Exterior Improvements.

END OF SECTION

SECTION 31 25 00
SOIL EROSION AND SEDIMENT CONTROL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Soil erosion and sediment control.

B. Related Specification Sections include but are not necessarily limited to:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Erosion control standards: Standards and Specifications for Soil Erosion and Sediment Control in Developing Areas by the United Sates Department of Agriculture (USDA), Soil Conservation Service, College Park, Maryland.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

2.1 MATERIALS

A. Erosion Control Logs, Wattles, and Matts:
   1. Aspen fiber, not straw, shall be used for all erosion-control products such as erosion control logs and wattles.
   2. Coconut fiber materials will be used, rather than jute or other fabrics, for erosion-control blankets on slopes greater than 3:1.

B. Reinforced Rock Berm:
   1. Crushed Rock:
      a. Crushed rock shall be fractured face (all sides) and shall have a gradation of 1-1/2 IN -.
      b. Recycled concrete meeting gradation requirement may be used
   2. Wire Mesh:
      a. 10-gauge wire twisted into a mesh with a maximum opening of 1.0 IN. Roll width shall be 48-IN.
      b. Wire mesh shall be secured using “Hog Rings” or wire ties at 6 IN centers along all joints and at 2 IN centers on ends of berm.

C. Silt Fence:
   1. Synthetic filter fabric shall conform to the following specifications:

Fabric Properties	Minimum Requirements	Test Method
Grab tensile strength (lbs.)	100	ASTM D4632
Elongation @ Failure (%)	15	ASTM D4632

Mullen Burst Strength (psi)	250	ASTM D3786
Puncture Strength (lbs.)	50	ASTM D4833
Apparent Opening Size (mm)	0.60	ASTM D6461
Ultraviolet Radiation Stability (%)	90	ASTM D4355

2. Synthetic filter fabric shall contain ultraviolet ray inhibitors and stabilizers to provide a minimum of six months of expected usable construction life at a temperature range of 0 to 120 degrees Fahrenheit.
3. Wood or steel fence posts shall be a minimum length of 4 feet. Steel posts will be standard "T" or "U" posts weighing not less than 1.33 pounds per lineal foot.
4. Wire fencing support, if needed, shall be at least 2.5 feet high and minimum 14-1/2 gauge with a maximum 6 inch mesh opening.

PART 3 - EXECUTION

3.1 PREPARATION

A. Prior to General Stripping Topsoil and Excavating:
   1. Install perimeter dikes and swales.
   2. Excavate and shape sediment basins and traps.
   3. Construct pipe spillways and install stone filter where required.
   4. Machine compact all berms, dikes and embankments for basins and traps.
   5. Install silt fence and erosion control logs where indicated, per manufacturer's specifications.

B. Construct sediment traps where indicated on Drawings during rough grading as grading progresses.

C. Temporarily seed basin slopes and topsoil stockpiles:
   1. Rate: 1/2 LB/1000 SQFT.
   2. Reseed as required until good stand of grass is achieved.

3.2 DURING CONSTRUCTION PERIOD

A. Maintain Basins, Dikes, Traps, Stone Filters, Silt Fence, Erosion Control Logs, etc.:
   1. Inspect regularly especially after rainstorms.
   2. Repair or replace damaged or missing items.

B. After rough grading, sow temporary grass cover over all exposed earth areas not draining into sediment basin or trap.

C. Construct inlets as soon as possible.
   1. Excavate and tightly secure straw bales completely around inlets as detailed on Drawings.

D. Provide necessary swales and dikes to direct all water towards and into sediment basins and traps.

E. Do not disturb existing vegetation (grass and trees).

F. Excavate sediment out of basins and traps when capacity has been reduced by 50 PCT.
   1. Remove sediment from behind bales to prevent overtopping.

G. Topsoil and Fine Grade Slopes and Swales, etc.: Seed and mulch as soon as areas become ready.

3.3 NEAR COMPLETION OF CONSTRUCTION

A. Eliminate basins, dikes, traps, etc.

B. Grade to finished or existing grades.

C. Fine grade all remaining earth areas, then seed and mulch.

END OF SECTION

SECTION 32 15 40
CRUSHED STONE SURFACING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Crushed Stone Surfacing in accordance with provisions of Contract Documents.

B. Completely coordinate with work of other trades.

C. Related Requirements:
   1. Division 00 – Procurement and Contracting Requirements.
   2. Division 01 – General Requirements.
   3. Division 31 – Earthwork.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. ASTM C117 Standard Test Method for Materials Finer than 75-μm (No. 200) Sieve in Mineral Aggregates by Washing.
   2. ASTM C136 Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
   3. ASTM D4491 Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
   4. ASTM D4751 Standard Test Methods for Determining Apparent Opening Size of a Geotextile.
   5. ASTM D6241 Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.3 SUBMITTALS

A. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.

B. Product Information:
   1. Acknowledgement that products submitted meet requirements of standards referenced.
   2. Crushed stone source information and sieve analysis.
   3. Source tests: submit certified test reports and service records to determine acceptability and application of stone material.

C. Samples:
   1. 1 QT sample of crushed stone.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

2.1 MATERIALS

A. Crushed Stone:
   1. Material shall be crushed stone or crushed gravel meeting ADOT Section 303 and AASHTO M 147
   2. Los Angeles wear test shall meet AASHTO T96.
   3. Liquid limit shall meet AASHTO T89.
   4. Plastic index shall meet AASHTO T90.
   5. Sieve analysis:

Crushed Stone	
Sieve Size	Percent Passing
3/4 inches	100
No. 4	50-78
No. 8	37-67
#100	13-35
#200	4-15
Plasticity Index	4-12

B. Geotextile Filter Fabric:
   1. Base: Mirafi 140 N.
   2. Nonwoven polypropylene.
   3. CBR Puncture: 310 pound.
   4. Apparent opening size: US Sieve 70.
   5. Water flow rate: 110 gal/min/sf.

C. Metal Edging
   1. See Drawings.

D. Stone Edging
   1. See Drawings for information regarding size, type, color, style of cut, and finish.

2.2 SOURCE QUALITY CONTROL

A. Furnish material from a single source.

B. Obtain samples per ASTM D75 from a local quarry that typically provides material to meet the specification requirements.

C. On-Site Aggregate Processing.

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that subgrades have been removed, recompacted, and rough graded to lines and grades to within 0.10 feet plus/minus to accept crushed stone surfacing. Compact sub-base to 95% Standard Proctor Density.

B. Install flush edging or curbs to the lines and grades and in the locations shown on the Drawings.

C. Thoroughly clean sub-base of debris, loose dirt and other extraneous materials before installing filter fabric or crushed stone. Do not install crushed stone when sub-base is wet or muddy.

D. Trim and dress all areas to required cross sections.

E. Bring areas that are below allowable minus tolerance limit to grade by filling with material similar to adjacent material.

F. Compact to density specified for backfill in accordance with Section 31 23 00 – Earthwork.

G. Do not place any stone on soft, muddy, or frozen material.

H. Prevent contamination of existing surfacing stone during excavation activities.

I. Do not place any stone material on prepared base prior to approval by Contracting Officer.

3.2 INSTALLATION

A. Place filter fabric under crushed stone areas while overlapping fabric a minimum of 6 inches and extending edges up edging or curbs a minimum of 2 inches.

B. Install crushed stone in two lifts:
   1. Compacting:
      a. Compact with a water ballast hand roller.
      b. Thoroughly compact to a minimum 90% Standard Proctor Density.
      c. Spray water onto the crusher fines while compacting.
      d. Do not overwork crusher fines. Any areas determined to be overworked shall be replaced at no cost to Government.
      e. After compacting, screed smooth.
   2. Grading:
      a. When surface areas have been rolled, add a thin layer of material to bring the surface to finished grade or to meet adjacent walking surface.
      b. Rake the previously rolled or compacted area to provide a bond with the added material.
      c. Provide a uniform texture and smooth, even surface to the finished paved area.
      d. Place to required thickness and grades:
         1) Depth: -0 IN, +2 IN.

3.3 CLEAN-UP

A. Keep areas of work clean, neat and orderly.

B. Clean up and remove debris from the work area prior to Final Acceptance.

END OF SECTION

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SECTION 32 31 13
CHAIN LINK FENCE AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Chain link fencing and gates.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 31 23 00 – Earthwork
   2. Section 31 23 33 - Trenching and Backfilling.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      b. A392, Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
      c. A824, Standard Specification for Metallic-Coated Steel Marcelled Tension Wire for Use with Chain-Link Fence.
      d. F552, Standard Terminology Relating to Chain Link Fencing.
      e. F567, Standard Practice for Installation of Chain-Link Fence.
      f. F626, Standard Specification for Fence Fittings.
      g. F900, Standard Specification for Industrial and Commercial Steel Swing Gates.
      h. F1043, Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
      i. F1083, Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
   2. American Welding Society (AWS).
   3. National Fire Protection Association (NFPA):
      a. NFPA 70, National Electrical Code (NEC).
   4. Underwriters Laboratories, Inc. (UL).
   5. Arizona Department of Transportation, Roadway Design Construction Standards.

B. Qualifications:
   1. Installer bonded and licensed in the Project state.
   2. Installer shall have a minimum two years experience installing similar fencing.
   3. Utilize only AWS certified welders.
   4. Electric gate operators to be UL listed.
   5. Grounding by an electrician licensed in Project state.

1.3 DEFINITIONS

A. See ASTM F552.

B. NPS: Nominal pipe size, in inches.

C. Installer or Applicator:
   1. Installer or applicator is the person actually installing or applying the product in the field at the Project site.
   2. Installer and applicator are synonymous.

1.4 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.
b. Manufacturer's installation instructions.

2. Scaled plan layout showing spacing of components, accessories, fittings, and post anchorage.
3. Mill certificates.
4. Source quality control test results.
5. Galvanized Surface Colorant:
   a. A copy of the manufacturer's product Safety Data Sheet.
   b. Independent lab tests showing that the material is environmentally safe.
   c. Bend Test results showing that the galvanized steel, treated by the reactive color treatment, exhibits no lifting or separation from mechanical stress as per ASTM B571.
   d. Cross-sectional metallographic examinations, in accordance with ASTM E3, conclude an average conversion depth of 0.18 mil and no decrease in total thickness.
   e. Corrosion resistance showing the performance of the galvanized steel, treated with the reactive color treatment, meets or exceeds the corrosion resistance of un-treated galvanized steel after 50 hours of salt spray as per ASTM B117.
   f. Reactive color treatment must not include volatile organic compounds (VOC's) or chromate compounds.

B. Samples:
1. Galvanized Surface Colorant Sample Section:
   a. Apply colorant to a minimum 12-inch sample section of galvanized metal. In the event more than one sample section is required by the Client Representative, each additional sample section will be paid for as change order work.
   b. Use the Client Representative approved sample as the standard of comparison in determining acceptability of final color.
      1) Please note there are many variables that can impact the finished appearance such as: variances in galvanizing, time of year that the sample and project items were galvanized, time of year that colorant was applied, etc. Due to this, the sample will not necessarily match perfectly with the final project but should be an approximate representation of the rustic/weathered finish.

PART 2 - PRODUCTS

Product requirements are to conform with the Arizona Department of Transportation Roadway Standard Drawings and the following salient characteristics.

2.1 COMPONENTS

A. Chain Link Fabric:
1. Fabric type:
   a. ASTM A392 zinc-coated steel:
      1) Coated before weaving, 2.0 oz/SQFT, Class 1 coating.
      2) 9 gauge for fabrics greater than 60" in height.
2. Mesh size: 1 inches.
3. Selvage treatment:
   a. Top: Knuckled.
   b. Bottom: Knuckled.
4. Galvanized Surface Colorant:
   a. The colorant must be a soluble solution (never in powdered form) and must contain organic acids to slightly etch into galvanized surfaces without affecting the protection of the galvanized layer.
   b. Organic acids used will have no negative effects on the environment.
   c. The product must react with the target surface to produce a rustic brown/weathered finish.

B. Concrete: See Specification Section 03 31 31 – Concrete Mixing, Placing, Jointing, and Curing.

C. Line Post:
   1. ASTM F1083 pipe:
      a. Schedule 40, NPS 2.

D. Corner or Terminal Posts:
   1. ASTM F1083 pipe:
      a. Schedule 40, NPS 2-1/2.

E. Brace and Rails:
   1. ASTM F1083 pipe:
      a. Schedule 40, NPS 1-1/4.

F. Tension Wire:
   a. 7 gauge (0.1777" Diameter) coil spring steel wire.
   b. Minimum tensile strength: 75,000 PSI
   c. Coating shall be zinc-coated.
   d. Truss rods: 3/8" Diameter adjustable rods.
   e. Strap Thickness: Not less than ¼".

G. Fence Fittings (Post and Line Caps, Rail and Brace Ends, Sleeves-Top Rail, Tie Wires and Clips, Tension and Brace Bands, Tension Bars, Truss Rods):
   1. ASTM F626.

H. Swing Gate:
   1. ASTM F900.
   2. Materials as specified for fence framework and fabric.
   3. Hardware:
      a. Galvanized per ASTM A153/A153M.
      b. Hinges to permit 180 degrees in and out gate opening.

2.2 SOURCE QUALITY CONTROL

A. Test related fence construction materials to meet the following standards:
   1. Posts and rails: ASTM F1043, Heavy Industrial.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install in accordance with:
   1. Manufacturer's instructions.
   2. Lines and grades shown on Drawings.
   3. ASTM F567.

B. Do not start fence installation before final grading is complete and finish elevations are established.

C. Drill holes in firm, undisturbed or compacted soil.

D. Place fence with bottom edge of fabric at maximum clearance above grade, as shown on Drawings.
   1. Correct minor irregularities in earth to maintain maximum clearance.

E. Space line posts at equal intervals not exceeding 10 feet on-center.

F. Provide post braces for each gate, corner, pull and terminal post and first adjacent line post.

G. Install tension bars full height of fabric.

H. Rails:
   1. Fit rails with expansion couplings of outside sleeve type.
   2. Rails continuous for outside sleeve type for full length of fence.

I. Provide expansion couplings in top rails at not more than 20 feet intervals.

J. Anchor top rails to main posts with appropriate wrought or malleable fittings.

K. Install bracing assemblies at all end and gate posts, as well as side, corner, and pull posts.
   1. Locate compression members at mid-height of fabric.
   2. Extend diagonal tension members from compression members to bases of posts.
   3. Install so that posts are plumb when under correct tension.

L. Pull fabric taut and secure to posts and rails.
   1. Secure so that fabric remains in tension after pulling force is released.
   2. Secure to posts at not over 15 inches on-center, and to rails at not over 24 inches on-center, and to tension wire at not over 24 inches on-center.
   3. Use U-shaped wire conforming to diameter of pipe to which attached, clasping pipe and fabric firmly with ends twisted at least two full turns.
   4. Bend ends of wire to minimize hazards to persons or clothing.

M. Install post top at each post.

N. Gates:
   1. Construct with fittings or by welding.
   2. Provide rigid, weatherproof joints.
   3. Assure right, non-sagging, non-twisting gate.
   4. Coat welds with rust preventive paint, color to match pipe.

O. Install electric gate operator in accordance with NFPA 70.

P. Galvanized Surface Colorant Application:
   1. Preparation:
      a. Target surfaces to be treated must be free of excessive oils, dirt, and other contaminants. All surfaces must be dry before application of colorant.
   2. Colorant Application:
      a. After areas to be treated have been prepared and the sample approved, apply colorant to target galvanized surfaces. Apply product according to the manufacturer′s instructions to achieve a color consistent with the approved sample.
      b. Colorant must be applied uniformly. Irregularities (above and beyond those that the product naturally produces) must be corrected according to the product manufacturer′s recommendations.
      c. Treated surfaces must be kept dry for a period of 5 days following the application of colorant or additional coats may be required.
      d. Material should be applied outdoors with daytime temperatures above 60 degrees and nighttime temperatures above 45 degrees (lower temperatures may be okay in some situations. Please contact the manufacturer for more information).
      e. For most applications, Manufacturer shall apply at their facility.

3.2 STORAGE

A. Surfaces treated with Galvanized Surface Colorant must be stored properly at the construction yard after delivery and before, and up to, time of installation per American Galvanizers Association (AGA) Guidelines.
   1. If components stack (as with guardrail), spacers should be placed between rows to allow for necessary airflow.
   2. Items should be stacked perpendicular to the ground slope to allow for proper drainage.
   3. Items should be elevated so they do not come into direct contact with soil or plant matter.

END OF SECTION

SECTION 32 91 13
FINISH GRADING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Topsoil quality and placing.
   2. Finish grading.
   3. Topsoil salvage, storage, and replacement

B. Related Requirements: Include, but are not necessarily limited to, the following:
   1. Section 32 92 21 – Native Grass Seeding

1.2 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment:
   1. Perform the Work of this Section for all areas within limits of grading and all areas outside limits of grading disturbed during construction.
   2. Perform the Work of this Section as part of the Lump Sum bid/pay item(s) indicated in the Contract.

1.3 REFERENCES

A. Reference Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. T194, Standard Method of Test for Determination of Organic Content of Soils by Loss on Ignition.
   2. ASTM International (ASTM):
      a. D2974, Standard Test Methods for Moisture, Ash, and Organic Matter of Peat and Other Organic Soils.
      b. D4221, Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer.
      c. D4972, Standard Test Methods for pH of Soils.
      d. D5268, Standard Specification for Topsoil Used for Landscaping and Construction Purposes.
      e. D6913, Standard Test Methods for Particle-Size Distribution (Gradation) of Soils Using Sieve Analysis.
      f. D7928, Standard Test Method for Particle-Size Distribution (Gradation) of Fine-Grained Soils Using the Sedimentation (Hydrometer) Analysis.
      g. E329, Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Contractor's Testing Laboratory:
      a. Retain the services of independent testing laboratory to perform testing and determine compliance with the Contract Documents of materials specified in this Section.
      b. When Contractor is expressly required, by this Section's "Quality Assurance" Article, "Source Quality Control" Article or elsewhere in the Contract Documents, to retain testing laboratory for tests required under this Section's "Quality Assurance" Article or "Source Quality Control" Article, retain one testing laboratory for quality assurance testing and field quality control testing.
      c. Testing laboratory shall comply with ASTM E329.
      d. Testing laboratory shall be experienced in the types of testing required.

e. Selection of testing laboratory is subject to Contracting Officer's Representative's acceptance. Upon Contracting Officer's Representative's request, submit qualifications statement for testing laboratory, including name of entity, location, copies of applicable certifications, summary of entity's experience, and names and qualifications of personnel who will perform the subject sampling and testing.

B. Quality Assurance Testing:
   1. Quality assurance testing, which may also be regarded as source quality control testing when topsoil to be installed will be topsoil originally stripped from the Site, is in addition to field quality control activities required by this Section's "Field Quality Control" Article.
   2. Allow free access to material stockpiles and borrow areas at all times. Tests shall be at Contractor's cost.
   3. Contractor's Testing Laboratory Scope:
      a. Obtain samples and perform testing of proposed topsoil materials, whether obtained from offsite borrow sources or stockpiled topsoil originally stripped from the Site, to provide assurance that the Work will comply with the Contract Documents.
   4. Required Quality Assurance Material Testing by Contractor's Testing Laboratory:
      a. Perform the following quality assurance tests for every 1,000 cubic yards of topsoil, or part thereof, to be incorporated into the Work. Submit results of such tests to Contracting Officer's Representative and obtain Contracting Officer's Representative's acceptance thereof prior to incorporating the subject topsoil into the Work.
         1) Gradation in accordance with ASTM D6913 and D7928.
         2) Clay content in accordance with ASTM D4221.
         3) pH in accordance with ASTM D4972.
         4) Organic content in accordance with ASTM D2974 or AASHTO T194.

1.5 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Quality Assurance Test Results Submittals:
      a. Submit results of quality assurance testing performed in accordance with this Section's "Quality Assurance" Article, unless included as part of another submittal under this Section.
         1) Tests on materials from onsite and borrow sources.
   2. Qualifications Statements:
      a. Quality assurance testing laboratory, when requested by Contracting Officer's Representative.
   3. Soil Survey Report
      a. Contractor will access the USDA NRCS Web Soil Survey, delineate project areas, and produce customized soil reports specific to each project area where soil disturbance will occur.
         1) Soils report to include soil profile descriptions, soil mapping units, characteristics, topsoil depth, soil textures, rock content, soil depth, available water holding capacity, permeability rates, and drainage classes.
      b. The contractor will meet with the Contracting Officer and GRCA Vegetation Program Manager 120 days before the start of topsoil salvage to discuss soils report and finalize topsoil management actions per project area.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

2.1 MATERIALS

A. Topsoil:
   1. All soil accepted as topsoil, whether obtained from onsite or offsite sources, shall comply with requirements of this Section.

2. Topsoil Source: Reuse surface soil stockpiled on Site, where possible. Verify suitability of stockpiled surface soil to produce topsoil, as specified. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.
   a. Supplement acceptable onsite soil with manufactured topsoil from offsite sources, when quantities available on-Site are insufficient to complete the Work.
   b. When existing soil material stripped from the Site and stockpiled does not comply with requirements of this Section, such soil may be provided as topsoil when addition of amendments and fertilizers will bring such soil material into compliance with this Section's topsoil requirements. Furnish to Contracting Officer written advisory of Contractor's intent to amend existing soil materials to be compliant with topsoil requirements.
   c. All topsoil must be confirmed as "weed free" by the supplier if sourced from offsite or by the NPS Vegetation Program if sourced onsite.
3. Provide fertile, friable, natural loam, surface soil, capable of sustaining vigorous plant growth; free of any admixture of subsoil, clods of hard earth, plants or roots, sticks, stones larger than one inch diameter, or other extraneous material harmful to plant growth, in compliance with ASTM D 5268.
4. Provide topsoil of the following characteristics:
   a. Required gradation:

Sieve Size	Percent Passing
3/4 inch mesh	100
No. 4-sieve	90 to 100
No. 200-sieve	0 to 10

   b. Clay content of material passing No. 200-sieve shall be not greater than 60 percent, as determined by hydrometer tests.
   c. pH-adjusted with ferrous sulphate or ground limestone to provide pH 5.5 to 7.0 at time of installation of lawns and meadow areas, unless particular species of planting requires a different pH for optimal growth.
   d. Electrical conductivity of a 1:2 soil-water suspension shall not exceed 1.0 milliohm per centimeter and with less than 200 parts per million of extractable aluminum.
   e. Cation Exchange Capacity: 5, minimum.
   f. Organic content not less than five percent, as determined by ignition loss of oven-dried samples passing No. 10-sieve (Muffle Furnace Temperature: 110 plus or minus five degrees C for eight hours).
   g. Free of pests and pest larvae.
   h. Relative to Constituents of Concern, topsoil shall be in accordance with Laws and Regulations. Constituents of Concern, if any, in topsoil furnished shall not constitute or result in a Hazardous Environmental Condition.

B. Topsoil Amendments and Fertilizer
   1. Fertilizer prohibited by NPS.

2.2 SOURCE QUALITY CONTROL

A. Tests and Inspections at Source of Supply:
   1. Perform quality assurance testing, and submit results to Contracting Officer's Representative, in accordance with the "Quality Assurance" Article in Part 1 of this Section.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protection of In-place Conditions:

1. Protect structures, utilities, sidewalks, pavements, and other facilities, and lawns and existing plants from damage caused by finish grading.

B. Topsoil Salvage
   1. Contractor to remove all topsoil prior to all other soil disturbances.
   2. Contractor to remove the topsoil in one pass, will not mix topsoil with subsoil, and will not compact or drive upon topsoil during removal
   3. Topsoil salvage depth will be a minimum of 6 inches of material in all cases, with additional topsoil salvageable in some locations.
   4. Live vegetation less than 3 feet in height and limbs less than 1 inch in diameter shall be incorporated as topsoil in the stockpiles.
   5. The contractor will properly dispose or bury all topsoil contaminated with invasive non-native plant species as directed by the Contract Officer and GRCA Vegetation Program Manager.

C. Topsoil Stockpiling
   1. Salvaged topsoil will be separated from the sub-soil and stockpiled in windrowed piles no higher than three feet, and no wider than three feet.
   2. The contractor will identify removal areas and stockpiles so that topsoil may be replaced in the same locations.
   3. If salvaged topsoil must be stored longer than 3 weeks, topsoil stockpiles will be hydroseeded and hyrdomulched by the contractor with locally collected seed provided by NPS.

D. Preparation – General:
   1. In accordance with Section 01 50 00 – Temporary Facilities and Controls, provide temporary measures for controlling erosion and sedimentation, airborne dust, and fugitive dust emissions from the Site.
   2. Adjust rough grading to within 0.1 foot of required elevations. Properly compact sub-grades. Rough grading shall provide for appropriate drainage in accordance with the Contract Documents.
   3. Correct, adjust and/or repair rough graded areas.
      a. Cut off mounds and ridges.
      b. Fill gullies and depressions.
      c. Perform other necessary repairs.
      d. Bring all sub-grades to specified contours, even and properly compacted.
   4. Before applying topsoil:
   5. Scarify all disturbed areas to a depth of 6” in a direction perpendicular to the natural flow of water.
   6. If the Contracting Officer and GRCA Vegetation Program Manager determines that subsoil is excessively compacted by the NPS or contractors’ operations, the contractor will scarify the subsoil to a depth of 24” to de-compact and break the interface between particles.

3.2 INSTALLATION

A. Installation Requirements:
   1. Required Depth of Topsoil:
      a. Spread conserved topsoil to a depth of 4 inches or greater (if additional topsoil is available) over all disturbed areas.
      b. Contractor to spread using lightest weight equipment possible.
      c. If the Contracting Officer and GRCA Vegetation Program Manager determine that topsoil is excessively compacted by the NPS or contractors’ operations, the contractor will scarify the topsoil to a depth of 8” to de-compact and break the interface between particles.
   2. Contractor to avoid mixing topsoil with subsoil materials.
   3. Do not place topsoil when subgrade is muddy, wet or frozen enough to cause clodding.

4. Provide finished surface smooth and true to required grades, in accordance with this Article's "Installation Tolerances" provision. Provide finished surface of topsoil equal to required finished elevations after light rolling and natural settlement.
5. Grade topsoil to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to provide required finish grades.
6. Restore topsoil if eroded or otherwise disturbed after finish grading and before planting.
7. Topsoil Quantity Differentials:
    a. If quantity of required topsoil exceeds the quantity, if any, of topsoil stockpiled at the Site and available for use by Contractor, provide the additional required quantity from appropriate offsite borrow sources at no additional cost to Government.
    b. When quantity of topsoil obtained from offsite borrow sources exceeds the required quantity of topsoil, remove excess from the Site, unless Government allows such excess to be stockpiled at an appropriate location at the Site.
    c. When quantity of required topsoil is less than quantity of onsite stockpiles, following installation of topsoil, properly grade remaining stockpile for appropriate drainage without undue erosion and seed stockpile as required for other areas of lawn restoration in accordance with the Contract Documents.

B. Installation Tolerances:
1. Finish Grading Tolerance: ±0.1 foot from finish elevation required by the Contract Documents. Ensure adequate drainage.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Upon completion of topsoil installation, obtain Contracting Officer's concurrence regarding grades and drainage.
2. Where directed by Contracting Officer's Representative, provide test holes to demonstrate that required depth of topsoil was provided. After observation and measurement by Contracting Officer's Representative, properly refill test holes.
3. Where insufficient depth of topsoil is revealed, remedy by providing required depth and quantity in accordance with the Contract Documents. When additional topsoil is added after initial establishment of plant growth, re-establish required plantings to provide compliance with the Contract Documents.

3.4 PROTECTION

A. Commencing immediately after topsoil installation, protect installed topsoil from erosion and damage from other causes, including personnel, vehicles, and equipment. Promptly perform hydro-seeding and hydro-mulching to permanently stabilize soils and prevent erosion, in accordance with Section 32 92 21 – Native Grass Seeding.

END OF SECTION

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SECTION 32 92 21
NATIVE GRASS SEEDING

PART 1 - GENERAL

1.1 SUMMARY

A. Furnish labor, materials, tools, equipment, and services for Native Grass Seeding by way of hydro-seeding and hydro-mulching, as indicated, in accordance with provisions of Contract Documents.
   1. NPS is responsible for providing all seed for the project, to be propagated by GRCA vegetation program.

B. Completely coordinate with work of other trades.

1.2 SUBMITTALS

A. Contract Closeout Information:
   1. Maintenance data.

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Deliver seed in standard sealed containers labeled with producer's name and seed analysis, and in accordance with US Department of Agriculture Rules and Regulations under Federal Seed Act.

B. Deliver fertilizer in original containers, labeled with content analysis.

1.4 JOB CONDITIONS

A. Perform hydro-seeding and hydro-mulching between October 1 and November 15, depending on weather and soil conditions.

B. Fall seeding, conducted when the possibility of frost is near, is acceptable; but do not water until the following growing season.

C. No work shall be done when the ground is frozen, snow covered, too wet or in an otherwise unsuitable condition for planting.
   1. Special conditions may exist that warrant a variance in the specified planting dates or conditions.
   2. Submit a written request to Contracting Officer's Representative stating the special conditions and proposed variance.

PART 2 - PRODUCTS

Product requirements are to conform with the following salient characteristics.

2.1 MATERIALS

A. Seed:
   1. NPS is responsible for providing certified seed of locally adapted strains.
      a. GRCA Vegetation Program has initiated seed collection efforts to provide locally-collected seed for propagation of plant materials.

B. Mulch:
   1. All slopes steeper than 3:1 shall receive mulch in addition to hydro-seeding.
   2. Bonded fiber mulch composed of strong tackifiers with crimped wood fibers
   3. Mulch shall we designed to assist with site stabilization for 1 to 1.5 years.

C. Fertilizer:
   1. Prohibited by NPS.

D. Cover crop: Sterile; Composed of Sorghum, soybeans, milo, millet or sudangrass, etc.

E. Water: Provide clean, fresh water free from impurities injurious to vegetation.

PART 3 - EXECUTION

3.1 SEEDING

A. Hydro-seeding:
   1. Contracted hydro-seeder/hydro-mulcher to apply a slurry of seed and water to application areas using a centrifugal pump.
      a. GRCA Vegetation Program staff to determine seed mixture and rate of application.
   2. Apply slurry evenly in a minimum of two (2) passes over prepared soil area.
      a. First pass: apply 50% of material from the bottom of the slope, directed upward on the slope, applying hydro-seed materials to the entire area.
      b. Second pass: apply 50% of material from the top of the slope, directed downwards on the slope, applying hydro-seed materials to the entire area.
      c. Using the color of the seed as a metering agent, spray the slurry mixture uniformly over the designated seeded area, taking care to avoid bare spots in the application of the material.
   3. Do not hydro-seed in the presence of surface water.
   4. Thoroughly clean site amenities after seeding.
   5. Hydraulic seeding equipment and accessories (i.e., centrifugal pump): Obtain Contracting Officer's Representative's approval for use.

B. Hydro-mulching:
   1. Contracted hydro-seeder/hydro-mulcher to apply a slurry of bonded fiber mulch and water to all hydro-seeded areas with slopes greater than 3:1.
      a. GRCA Vegetation Program staff to determine seed mixture and rate of application.
   2. Apply slurry evenly in a minimum of two (2) passes over hydro-seeded area.
      a. First pass: apply 50% of material from the bottom of the slope, directed upward on the slope, applying hydro-mulch materials to the entire area.
      b. Second pass: apply 50% of material from the top of the slope, directed downwards on the slope, applying hydro-mulch materials to the entire area.
      c. Using the color of the mulch as a metering agent, spray the slurry mixture uniformly over the designated seeded area, taking care to avoid bare spots in the application of the material.
   3. Do not hydro-mulch in the presence of surface water.
   4. Thoroughly clean site amenities after mulching.
   5. Hydraulic mulching equipment and accessories (i.e., centrifugal pump): Obtain Contracting Officer's approval for use.

C. Quality Assurance:
   1. Contractor shall coordinate with the Contracting Officer's Representative for inspection of the first test area of hydro-seeding and hydro-mulching to verify application technique, coverage, and adherence to slope requirements.

3.2 MAINTENANCE

A. Maintain seeded areas for one full growing season.

B. Do not mow native grass.

C. When weeds are shading out native grass seedlings, shred weeds back to height of seedlings with rotary shredder.
   1. Before August of growing season, shred weeds at least 2 times.

END OF SECTION

SECTION 33 05 31.11
POLYVINYL CHLORIDE GRAVITY SEWER PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. PVC gravity sewer pipe and fittings.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 31 23 33 - Trenching and Backfilling.
   2. Section 33 31 11 - Gravity Sewer Pipeline and Manhole Construction.

1.2 QUALITY ASSURANCE

A. See Specification Section 33 31 11.

B. Referenced Standards:
   1. ASTM International (ASTM):
      a. PVC (polyvinyl chloride) materials:
         1) D1784, Standard Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
         2) D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems
         3) D2729, Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings
         4) D3034, Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
         5) D3212, Standard Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
         6) F477, Standard Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
         7) F679, Standard Specification for Poly(Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
         8) F1336, Standard Specification for Poly(Vinyl Chloride) (PVC) Gasketed Sewer Fittings
         9) D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

1.3 DEFINITIONS

A. DR: Dimension Ratio, Outside Diameter/Minimum Wall Thickness, both in inches

B. Diametral Deflection: reduction in diameter caused by earth and surcharge loads acting on the installed pipe.

C. PS: Pipe Stiffness, PSI

D. SDR: Standard Dimension Ratio.

1.4 SUBMITTALS

A. Action Submittals:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
      c. Schedule sheet showing compliance of all system components.

1) Attach technical product data on gaskets, pipe, fittings, and other components.

B. Where an option for joint type is specified, submit jointing method(s) selected and where each will be used.

C. Painted green, submit color sample for approval.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. JM Eagle
   2. Or equal.

2.2 PVC DRAINAGE AND SEWER PIPING

A. Materials:
   1. PVC pipe and fittings: rigid, unplasticized polyvinyl chloride (PVC) made of PVC plastic having a cell classification of 12454-B or 12454-C per ASTM D1784.

B. Pipe:
   1. ASTM D3034
      a. DR: See Drawings
   2. ASTM F679
      a. DR: See Drawings
   3. Ensure impact strengths and pipe stiffnesses are in full compliance to these Specifications.

C. Joints
   1. Elastomeric gasket joint meeting requirements of ASTM D3212.
      a. Gaskets (seals) per ASTM F477.

D. Fittings:
   1. Elastomeric Joints: Per ASTM D3034 and ASTM F649

PART 3 - EXECUTION

3.1 IDENTIFICATION

A. Identify each length of pipe clearly at intervals of 5 feet or less per governing ASTM Standard for each type of pipe used.

3.2 INSTALLATION

A. See Section 31 23 33.

B. See Section 33 31 11.

C. Install pipe and fittings in accordance with ASTM D2321, the above referenced Specification Sections and as recommended by the manufacturer.

D. Diametral Deflection:

1. After backfilling, check each section of pipe for diametral deflection by pulling a mandrel through the pipe.
2. Pipe with deflection exceeding 3 % of the inside diameter: remove and replace to provide a deflection of less than 3 %.
3. Retest any repaired pipe.

END OF SECTION

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SECTION 33 05 33.23
HIGH DENSITY POLYETHYLENE (HDPE) PIPE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. High Density Polyethylene (HDPE) pipe, fittings, and appurtenances.

B. Related Sections include but are not necessarily limited to:
   1. Section 31 23 33 – Utilities Trenching and Backfilling.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer of HDPE Pipe:
      a. Obtain all HDPE pipe and fittings from one manufacturer, unless otherwise acceptable to Government and Contracting Officer's Representative.
      b. Manufacturer of pipe required by this Section shall be regularly engaged in the business of manufacturing HDPE piping of the size and type(s) required for the Work. Upon Contracting Officer's Representative's request, submit documentation of manufacturer's prior furnishing of PE pipe of the type(s) required for not less than five other projects, similar in size and complexity to the HDPE piping Work of this Project, in North America.
      c. Equipment:
         1) Qualify each extrusion line and molding machine to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D1598.
      d. QA and QC Program:
         1) HDPE pipe manufacturer shall have documented quality assurance and quality control programs as part of manufacturer's routine business.
         2) HDPE piping manufacturer shall maintain permanent Quality Control (QC) and Quality Assurance (QA) records.
   2. Installer:
      a. Use one entity for all HDPE pipe Work, unless otherwise acceptable to Government and Contracting Officer's Representative.
      b. Installer shall be experienced with HDPE piping installation work similar in scope and complexity to the Work of this Section. When required by Contracting Officer's Representative, submit documentation of successful completion of not less than five similar projects to the HDPE piping Work completed within the past five years.
      c. Where HDPE pipe joints are made by fusing, fusion machine operators shall have been trained by fusion machine manufacturer within 12 months of starting to perform joint fusion Work. Submit documentation of such training, acceptable to Contracting Officer's Representative, when requested by Contracting Officer's Representative.
      d. Installer's training and qualifications shall be acceptable to HDPE pipe Supplier retained for the Project.

B. Referenced Standards:
   1. American National Standards Institute (ANSI):
      a. B1.1, Unified Inch Screw Threads (UN and UNR Thread Form).
      b. B16.1, Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250, and 800.
      c. B16.21, Nonmetallic Flat Gaskets for Pipe Flanges.
   2. ASTM International (ASTM):
      a. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.

b. A193, Standard Specification for Alloy-Steel and Stainless Steel Bolting for High Temperature or High Pressure Service and Other Special Purpose Applications.
c. A194, Standard Specification for Carbon Steel, Alloy Steel, and Stainless Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
d. A536, Standard Specification for Ductile Iron Castings.
e. B695, Standard Specification for Coatings of Zinc Mechanically Deposited on Iron and Steel.
f. D638, Standard Test Method for Tensile Properties of Plastics.
g. D1248, Specification for Polyethylene Plastics Molding and Extrusion Materials.
h. D1505, Test Method for Density of Plastics by the Density-Gradient Technique.
i. D1598, Test Method for Time-to-Failure of Plastic Pipe Under Constant Internal Pressure.
j. D1599, Test Method for Short-Time Hydraulic Failure Pressure of Plastics Pipe, Tubing and Fittings.
k. D2239, Standard Specification for Polyethylene (PE) Plastic Pipe (SIDR-PR) Based on Controlled Inside Diameter.
l. D2290, Test Method for Apparent Tensile Strength of Ring or Tubular Plastics and Reinforced Plastics by Split Disk Method.
m. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
n. D2737, Standard Specification for Polyethylene (PE) Plastic Tubing.
o. D2837, Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.
p. D3035, Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
q. D3261, Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
r. D3350, Standard Specification for Polyethylene (PE) Plastics Pipe and Fittings Materials.
s. F714, Standard Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
t. F1055, Standard Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
u. F2620, Standard Practice for Heat Fusion Joining of Polyethylene Pipe and Fittings.

3. American Water Works Association (AWWA).
   a. C207, Steel Pipe Flanges for Waterworks Service, Sizes 4 In. through 144 In.
   b. C901, Polyethylene (PE) Pressure Pipe and Tubing, ¾ In. through 3 In. for Water Service.
   c. C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 In. through 65 In. for Waterworks.
4. Plastic Pipe Institute (PPI):
   a. TR-3, Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Material.
   b. PPI TR-4, Recommended Hydrostatic Strengths and Design Stresses for Thermo-plastic Pipe and Fittings Compounds.
5. Military Specification (Mil Spec):
   a. QQ-P-416F, Plating, Cadmium Electro Deposited.
6. National Sanitation Foundation International (NSF):
   a. 14, Plastic Piping Components and Related Materials.
   b. 61, Drinking Water System Components – Health Effects.

1.3 DEFINITIONS

A. DIPS: Ductile Iron Pipe Size

B. CTS: Copper Tube Size.

C. DR: Dimension Ratio, Outside Diameter/Minimum Wall Thickness, in inches.

D. Diametral Deflection: reduction in diameter caused by earth and surcharge loads acting on the installed pipe.

E. ESCR: Environmental Stress Crack Resistance.

F. HDB: Hydrostatic Design Basis per ASTM D2837.

G. IPS: Iron Pipe Size.

H. SDR: Standard Dimension Ratio.

I. SIDR: Standard Inside Diameter Ratio.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Dimensioned, scaled drawings showing Contractor's proposed deviations from piping alignment shown on the Drawings.
      b. Where necessary, include both plans and profiles and section views in Shop Drawings.
   2. Product Data:
      a. Manufacturer's published catalog information and specifications for each size and type of HDPE piping required, including pipe, fittings, and jointing materials.
      b. Clearly indicate in product data submittal the reference standards with which pipe and appurtenances comply.
      c. Where couplings are required, submit coupling manufacturer's catalog literature and specifications for the specific couplings proposed.

B. Informational Submittals; Submit the following:
   1. Supplier Instructions:
      a. Submit manufacturer's written instructions for handling, storing, and installing piping furnished.
   2. Source Quality Control:
      a. Submit documentation from manufacturer that piping materials furnished were inspected at the production facility and successfully passed manufacturer's quality control procedures.
      b. Manufacturer's affidavit certifying piping materials furnished comply with AWWA standards C906 and C901.
   3. Fusion machines proposed for joining pipe/fittings.
   4. Field Quality Control:
      a. Documentation of temperature and pressure profiles from data logger for each butt fusion joint.
      b. Results of field quality control testing and inspections required in this Section.
      c. Documentation of temperature and pressure profiles from data logger for each butt fusion joint.
   5. Qualifications:
      a. Piping materials manufacturer, when requested by Contracting Officer's Representative.
      b. Installer, when requested by Contracting Officer's Representative, including documentation of training in use of joint fusion equipment.
      c. Documentation showing fusion machine operators have been trained within 12 months prior to installation.

1.5 DELIVERY, HANDLING, AND STORAGE

A. In addition to requirements elsewhere in the Contract Documents, also comply with the following:
   1. During handling and installation avoid conditions where pipe bends excessively and avoid imparting kinks in the pipe.

PART 2 - PRODUCTS

2.1 MANUFACTURER'S

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. HDPE Pipe and Fittings:
      a. JM Eagle.
      b. Or equal.
   2. Restrained Transition Fitting:
      a. Romac Industries, Alpha Wide Range Restraint Coupling
      b. Or equal.
   3. Butt Fusion Equipment:
      a. McElroy Manufacturing, Inc.
      b. Or equal.
   4. Adaptor Couplings
      a. Central Plastics Co.
      b. Or equal.

2.2 MATERIALS

A. Pipe:
   1. AWWA C906 for pipe 4 IN and larger, C901 for pipe less than 4 IN.
      a. PE 4710 polyethylene material.
      b. ASTM D3350 cell classification 445574C/E.
      c. Minimum Hydrostatic Design Basis (HDB) of 1600 psi at 73 degF when tested in accordance with PPI TR-3.
      d. NSF/ANSI 61/14 approved.

B. Fittings:
   1. Same material and thickness as adjoining pipe.
      a. Fittings may be one DR lower (thicker) than the adjoining pipe.
   2. Molded fittings:
      a. Butt fused: ASTM D3261.
      b. Socket: ASTM D2683.
      c. Electrofusion: ASTM F1055.
   3. Fabricated fittings: Fabricate from same material as pipe.
   4. NSF 61 approved.

C. Back-up flanges:
   1. Stainless steel: ASTM A182, dimensions per AWWA C207, Class 150.
   2. Ductile iron: ASTM A536 Grade 70-50-5, dimensions per ANSI B16.1, Class 150.

D. Nuts and Bolts:
   1. Buried:
      a. Tee-Head bolts for mechanical joints: Per AWWA/ANSI C111/A21.11.
      b. Other bolts and nuts: ASTM A307 ASTM A193/A194 Grade B8 Class 1.
      c. Wax Tape Coatings per AWWA C217.
   2. Exposed: Mechanical galvanized ASTM B695, Class 40 ASTM A193/A194 Grade B8, Class 1.
   3. Heads and dimensions per ASME B1.1.

4. Threaded per ASME B1.1.
5. Project ends 1/4 to 1/2 inches beyond nuts.

2.3 MANUFACTURED UNITS

A. Adaptor Fittings:
   1. Mechanical joint: Adaptor fitting butt fused to pipe.
      a. Capable of developing same pressure rating as specified for pipe.
      b. Restrained.

B. Restrained Adapter Fitting:
   1. Restrained coupling for pipe material transition.

C. Butt Fusion Equipment:
   1. Designed to create a joint at least as strong as the adjacent pipe.
   2. Equipment to contain stops to prevent excessive pressure on pipe ends during fusion process.
   3. Equipment to plane pipe ends prior to fusion process.
   4. Provide a data logger to document temperatures and pressures for each butt fusion joint.

2.4 DESIGN CRITERIA

A. DR:
   1. See Drawings

B. Pipe Outside Diameter (OD):
   1. Minimum allowable pipe outside diameter: Per AWWA C906, Table 4 (DIPS sizing).
   2. Minimum allowable pipe outside diameter: Per AWWA C901, Table 4 (IPS sizing).

C. Stub flanges: Design to develop full pressure specified for pipe with blind flange connected to back up flange.

D. Test Pressure:
   1. Sewer Force Main: 3”, 4”, 6” DR-11 and SCH 80, 50 psi for 2-hours
   2. Water pressurized: 90 psi for 2-hours

2.5 FABRICATION

A. Pipe:
   1. Clearly mark pipe and fittings per AWWA C906 for 4 IN and larger or AWWA C901 for less than 4 IN.
   2. Coiled HDPE Pipe
   3. Service Indication:
      a. Provide integral color or longitudinal color banding at 180 degrees apart.
         1) Potable Water: Black pipe with blue stripes.
         2) Sanitary Sewer or Force Main: Black pipe with green stripes.
         3) Raw Water: Black pipe

B. Stub flanges:
   1. Design for use with backing flange.
   2. Fabricate per manufacturers recommendations to develop full pressure specified for pipe with blind flange attached.

2.6 SOURCE QUALITY CONTROL

A. Materials:
   1. Incoming polyethylene materials:
      a. Inspect for density per ASTM D1505, melt rate per ASTM D1248, and carbon containment.
      b. Provide certification from material supplier for a minimum of 30% of all incoming polyethylene materials.

c. HDPE pipe manufacturer shall verify certifications prior to processing into finished pipe or fittings.

2. Outgoing materials:
   a. Manufacturer to inspect for diameter, wall thickness, length, straightness, out-of-roundness, concentricity, toe-in, inside and outside surface finish, markings, and end cut.
   b. Perform tests to determine density, melt flow rate, carbon content, and carbon dispersion.
   c. Test representative samples of the pipe provided to determine hoop tensile strength and ductility by either quick burst per ASTM D1599 or ring tensile per ASTM D2290.

B. Equipment:
1. Qualify each extrusion line and molding machine to produce pressure rated products by taking representative production samples and performing sustained pressure tests in accordance with ASTM D1598.

C. Quality Control Program:
1. Pipe and fitting manufacturer shall maintain permanent Quality Control (QC) and Quality Assurance (QA) records.
2. Certified copies of the quality control data taken during product manufacture shall be supplied to the Government upon request.

D. Factory Inspection:
1. HDPE pipe manufacturer's production and quality assurance facilities shall be open and available for inspection by Government and its authorized representatives.

PART 3 - EXECUTION

3.1 GENERAL

1. Locations: Provide HDPE piping at the locations shown on the Drawings or as otherwise shown and indicated in the Contract Documents.
2. Install HDPE piping in accordance with:
   a. Section 31 23 33 - Trenching and Backfilling.
   b. Section 33 11 13 – Water Main Construction.
   c. Other provisions of the Contract Documents.
   d. Laws and Regulations.

3.2 INSTALLATION

A. General:
1. Locations: Provide HDPE piping at the locations shown on the Drawings or as otherwise shown and indicated in the Contract Documents.
2. Install HDPE piping in accordance with:
   a. Manufacturer's recommendations.
   b. Section 31 23 33 - Trenching and Backfilling.
   c. Other provisions of the Contract Documents.
   d. Laws and Regulations.
3. Field repairs of pipe and fittings are not permitted, with the exception that portions of straight pipe which are damaged may be cut off provided this alteration is in accordance with the manufacturer's established procedures.

B. Joining method - Fusion Joints:
1. Joint Fusing – General:
   a. Comply with ASTM F2620, the Contract Documents, pipe manufacturer's written instructions, and fusion machine manufacturer's written recommendations. Where any of the foregoing are inconsistent, comply with the more-stringent requirement. When unclear, request and obtain from Contracting Officer's Representative written interpretation or clarification.

b. Fusion joiner shall be appropriately qualified and experienced in making the type of fusion joint required (butt fusion, socket fusion or sidewall fusion). Fusion joiner shall perform fusion jointing only for the types of joints for which such person possesses appropriate qualifications and experience.
c. Cost of certifying its workers and performing testing required for fused joints is Contractor's responsibility.
d. Provide appropriate protection for fusing joints based on weather conditions.
e. Fuse HDPE pipe joints on the surface prior to installation into the trench.
f. Plane ends of joints in fusion machine prior to heating.
g. Push pipe ends together in fusion machine and visually inspect compatibility and alignment of the two ends.
h. Comply with pipe manufacturer's written procedures and recommended heating time for pipe ends based upon pipe diameter and ambient temperature.
i. Visually inspect joint immediately upon removal of heating element to verify blistering of pipe has not occurred. Blistering of pipe is unacceptable.
j. Do not remove pipe from fusion machine until pipe has cooled in accordance with the pipe manufacturer's written instructions.

2. HDPE pipe 1 inch diameter and smaller shall be socket fused.
3. HDPE pipe joints 1.5 inch diameter and larger shall be butt fused.
4. Electro-Fusion Fittings:
   a. Comply with pipe fitting manufacturer's written instructions.
   b. Ensure ends of connecting pipe are round when fusing.
   c. Couplings: Provide means to place pipe ends in compression when fusion coupler is heated/cooled until connection process is complete.

C. Joining method – Flanged Joints:
1. Slide back up flange on HDPE pipe.
2. Install stub flange on end of pipe with butt fusion.
3. Make flange faces flat and perpendicular to pipe centerline.
4. Allow one flange free movement in any direction while bolts are being tightened.
5. Do not assemble adjoining flexible joints until flanged joints in piping system have been tightened.
6. Gradually tighten flange bolts uniformly to permit even gasket compression.
7. Check bolt torque after 24 hours to ensure that stress relief has not occurred.

D. Joining method – Mechanical Joint:
1. Use only for joining HDPE pipe to DIP or PVC (AWWA C900).
2. Install MJ adapter on end of HDPE pipe with butt fusion.
3. Clean components before installation.
   a. Clean bolts and nuts by wire brushing.
   b. Lubricate bolts with vegetable-based oil only.
4. Insert nuts and bolts (or studs), finger tighten, and progressively tighten diametrically opposite bolts uniformly around the flange to the proper tension.
5. Execute care when tightening joints to prevent undue strain upon adjoining pipe.
6. Test joint for leakage.
   a. If joint leaks under pressure testing, loosen or remove nuts and bolts, reset, or replace the gasket, reinstall or retighten bolts and nuts, and retest the joints.
   b. Completed joints shall be watertight.
7. Check bolt torque after 24 hours to ensure that stress relief has not occurred.

E. Install buried pipe per Section 33 11 13 and per details shown on Drawings.
1. Allow pipe to stabilize to trench bottom or casing temperature before final tie-in or backfilling.
2. For field sweeps, the minimum cold bending allowable radius:

DR	Minimum Radius
7-9	20 times pipe OD
>9 - 13.5	25 times pipe OD
>13.5 - 21	27 times pipe OD
>21	30 times pipe OD
With flange or fitting inside sweep	100 times pipe OD

3.3 FIELD QUALITY CONTROL

A. Use only fusion machine operators who have been trained by machine manufacturer no more than 12 months prior to installation of first fused joint.

B. Visually inspect all pipe for gouges.
   1. Gouges in excess of 10% of the pipe wall thickness are not acceptable.
   2. In area where excessive gouges are present, cut out affected pipe section and butt fused to remaining pipe to make a continuous section.

C. Check integrity of the heating plate in the fusion equipment a minimum of twice per each 8-hour work shift for temperature uniformity.

D. Butt-fused specimen joint inspection and testing per ASTM F2620, Appendix X4.
   1. Visually inspect all joints during and after joining to ensure that the joint meets the requirements of the butt fusion welding procedure.
   2. On every day that butt fusions are to be made, prepare a trial butt-fused joint specimen.
   3. Allow specimen to cool completely and cut into test straps.
   4. Test straps:
      a. Length: 12 inches (min) or 30 times the wall thickness.
      b. Location of fusion: Center of strap.
      c. Width: 1 inch (min) or 1.5 times the wall thickness.
   5. Visually examine the straps for voids or discontinuities.
   6. Deform the straps by bending, torque, or impact.
   7. If failure of the joint occurs outside of the joint area, the test is acceptable.

E. Diametral Deflection:
   1. After backfilling, check each section of pipe for deflection by pulling a mandrel through the pipe.
   2. Pipe with deflection exceeding 3% of the inside diameter: remove backfill and replace to provide a deflection of less than 3%.
   3. Retest any repaired pipe.

F. Hydrostatically test installed pipe and fittings in accordance with Section 33 11 13.
   1. Provide butt fused stub flanges, back up flanges and blind flanges on both ends of each pipe string for hydrostatic testing prior to and following installation.

END OF SECTION

SECTION 33 05 61
CONCRETE MANHOLES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Precast concrete round manhole structures and appurtenant items.
      a. Sanitary sewer manholes and appurtenances.
      b. Drain manholes and appurtenances.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 03 21 00 - Reinforcement.
   2. Section 03 31 30 - Concrete Materials and Proportioning.
   3. Section 31 23 33 – Utilities - Trenching and Backfilling.

1.2 QUALITY ASSURANCEF

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48/A48M, Standard Specification for Gray Iron Castings.
      b. C150/C150M, Standard Specification for Portland Cement.
      c. C478, Standard Specification for Precast Reinforced Concrete Manhole Sections.
      d. C923, Standard Specification for Resilient Connectors Between Reinforced Concrete Manhole Structures, Pipes, and Laterals.
      e. D1227, Standard Specification for Emulsified Asphalt Used as a Protective Coating for Roofing.
      f. D4586, Standard Specification for Asphalt Roof Cement, Asbestos-Free.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Manufacturer's installation instructions.
   2. Fabrication and/or layout drawings:
      a. Include detailed diagrams of manholes showing typical components and dimensions, reinforcements and other details.
      b. Itemize, on separate schedule, sectional breakdown of each manhole structure with all components and refer to drawing identification number or notation.
      c. Indicate knockout elevations for all piping entering each manhole.
   3. Buoyancy uplift and structural calculations.
   4. Drawings shall be signed and sealed by a Professional Engineer registered in the State of Arizona.

B. Unless approved prior to submittal, submit all products from this Specification Section in one complete submittal package. Include all products and accessories together.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Manhole rings, covers and frames:
      a. Deeter Foundry.
      b. Or Equal.
   2. Black mastic joint compound:
      a. RAM-NEK.
      b. Or Equal.
   3. Premolded joint compound:
      a. RAM-NEK.
      b. Or Equal.
   4. Emulsified fibrated asphalt compound:
      a. Sonneborn Hydrocide 700B.
      b. Or Equal.

2.2 SANITARY SEWER, STORM AND DRAIN MANHOLE STRUCTURE COMPONENTS

A. Manhole Components:
   1. Reinforcement: ASTM C478.
   2. Minimum wall thickness: 5 inches.
   3. Minimum base thickness: 12 inches.
   4. Provide the following components for each manhole structure:
      a. Base (precast) with integral bottom section or (cast-in-place).
      b. Precast bottom section(s).
      c. Precast barrel section(s).
      d. Precast eccentric transition section.
      e. Precast adjuster ring(s).
      f. Precast concrete transition section.
      g. Precast flat top.
   5. Unless dimensioned or specifically noted on Drawings, provide manhole section with minimum 48 inches inside dimensions.

B. Nonpressure Type Frames and Cover:
   1. Cast iron frame and covers: ASTM A48/A48M, Class 35 (minimum).
   2. Use only cast iron of best quality, free from imperfections and blow holes.
   3. Furnish frame and cover of heavy-duty construction a minimum total weight of 450 pounds.
   4. Machine all horizontal surfaces.
   5. Furnish unit with solid nonventilated lid with concealed pickholes.
      a. Letter covers "SEWER" for all collection system manholes, "SEWER" for all gravity unit drains returning flow to the headworks, and "WATER" for water systems.
   6. Ensure minimum clear opening of 24 inches diameter.

C. Pressure Type Frame and Cover:
   1. Provide covers meeting the requirements of the Nonpressure Type Frames and Cover paragraph above and as modified below.
   2. Furnish frame and bolted cover of heavy-duty construction.
      a. Equip unit with six stainless steel countersunk 3/8 inches diameter by 1-1/2 inches long bolts with stainless steel washers.
   3. Provide solid lid and minimum 1/8 inches thick x 1/2 inches wide continuous strip neoprene gasket.
   4. Furnish unit with a minimum of six anchorage holes and six, 6 inches long x 3/4 inches diameter stainless steel anchor bolts.

D. Special Coatings and Joint Treatment:

1. Joints of precast sections:
    a. Black mastic compound: ASTM D4586.
2. Vertical wall surfaces:
    a. Emulsified fibrated asphalt compound meeting ASTM D1227 Type II for all exterior and interior vertical wall surfaces.

E. Sanitary Sewer Manhole Concrete:
1. Provide all sanitary manholes constructed with Portland ASTM C150/C150M, Type I or II cement with a tricalcium aluminate content not to exceed 8%.
2. Mix aggregate shall be a minimum of 50% crushed limestone.
3. Provide 3000 psi nonshrink grout.

PART 3 - EXECUTION

3.1 MANHOLE CONSTRUCTION

A. General:
1. Construct cast-in-place concrete base slabs.
2. Make inverts with a semi-circular bottom conforming to the inside contour of the adjacent sewer sections.
3. On all straight runs, lay pipe through manhole and cut out top half of pipe.
    a. See detail on Drawings.
    b. If pipes deflect at manhole, shape as specified in Paragraphs 2 and 4 inches this General Paragraph.
4. Shape inverts accurately and steel trowel finish.
    a. For changes in direction of the sewer and entering branches into the manhole, make a circular curve in the manhole invert using as large a radius as manhole inside diameter will permit.
    b. Pour base slab integral with bottom barrel section.

B. Build each manhole to dimensions shown on plans and at such elevation that pipe sections built into wall of manhole will be true extensions of line of pipe.

C. For all horizontal mating surfaces between concrete and concrete or concrete and metal, above established high groundwater elevation shown trowel apply to clean surface black mastic joint compound to a minimum wet thickness of 1/4 inches immediately prior to mating the surfaces.

D. For horizontal joints that fall below established high groundwater elevation shown, install a resilient O-ring type gasket or pre-molded joint compound.

E. Seal all pipe penetrations in manhole.
1. Form pipe openings smooth and well shaped.
2. After installation, seal cracks with, non shrink grout.
3. After grout cures, wire brush smooth and apply two coats emulsified fibrated asphalt compound to minimum wet thickness of 1/8 inches to ensure complete seal.

F. Set and adjust frame and cover final 6 inches (minimum) to 18 inches (maximum) to match finished pavement or finished grade elevation using precast adjuster rings.

END OF SECTION

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SECTION 33 16 33
HYDROPNEUMATIC TANKS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hydropneumatic tanks:
      a. North Rim TWWTP (TK-8011).
   2. Automatic level control system.
   3. Miscellaneous instruments and valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Works Association (AWWA)
      a. C652-11 Disinfection of Water-Storage Facilities.
   2. American Society of Mechanical Engineers (ASME):
      a. Section VIII, Division 1, Boiler and Pressure Vessel Code.
   3. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   4. National Sanitation Foundation International (NSF):
      a. 612, Drinking Water System Components - Health Effects.
   5. National Fire Protection Association (NFPA):
      a. 70, National Electric Code (NEC).

B. Miscellaneous:
   1. Pressure vessels shall be in accordance with the latest revision of the ASME Code for Unfired Pressure Vessels, Section VIII, Division 1.
   2. The NEC shall be used for all wiring.
   3. All local Plumbing Codes shall be met.
   4. The system and anchorage of the tank shall conform to the building code.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. The control system manufacturer shall provide the following submittals as a minimum:
      a. Show all taps, location of control equipment, supports and other appurtenant devices.
         1) Drawings shall include dimensions and cross sectional views of all equipment showing detail of construction.
      b. Equipment weights and anchor bolt designs.
   3. Instrumentation description sheets verifying controls as specified herein including sight glass, air pressure gage.
      a. Source quality control test reports.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 QUALIFICATIONS

A. The vendor shall be capable of demonstrating technical competence in the design of hydropneumatic tanks with a minimum of ten (10) years of experience.

B. The Contractor shall arrange for personnel representing the tank manufacturer to check the installations and instruct the Contracting Officer's personnel in the proper operation.

C. Tank Supplier: Provide a minimum of five references for a comparable installation.

D. Tank Welders: ASME certified.

1.5 SYSTEM GUARANTEE

A. All work shall be guaranteed for a minimum of two years after Substantial Completion. Guarantee that the performance of the equipment will meet the specified requirements, and that a safe operating system will result.

B. This guarantee will be in the form of a letter supplemented by a field test report showing compliance with these Specifications.

C. The guarantee letter and report shall be submitted to the Contracting Officer and shall be the sole responsibility of the tank supplier.

D. Just before one year after Substantial Completion, assist the Government in performing an inspection and evaluation of the tank and system performance.

E. Be present for this inspection and shall furnish an experienced foreman, rigging, and assistance for the evaluation.

F. If the system does not meet the specified requirements, perform replacement and repairs.

The contractor must coordinate its repair work with a time convenient for the Government.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements.
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.
   2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Charlatte America, (Basis of Design).
   2. Or Equal.

C. Submit request for product substitution in accordance with Specification Section 01 33 23.

2.2 GENERAL REQUIREMENTS

A. The control system shall include a vertical bladder-type hydropneumatic tank.

B. North Rim TWWTP:
   1. The hydropneumatic tank must be designed to match the dynamics of the plumbing fixtures, screen spray demands, and water service to the portable laboratory

C. There shall be no less than 10% reserve water in the tank at the maximum outflow conditions.

2.3 DESIGN AND PERFORMANCE REQUIREMENTS

A. Provide hydropneumatic control system. Major components shall include:
   1. Hydropneumatic Tanks.
   2. Miscellaneous instruments and valves.

B. Hydropneumatic tanks shall be designed to limit pump cycling during expected flow rates in the system.
   1. The tank shall be designed to meet the pressure requirements at the flow rate specified.
   2. Tank performance will be verified by operational field tests at pumping rates defined below for piping system.

C. The manufacturer shall conduct an analysis of the piping system, utilizing the specified data. Results of the analysis shall:
   1. Clearly indicate that the design and size of the tank provided will limit pump cycling
   2. Show that the system will meet the performance guarantees outlined in Article 1.5 SYSTEM GUARANTEE.

D. Design for anchor bolts by supplier. Materials for complete anchor bolt assembly including studs, nuts and washers to be provided by Contractor.

2.4 COMPONENTS

A. Hydropneumatic Tanks:
   1. The tank shall be a vertical, bladder-type vessel suitable for use with potable water.
   2. Tanks shall be constructed of carbon steel for a maximum allowable working pressure of 150 PSIG in accordance with the ASME Section VIII.
      a. Tanks shall be provided with a flanged line connection, two support saddles, lifting lugs, drain, safety relief valve.
   3. Size of the tanks is shown in Drawings.
      a. Each tank shall have a minimum volume of:
         1) North Rim WWTP: 53 GAL.
      b. Each tank shall have a maximum outside diameter of:
         1) North Rim WWTP: 24 IN.
      c. Each tank shall have a maximum outside height of:
         1) North Rim WWTP: 43 IN.
   4. Tank finish system:
      a. All painting and coating shall be completed at the factory. Field painting and coating will not be accepted.
         1) The tank interior shall be painted with an NSF 61 epoxy coating with a uniform layer thickness of no less than 6 mils.
         2) The tank exterior shall be painted with an anti-corrosion polyurethane and shall have a uniform layer with a minimum thickness of 10 mils.
   5. Structural Design and Supports shall include the tank, supports, and anchor bolts shall be designed based by the manufacturer based upon local building codes in addition to the following criteria:
      a. Design for a hydrostatic pressure of 150 PSIA and a factory test pressure of 225 psi with no reactive load permitted through the inlet/outlet piping.
      b. Support tank by THREE support legs. Material of construction shall comply with ASTM A 36 or ASTM A 285, Grade C. Weld the support legs to the tank. Bolted type leg extensions shall be provided to raise the tank height sufficient to clear the attached piping as shown on project plans.

B. Level Indication System:
   1. The purpose of the level indication system is to monitor the water level in the pressure vessel within the designed range depending on the number of pumps in operation and the associated dynamic heads.
   2. Provide an Automatic Level Indication System for water level in the tank that includes the following principal components:

a. Flag-style Magnetic Level Gauge for visual monitoring of tank level. Level gauge shall be furnished with manual isolation valves at the top, at the bottom and for draining the gauge.
   1) Continuous vessel monitoring shall be provided via differential pressure transmitter mounted directly to a 2” side mounted flange on the vessel outlet. Transmitter shall be configured to transmit a 4-20 mA signal corresponding to 0-100% vessel level. Diaphragms and capillary tubing shall be provided for connection to the air side charging connection manifold at the top of the vessel. A 2” flanged stainless steel ball valve shall be supplied for isolation of the transmitter, Apollo standard port or equal. Ball valve provided with bolt kits for mounting.
   2) A 1/2" side mounted theaded connection shall be provided on the vessel outlet for tank drain. Also provided for this function shall be a 1/2” threaded stainless steel ball valve for isolation of the tank drain, Apollo standard port or equal.

2.5 SOURCE QUALITY CONTROL:

A. Hydrostatic test the hydropneumatic tank in accordance with ASME Code for Unfired Pressure Vessels.

B. Submissions shall include Form U-1A "Manufacturers' Data Report for Unfired Pressure Vessels” prepared by the tank manufacturer to certify that the tank was built in accordance with ASME Code Rules for the Construction of Unfired Pressure Vessels and inspected by a certified inspector.
   1. Include copies of this form in the Operation and Maintenance Manual.

2.6 SERVICE CONDITIONS

A. Vessel hydraulic performance conditions and design data shall be as shown below. In the event that the manufacturer’s hydraulic analysis of the system yields varying design requirements, the Contracting Officer’s Represtative should be contacted.
   1.
      a. North Rim TWWTP (TK-8011).Tank Configuration: Vertical.
      b. Minimum Capacity: 53 GAL.
      c. Minimum Operating Pressure: 70 PSIG.
      d. Maximum Operating Pressure: 100 PSIG
      e. Minimum Field Test Pressure: 125 PSIG.
      f. Design Pressure: 150 PSIG.
      g. Factory Hydrostatic Test Pressure 225 PSIG.
      h. Bladder Material: Food Quality Butyl Rubber.
      i. Precharge Pressure Setting: 37.1 PSIG.
      j. Outlet Flange Size: 2 IN.
      k. Outlet Flange Pressure Rating: ANSI Class 150 per ANSI B16.5.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Cast anchor bolts in concrete foundation as embedded items.
   1. Use rigid template for each set of bolts.

B. Furnish and install the tank to include all necessary piping, valves, and other related appurtenances.

C. Tank shall be installed in accordance with manufacturers recommendations.

D. All supports, piping, valves, and related appurtenances shall be provided and installed by the Contractor at no additional cost to the Government

3.2 FIELD QUALITY CONTROL

A. Testing shall be performed by the Contractor in the presence of the Contracting Officer's Representative and a representative of the manufacturer.

B. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by these Specifications.
   2. Supervise any adjustments and installation checks.
   3. Conduct startup of equipment and perform operational checks.
   4. Provide Contracting Officer, through the Contractor, with a written statement that manufacturer's equipment has been installed properly, started up, and is ready for operation by Government's personnel.
   5. Instruct Government's personnel for a minimum of 44 hours at jobsite on operation and maintenance of the piece of equipment.

END OF SECTION

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SECTION 33 31 11
GRAVITY SEWER PIPELINE AND MANHOLE CONSTRUCTION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Installation and testing of sewer pipes, manholes, structures and appurtenances.
   2. Connections to existing sewers.
   3. Coordination and interface with existing facilities and utilities.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 32 91 13 - Finish Grading.
   2. Section 31 23 00 - Earthwork
   3. Section 31 23 33 – Utilities – Trenching and Backfilling
   4. Section 33 05 61 - Concrete Manholes.
   5. Section 33 05 31.11 – Polyvinyl Chloride Gravity Sewer Pipe.
   6. Section 33 05 33.23 – High Density Polyethylene (HDPE) Pipe.

C. Alternates:
   1. The following materials may be used at Contractor's option unless otherwise specified or shown on Drawings:

1.2 REFERENCES

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C1244, Standard Test Method for Concrete Sewer Manholes by the Negative Air Pressure (Vacuum) Test Prior to Backfill.
      b. F1417, Standard Practice for Installation Acceptance of Plastic Non-pressure Sewer Lines Using Low-Pressure Air.
   2. Occupational Safety and Health Administration (OSHA).

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Catalog data sheets for all materials.
      c. Details of all piping system components confirming that the pipe, fittings, and appurtenances conform to the specified requirements.
      d. Manufacturers' written recommendations for material handling, delivery, storage, installation, and minor repair of materials damaged in shipping.
      e. Recommended details for buoyancy restraint and for manhole/pipe connections.
      f. Fabrication and/or layout drawings as specified in individual pipe material specifications.
   2. See individual pipe material specifications for additional required submittals.

B. Informational Submittals: Submit the following:
   1. Submit Test Report of leakage tests results including the following:
      a. Test procedure.
      b. Pipeline segment tested.
      c. Length of pipe tested.
      d. Test pressure.
      e. Test duration
      f. Amount of leakage.
      g. Corrective action, if any.

C. Contract Closeout Information:
   1. Operation and Maintenance Data.

1.4 DELIVERY, STORAGE, AND HANDLING OF PRODUCTS

A. In addition to the requirements specified in this section, see related paragraphs in individual pipe specifications.

B. Deliver, handle and store products in accordance with manufacturer's instructions.

C. Protect pipeline sections stored at the site from damage.

D. Store all products above the ground upon platforms, pallets, skids, or other supports supplied by the Contractor.
   1. Store in a way to permit ready access for identification and inspection by the Contracting Officer.

E. Keep products free from dirt and other foreign matter.

F. Provide suitable quantities of all lifting equipment to handle the pipe.
   1. Do not utilize any equipment that is not rated to handle the intended loading or conditions of use to which it will be subjected, or which will damage or gouge the pipe.
   2. Do not drag or drop pipe.

G. Place pipe lain directly on the ground prior to placement on an area free of loose stones or sharp objects.

H. Repair or replace any new pipe and fittings damaged before or during installation at Contractor’s expense, before proceeding further.
   1. Utilize repairs methods as recommended by the manufacturer.
   2. Replace damaged materials as directed by Government’s project representative.

I. Protect PVC pipe from UV degradation if stored outside for more than 60 days.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Pipe:
   1. See individual pipe material specifications listed in Paragraph 1.1 B above.

B. Manholes: See Specification Section 33 05 61.

C. Fill and Backfill at manholes: See Specification Section 31 23 33.

D. Embedment and Bedding Materials for pipelines: See Section Specification 31 23 33.

E. Size mandrels to meet deflection requirements specified herein or in the individual pipe material specifications.

F. Pipe Joint Testing Equipment:
   1. Utilize joint testing equipment capable of providing sufficient sealing pressure for air bladder to prevent leakage through bladder seals.
   2. Include pressure gage to aid in verification of adequate applied pressure and joints ability to withstand the applied pressure without leaking.
   3. Utilize joint testing equipment that encapsulates the full 360 degrees circumference of the joint and at least 6 inches each side of the joint.
   4. Pipes furnished with an integral "testable" joint, consisting of two gaskets with fittings to pressure test between the two gaskets, will be tested using the test equipment and fittings recommended by the pipe manufacturer.

PART 3 - EXECUTION

3.1 GENERAL REQUIREMENTS

A. Furnish all construction materials and equipment required for installation and backfill.

B. Install the pipeline complete, including bends, stop logs, and other associated work and appurtenances, as shown on the Drawings or as herein specified.

C. Make all necessary connections to sewer lines shown on the Drawings and in accordance with the Specifications.

D. Construct all sewer piping, manholes, and structures to be free of visible ground water inflow.
   1. Install sanitary sewer manholes and structures that are watertight.
      a. Repair or replace any manhole or structure showing infiltration of ground water through joined surfaces, pipe to manhole/structure connections or manhole/structure wall.
   2. Install pipe with water tight pipe joints.
      a. Repair or replace any joint showing infiltration of ground water through pipe joints or pipe to manhole connections.

E. Alignment: Lay gravity sewer lines in straight alignment and uniform grade between manholes.
   1. Install at grade as shown on drawings.

F. Brace and protect pipe sections to prevent deformation during installation and backfill.

G. Deflection: Pipe deflection after final backfill shall not exceed the specified limits detailed in the individual pipe specifications.
   1. Remove and replace any pipe observed to be deflecting in excess of the specified limits.

H. Perform testing in accordance with requirements of this Section.

I. Provide Contracting Officer with free access to work for inspection.
   1. Such inspection shall not relieve the Contractor of his responsibility for performing Work in accordance with the Contract Documents.

3.2 PIPELINE INSTALLATION

A. Lateral shoring of the trench walls or other similar construction methods may be required.
   1. Design and implement all such methods.
   2. When required, install shoring in accordance with all applicable local, State and OSHA regulations.
   3. Remove shoring prior to backfilling.

B. Grade bottoms of trenches such that when bedding is placed between the trench bottom and the pipe, each section of pipe is installed to the specified depth or elevation with uniform support.

C. Determine and fix alignment and grade or elevation of each pipeline from offset stakes or calibrated laser instruments.

D. Install pipelines on the line and grade shown on the drawings.
   1. Calculate required elevation of each pipe joint and survey installed elevation at each joint prior to stabbing the next joint to verify grade.
   2. Relay pipe to proper grade if any joint elevation deviates from the calculation by more than 0.01 feet.

E. Remove material at the bottom of the trench if determined to be unsuitable by the Contracting Officer.
   1. Backfill trench with approved subgrade material or bedding material to the specified depth or elevation as described in Specification Section 31 23 33.

F. Install only clean pipe and fittings.
   1. Provide physical barriers to protect open ends of sections of pipe in place from the entrance of trench water, mud, dirt, or other foreign substances with when pipe installation is not in progress.

G. Begin pipe laying at the lowest elevation with bell ends facing the direction of laying, except when reverse laying is permitted by Contracting Officer.

H. Where the drawings require concrete encasement or flowable fill embedment and backfill, anchor pipe as required to prevent floatation.
   1. Alternatively, Contractor may place concrete or flow fill materials in staged lifts allowing each lift to reach initial set prior to placing the subsequent lift to limit buoyancy effects and prevent floatation of the pipeline.

I. Pipeline may be backfilled as it is installed, provided all inspection and testing requirements are met.

J. Pipe, fittings, and special pieces will be subject to inspection by Contracting Officer, prior to installation.
   1. Report all damages not detected by Contracting Officer but discovered by Contractor during installation to Contracting Officer for corrective action or replacement.

K. Repair of pipe damaged during installation shall conform to the manufacturer's repair procedures; with the concurrence of Contracting Officer.

3.3 RESTORATION

A. Restore all existing structures or services damaged by Contractor's operations at no cost to Government.
   1. Repair or replace culverts that are damaged, removed or interfere with the work as part of restoration at no additional cost to Government.

B. Restore all area disturbed by installation of the pipelined in accordance with the Specifications, the Drawings,
   1. Provide slope protection, re-vegetation, and road restoration as necessary.

C. Driveway Removal and Replacement:
   1. All Portland cement concrete and asphalt noted for removal and replacement shall be cut prior to removal.
      a. Cut by sawing, vertical cut to be 1 inch minimum.
      b. The remaining depth of section may be broken out in a manner subject to Contracting Officer's approval.
      c. Width of section removed to be either a width not greater than the outside diameter of the sewer plus 4 feet-0 inches or broken out to the nearest joint.
   2. Replace Portland cement concrete and asphalt equal to or better than original paving.
   3. Debris resulting from the above operations shall be removed and disposed offsite.
   4. Include driveway removal and replacement in cost of the bid unit price of the sewer pipe.

D. Gravel Surfaced Drives and Roadways:
   1. Restore all damaged gravel surfaced drives and roadways to a condition equal to or better than original.
   2. Replace using ADOT Class 2 ABC

E. Trees:
   1. Do not remove trees without written instructions from the Contracting Officer unless tree removal is shown on drawings.

F. Fences, Signs, Mailboxes, etc.:
   1. Restore all damaged fences, signs, mailboxes, etc., to their original conditions.
      a. No separate payment will be made for these items.

3.4 PROTECTION OF EXISTING UTILITIES

A. Verify the location of all underground utilities.
   1. Omission from, or the inclusion of utility locations on the plans is not to be considered as the nonexistence of or a definite location of existing underground utilities.

B. Notify utility representative prior to construction to obtain available information on location of existing utilities.
   1. Contractor shall be responsible for locating all utilities.

C. Notify representative of the underground utilities 72 hours in advance of crossings.

D. Existing water services and sewer services:
   1. Repair damage to existing water service using copper pipe and union the same size as existing service.

3.5 FIELD QUALITY CONTROL

A. General Testing Requirements:
   1. Furnish necessary personnel, materials, and equipment, including bulkheads, restraints, anchors, temporary connections, pumps, water, pressure gauges, and other means and facilities required to perform tests.
   2. Obtain Contracting Officer's approval of methods and the equipment used for the tests prior to testing.
   3. Provide reasonable facilities and access for Contracting Officer to inspect, test and obtain such information as required with respect to the materials used and the progress and condition of the Work and the results obtained.
      a. Work that is not performed in accordance with the procedure or does not comply with the requirements of the Specifications will be rejected.
   4. Coordinate testing schedules with Contracting Officer.
      a. Perform all specified tests under observation of Contracting Officer.
      b. Provide a minimum of 24 hours advance notice prior to commencing any testing.
   5. Perform testing as work progresses and as required to facilitate connections with existing sewers.
   6. Obtain water for testing and cleaning at no additional cost to the Government.
   7. Test only those portions of pipes that have been installed as part of this Contract.
      a. Test new pipe sections prior to making final connections to existing piping.
      b. Furnish and install plugs, bulkheads, and restraints required to isolate new pipe sections.
   8. Unsuccessful Tests:
      a. Where tests are not successful, correct defects or remove defective piping and appurtenances and install piping and appurtenances that comply with the specified requirements.
      b. Repeat testing until tests are successful at no additional cost to Government.
   9. Deflection:
      a. Check each section of pipe after backfilling for deflection by pulling a mandrel through the pipe.
      b. Conduct test after the final backfill has been in place at least 30 days.
      c. Maximum long term deflection: less than 5% of the initial diameter.

B. Low Pressure Air Testing:
   1. Test all gravity sewer pipes up to 30-inch diameter with a low pressure air test.
      a. Comply with ASTM F1417.
      b. Time elapsed for a 1 psi drop in air pressure: Per ASTM F1417.
      c. Maximum air loss: Per ASTM F1417.
   2. Submit schedule to Contracting Officer for approval prior to starting the tests.
   3. Conduct air test after the final backfill has been in place for a minimum of 30 days.
   4. Correct pipes failing air test and conduct second test after final backfill has been in place an additional 30 days.
   5. If the length of sewer to be tested is fully or partially submerged in groundwater, increase test pressure as necessary to overcome the actual static pressure exerted by the groundwater.
      a. If a test pressure greater than 8 psi results, utilize water infiltration testing in lieu of air testing.
   6. Locate leaks by testing short sections of pipe.

a. Repair leaks and retest affected reach of sewer.

C. Deflection Testing: Test all flexible sewer pipes for deflection.
   1. Perform the mandrel test with the Contracting Officer in observance for all pipe sizes.
   2. Deflection limits: as indicated in the individual pipe sections or as specified in article titled "General Testing Requirements" above, whichever is more stringent.
   3. Conduct test after the final backfill has been in place at least 30 days.
   4. Correct pipes failing deflection test and conduct second test after final backfill has been in place an additional 30 days.

D. Joint Testing:
   1. Test all sewer pipe joints for pipe diameters 36 inches and greater.
   2. Conduct test after final backfill has been in place for at least 30 days.
   3. Supply pressure gages of type, calibration, accuracy acceptable to the Contracting Officer.
      a. Contracting Officer may request certification of the gages by a reliable testing firm and may compare these gages with an Government's gage at any time.
   4. Repair or replace pipe joints that do not pass joint test and retest.
      a. Conduct retests after repairs have been made and final backfill has been in place for 30 days.
   5. Test procedure:
      a. Center joint tester over joint to be tested and inflate seals.
      b. Apply 3.5 psiG pressure to joint and allow pressure to stabilize.
      c. If the pressure holds or drops less than 1 psi in 30 seconds, joint is acceptable.
   6. When pipe materials are provided with a "testable joint", cap testing tube securely with a plug at testing port following successful completion of joint test and acceptance by Contracting Officer.

E. Manhole Testing:
   1. Vacuum test all manholes per ASTM C1244 for leakage after installation, before epoxy lining is placed, and prior to being backfilled.
   2. Visually inspect all manholes for leaks and defects prior to vacuum testing.
   3. Repair all leaks, defects or cracks discovered by visual inspection prior to vacuum testing.
   4. Seal all pipes entering manholes at a point outside the manhole walls so as to include testing of the pipe/manhole joints.
   5. Make all necessary repairs and retest the manhole.
      a. Inspect exterior of the manhole during this period for visible evidence of leakage.
      b. All repairs will be subject to acceptance by the Contracting Officer.

END OF SECTION

SECTION 33 32 13
PACKAGE SEWAGE PUMPING STATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Package sewage pumping station, structural components, process equipment, piping, valves, HVAC, electrical and control components, and appurtenant items.
   2. Wetwell is Class 1, Div 1 per NFPA 820. All instrumentation and equipment within and adjacent to wetwell shall be intrinsically safe.

B. Related Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment – Basic Requirements.
   2. Section 01 81 33 - Cyber Security Requirements.
   3. Section 05 50 00 - Metal Fabrications.
   4. Section 09 96 00 - High Performance Industrial Coatings.
   5. Section 26 05 00 – Common Work Results for Electrical.
   6. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
   7. Section 26 24 19 – Motor Control Equipment.
   8. Section 26 29 23 – Variable Frequency Drives – Low Voltage.
   9. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements.
   10. Section 40 05 07 - Pipe Support Systems.
   11. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   12. Section 40 05 62 - Plug Valves.
   13. Section 40 05 66 - Check Valves.
   14. Section 40 61 13 – Process Control System General Requirements.
   15. Section 40 63 43 – Programmable Logic Controllers.
   16. Section 40 66 05 – Network Equipment
   17. Section 40 67 00 – Control System Equipment Panels and Racks.
   18. Section 40 67 63 – Uninterruptible Power Supply
   19. Section 40 68 63 – Configuration of HMI Software and Reports
   20. Section 40 78 00 – Panel Mounted Instruments

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American National Standards Institute (ANSI).
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A48, Standard
   4. American Welding Society (AWS):
      a. A5.1/A5.1M, Specification for Carbon Steel Electrodes for Shielded Metal Arc Welding.
      b. D1.1, Structural Welding Code - Steel.
   5. FM Global (FM).
   6. Hydraulic Institute (HI):
      a. Standards for Centrifugal, Rotary, and Reciprocating Pumps.
   7. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 6, Industrial Control and Systems Enclosures.
   8. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC):
         1) 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

b. 820, Standard for Fire Protection in Wastewater Treatment and Collection Facilities.
9. Occupational Safety and Health Administration (OSHA).
10. Underwriters Laboratories, Inc. (UL):
    a. 62, Flexible Cord and Fixture Wire.

B. Qualifications:
1. Manufacturer shall be regularly engaged in the manufacture of packaged sewage pumping stations for not less than five years.
2. Structural design of the pumping station shall be accomplished by a structural engineer registered in the State of Arizona.

C. Single Source Responsibility:
1. Provide single source responsibility for all station components and systems through supplier of package pump station.

1.3 SYSTEM DESCRIPTION

A. Influent Lift Station

B. Filtrate Lift Station

1.4 SUBMITTALS

A. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.

B. Shop Drawings:
1. See Section 01 33 23.
2. Requirements in Section 01 61 03.
3. Requirements in Section 26 29 23.
4. Requirements in Section 43 21 00.
5. Scaled (1/4 IN = 1 FT minimum) fabrication and/or layout drawings showing all equipment piping, mechanical, and electrical components.
6. Submit Shop Drawing for station and all mechanical, electrical, and instrumentation components, complete, in single, coordinated submittal.
    a. Provide separate tabs for each major section of work being provided.
    b. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70. Include any required calculations per Section 01 61 03.
7. Certifications:
    a. Provide Contracting Officer with a written certification that station has been installed properly and started up and is ready for operation by Contracting Officer's personnel.
    b. Factory checkout certification for all systems in lift station.

C. Operation and Maintenance Manuals:
1. See Section 01 78 23 for requirements for:
    a. The mechanics and administration of the submittal process.
    b. The content of Operation and Maintenance Manuals.

D. Project Information:
1. Executed Manufacturer’s Installation Certification Form.

1.5 SHIPPING

A. Per Section 01 61 03.

1.6 WARRANTY

A. Provide Government with manufacturer's warranty guaranteeing pumping station to be free from defects for 2 year(s) from date of Contracting Officer issuance of substantial completion letter.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.
   2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.
   3. Manufacturer shall be responsible for a packaged lift station that includes, but is not limited to, pumps, rails, valves, base supports, guides, control panel, control panel supports, and appurtenant work.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Flygt (Basis of Design).
   2. Or Equal.

C. Submit request for product substitution in accordance with Specification Section 01 33 23.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Influent Lift Station:
   1. Primary design point with one pump in operation: 144 GPM at 32 FT TDH, full speed.
   2. Minimum shutoff head condition: 1 FT above bottom of pump.
   3. Efficiency at primary design point: 43% minimum
   4. NPSHr: 13 FT maximum
   5. Minimum speed: 1750 rpm
   6. Minimum driver horsepower: 4 HP
   7. Voltage: 460 V, 3-Phase
   8. Discharge Flange size: 3 IN
   9. Type: Submersible Solids Handling
      a. Max solids size: 1 ½ inch
   10. Type: submersible, constant speed.
   11. Submersible pressure transducer for primary level control
   12. Float backup level control
      a. Field adjustable
      b. Setpoint elevations: see drawings
   13. Single Pump Maximum Starts per Hour: 5
   14. Wetwell:
      a. Type: Fiberglass Reinforced Plastic (FRP).
      b. Dimensions: See drawings.
   15. Valve Vault:
      a. Type: Fiberglass Reinforced Plastic (FRP).
      b. Dimensions: See drawings.

B. Filtrate Lift Station:
   1. Primary design point with one pump in operation: 100 gpm at 10 FT TDH, full speed.
   2. Minimum speed: 1750 rpm
   3. Minimum driver horsepower: 2 HP
   4. Voltage: 460 V, 3-Phase
   5. Discharge Flange size: 1-1/2 IN
   6. Type: Submersible Solids Handling Pumps.
   7. Type: submersible, variable speed.
   8. Submersible pressure transducer for primary level control

9. Float backup level control
    a. Setpoint elevations: see drawings
10. Single Pump Maximum Starts per Hour: 5
11. Wetwell:
    a. Type: Fiberglass Reinforced Plastic (FRP).
    b. Dimensions: See drawings.
12. Valve Vault:
    a. Type: Fiberglass Reinforced Plastic (FRP).
    b. Dimensions: See drawings.

2.3 MATERIALS

A. See referenced Specification Sections for materials of construction for station components not defined in this Specification Section.

B. General:
1. Packaged system including pumps, rails, supports, floats, local free-standing pump control panel (mounted).
    a. All hardware including, but not limited to rails, supports, fasteners, lifting chain, stem guide, rail, and appurtenances shall be type 316 stainless steel
2. Contractor to provide two (2), one-hundred (100) feet hoses and spray nozzles for each lift station hose bib

C. Anchor Bolts, Nuts and Washers: 316 stainless steel.

D. Submersible pressure level transducer:
1. Probe: 316 SS, Viton, Titanium.
2. Cable: Hytrel, FEP, HDPE.

E. Float Switches and Switch Support:
1. Floats: Polypropylene or Teflon coated 316 stainless steel.
2. Cable jacket: PVC or neoprene.
3. Cable clamp: Polypropylene or 316 stainless steel.
4. Float support: 316 stainless steel pipe and anchor hardware.

F. Conduits: PVC-RGS.

G. Pumps:
1. Service:
    a. Influent Lift Station: Screened Raw Sewage
    b. Filtrate Lift Station: Drying Bed Filtrate
2. Type: Submersible
3. Number per Lift Station: 1 duty, 1 standby (two total)
    a. Provide one spare pump for each lift station to be stored in the material storage container.
4. Case: Cast iron, ASTM A48, Class 35.
5. Motor housing: Cast iron, ASTM A48, Class 25 or Class 30.
6. Impeller: Hard-Iron.
7. Shaft: Stainless Steel, Series 300 or 400.
8. Suction cover: Cast Iron, ASTM A-532 Class III, Type A.
9. O-rings: Nitrile (Buna-N) or fluorocarbon (Viton).
10. Fasteners: Type 316

H. Electrical and Control Systems:
   1. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
   2. Refer to Division 26 for additional Electrical Requirements.
   3. Manufacturer to provide electrical service entrance and grounding.
   4. Manufacturer provided panels to have NEMA 4X rating.
   5. Power distribution:
      a. Wiring: Copper conductor with type XHHW insulation.
      b. Starters: Combination magnetic type with MCP type circuit breaker disconnect, NEMA full size rated with ambient compensated thermal type overload relay with external reset button and oversized control power transformer.
      c. Main Service disconnect for station: Thermal magnetic circuit breaker sized and located per NFPA 70.
      d. Install wiring in accordance with NFPA 70, NEMA and applicable local codes.
      e. Provide selectively polarized, grounded convenience outlets located close to equipment having plug-in power connection such as sump pump and dehumidifier.
      f. Provide short conduit leads of flexible, liquid-tight polyvinyl covered steel with compatible grounding fittings between the fixed conduit and mechanical equipment requiring power.
      g. Install all wiring outside of control panels in conduit except for 115 V items which are provided with power cords for receptacle power.
      h. Include conduit seals for all conduits from control panels to the wetwells.
      i. Furnish thermal magnetic circuit breakers for branch disconnect service, over current protection of all motor controls and all auxiliary circuits.
         1) Label switches using phenolic nameplates.
      j. Size electrical distribution system for (2) 3 HP pumps for the Filtrate Lift station and (2) 4 HP pumps for the Influent Lift Station..
   6. Control components:
      a. Pump control panel:
         1) Prefabricated steel enclosure for the Lift Stations
         2) Prefabricated steel free-standing panel provided by pump manufacturer
            a) Coordinate installation location with
         3) Provide panel with NEMA 4X rating.
         4) Phenolic nameplate for each panel face component.
         5) Operator devices to be heavy duty oil tight design.
         6) Push buttons and selector switches to have NEMA A600 rated contacts.
         7) Indicating lights to be push-to-test type.
            a) Provide green lens for on or running, red for off or stopped and amber for alarm.
         8) Utilize plastic sleeve type wire markers to identify all wires.
            a) Identify circuit numbers, function and polarity.
         9) Panel face mounted components:
            a) HAND/OFF/AUTO switch for each wastewater pump.
            b) Status indicating light for each pump.
            c) Alarm status lights for high and low level in wet well.
            d) Six-digit non-resettable running time indicator for each wastewater pump.
            e) Station flooding alarm and alarm reset switch.
         10) Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes. See Section 01 61 03 for information on how to determine the available fault current, such that the SCCR rating meets or exceeds the available fault current.
         11) Install alarm horn and beacon in control panel. See Specification 40 78 00 – Panel Mounted Instruments for requirements.
      b. Submersible Level Transducer - Primary:
         1) Manufacturers:

a) Endress Hauser
b) Or Equal.

2) Mounted, wired, and calibrated at factory.
3) Measurement Principle: Differential-pressure (hydrostatic) based on the height of the liquid head with the use of an integrated strain gauge or Ceramic Capacitive Sensor (CCS).
   a) Open (to atmosphere) or Closed Tanks.
   b) Fully submersible.
   c) Vented cable.
4) Minimum/Maximum span: 1 to 100 psig (2.31 to 230.67 feet).
5) Accuracy: ±0.25% of span.
6) Process Connection: None: Mount vertically at the bottom of the tank.
7) Electrical:
   a) Signal Power: Loop-powered, 2-wire, 24 VDC.
   b) Current Output: Analog 4-20 mA into a 600 ohm loop.
   c) Cable Entry: ¼ inches NPT connection to attached jacketed cable.
8) Materials of construction designed to withstand continuous operation within domestic wastewater sewage service.
9) Number: 1 level instrument in the wetwell.

c. Float control system - Secondary:
   1) Minimum of 2 field adjustable floats in wet well for wastewater pump control.
   2) See Drawings for float function and respective elevation.
   3) Materials:
      a) Float material: Polypropylene or Teflon coated type 316 stainless steel.
      b) Cable jacket: PVC, neoprene.
      c) Cable clamp: Polypropylene or 316 stainless steel.
   4) Mercury-free switch.
   5) Level switches:
      a) Tilt type – actuates on rising level.
      b) Provided complete with flexible electrical cable length required for application.
      c) Contact rated at 4.5 A at 120 VAC.
      d) 1 inch diameter stainless steel support pipe connected to wet well wall using stainless steel mounting brackets and hardware.

d. Equipment Control Loops:
   1) Lead pump will turn on when lead pump on-setpoint is activated. Lead pump will turn off when pump off-setpoint is activated.
   2) Alternate lead and standby pumps.
      a) After the lead pump turns off, the next cycle will use the standby pump as the lead pump and turn on when the setpoint is activated
   3) If the lead pump fails to start or run, the standby pump shall turn on.

I. Lift Station Wetwell:
   1. FRP laminate on tank shell
   2. Hand layup structural laminate outside of tank shell
   3. Surface of the liner exposed to the corrosive medium shall be resin rich reinforced with a “C” grade surfacing veil.
   4. Veil shall be saturated with white pigmented resin or an ISO-NPG white gelcoat.
      a. Minimum .01-inch thickness.
   5. Liner behind the surfacing veil shall have a minimum thickness of .10" and shall be reinforced with not less than 20% and not more than 30% by weight of non-continuous chopped strand mat.
   6. Inside surface is to be a smooth molded surface with a bright white finish.
   7. Corrosion liner shall be free of air and voids for optimum corrosion resistance.

J. Valve Vault:

1. Separate square structure shall be laminated to the side of the wet well to house valves in a separate chamber integrally attached to the wet well cylinder.
2. Match materials of construction to wet well.
3. Provide supports as required to additionally secure the weight of the valve chamber against the cylinder wall to maintain a 4:1 safety factor.
4. Vault shall include isolation and check valves.
5. Include a header with a single outlet for connection to the force main.
6. Provide drain line with a non-return valve shall be installed at the factory to permit water to flow back into the wet well.

K. Pump Discharge Piping:
1. All piping shall be made of either schedule 10 stainless steel or schedule 80 PVC.
2. Guide rails to be schedule 40 stainless steel.
3. The riser from each pump shall exit the lift station wall independently to enter a separate valve vault.
4. All flanges shall be full and flat face type and have ANSI B16.1, class 125 drilling.

L. Miscellaneous:
1. Anchor bolts:
   a. Size and number to be determined by station manufacturer.
   b. Sized to resist uplift on station due to hydrostatic forces.
2. Panel mounted Alarm beacon:
   a. Rotating sealed beam incandescent type.
   b. 200 W, 120 VAC.
   c. Metal globe guard enclosing red lens.
   d. UL listed for outdoor use.

2.4 ACCESSORIES

A. Controls:
1. See Electrical and Instrument and Controls Designs for controls requirements.
2. Provide instrumentation and controls:
   a. Provide submersible level transducer for primary level control
   b. Provide floats for secondary level control. Provide four sealed float-type switches to control pumps and provide alarm signal.
      1) Seal switches in a solid polypropylene float.
      2) Provide float with large radius top at electrical cable connection to assure trouble-free operation.
      3) Suspend floats on their own cable.
      4) Provide floats to operate at elevation shown on Drawings.
      5) Design floats to be field-adjustable.
      6) Four floats for secondary level control and alarms:
         a) One for low low level alarm
         b) One for low level shutoff
         c) One for high level lead pump start
         d) One for high-high level alarm
         e) Provide an intrinsically safe relay for each level control circuit to reduce the energy in the circuit to the point that no spark is created by switching.
   c. Control Panel:
      1) Pump supplier to provide locally mounted control panel at location shown on drawings and rated NEMA 4X.
      2) Control panel shall be labeled by an approved organization such as UL or ETL
      3) Include a terminal board for connection of level sensors.
      4) Provide the following features:
         a) NEMA 4X stainless steel watertight enclosure with continuous hinge, neoprene gasket in cover and continuous seam weld.
            (1) Include locking mechanism complete with padlock.

b) Thermal-magnetic main circuit breaker with external operating handle.
c) Hand-Off-Automatic selector switches.
d) Automatic alternator.
e) High level alarm with alarm horn, silence pushbutton, and alarm light.
f) Low level alarm.
g) Pump running lights.
   (1) See Section 26 24 19 for running light colors.
h) Elapsed time meters.
i) Overload reset button to reset overload relays.
j) Pump sequence selector switch which overrides automatic alternator.
k) Transient Voltage Surge Suppression (TVSS):
l) UL 1449 listed.
m) Maximum lead length 6 IN.
n) Condensation heater.
o) Moisture detector alarm light.
p) Motor over-temperature alarm and shutdown.
q) 120 V, 20 amp duplex outlet.
r) Float switch test pushbuttons.
s) Auxiliary contacts wired to terminal blocks.
t) Power ON control relay.
u) Remote telemetering contact.
v) Remote alarm upon power failure.
w) Normal emergency power transfer switch.
x) Inner door in cabinet-mounted on a continuous vertical steel hinge; size to completely cover wiring and components mounted on the back panel.
   (1) provide for mounting of controls and instruments on inner door.
   (2) Wall mounting.
y) Main service disconnect switch

B. Access Covers:
   1. Furnish and install single or double hinged cover constructed of aluminum or stainless steel.
   2. Furnish size adequate to install and remove pumps.
   3. Equip with non-sparking upper guide rail support, float bracket, and flush locking mechanism.
   4. Cover shall be able to remain in open position while work is being performed.
   5. Securely place frame above pump(s).
   6. Provide covers of skidproof design.
   7. Provide covers with snap locks and removable handle.
   8. Provide cover hardware including latching mechanism and hinges of stainless steel materials.
   9. Provide covers with integral fall protection.

C. Pipe Connections:
   1. Contractor to coordinate with Manufacturer on allowable locations for link seal penetrations based on drawings and field conditions.
   2. Manufacturer to provide Contractor with standard instructions on typical link seal penetration detail.

D. Valves:
   1. Check Valves:
      a. Provide non-clog ball type check valve.
      b. Hollow steel covered with nitrile rubber resistant to grease, animal and vegetable fats, diluted concentrations of acids and alkaline (pH 4 to 10), tearing and abrasion.
      c. Ball should be guided to and from the seat by guide vanes cast in the housing.
      d. Ball shall clear the water by providing “full flow” equal to nominal size.
      e. There shall be only one moving part (the ball) and no outside levers, weights, springs, dash pots or other accessories are required.

f. Material: grey cast iron, class 35.
g. Painted with a black coal tar epoxy.
h. Flange drilling shall be according to ANSI- B16.1, Class 125.
i. Flygt-HDL type 5087.

2. Plug Valves:
a. Provide round port eccentric plug type, plug valve.
b. Material: ASTM - A126 Class B Cast Iron, lever operated.
c. Provide resilient nitrile rubber coating, wear and corrosion resistant.
d. Flange drilling shall be according to ANSI B 16.1, Class 125.

2.5 SOURCE QUALITY CONTROL

A. Testing:
1. All components of pump station shall be given an operational test at factory to check for excessive vibration, for leaks in piping or seals, and for correct operation of automatic control system and auxiliary equipment.
a. Correct all deficiencies.
2. Couple pump suction and discharge lines to a reservoir and have the pumps recirculate water for at least 1 hour under simulated service conditions.
3. Adjust automatic control to start and stop pumps at approximate levels required by job conditions.

2.6 MAINTENANCE MATERIALS

A. See individual equipment Specification Sections.

B. Touch up kit for coating field welds and for repair of scratches.

C. Extra Materials:
1. Furnish Owner the following extra parts for each pump service category:
a. 1 spare pump per lift station.
b. 1 spare set level switches

PART 3 - EXECUTION

3.1 INSTALLATION

A. For wet pit pumps, permanently install discharge connection elbow in wet well along with discharge piping.

B. Seal pump cable end with a high quality protective covering, to make it impervious to moisture or water seepage prior to electrical installation.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of authorized Manufacturer's field service representative to:
1. Inspect equipment to be installed under these Specifications
2. Supervise any adjustments and perform modifications a necessary.
3. Conduct startup of equipment.

B. See Section 01 79 00 for system demonstration and Operator Training requirements.

C. See Section 43 21 00.

3.3 CLOSEOUT ACTIVITIES

A. Refer to Section 01 81 33 – Cyber-Security Requirements for cyber security related closeout requirements.

END OF SECTION

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SECTION 40 05 00
PIPE AND PIPE FITTINGS - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Process piping systems for “interior” piping at North Rim Temporary WWTP.

B. See Division 33 for all “buried” piping specifications including water transmission, distribution piping, yard piping, and sewer.

C. Related Specification Sections include but are not necessarily limited to:
   1. Section 31 23 33 – Utilities – Trenching and Backfilling
   2. Section 40 05 07 – Pipe Support Systems.
   3. Section 40 05 31 – Pipe - Plastic.
   4. Section 40 05 51 – Common Requirements for Process and Utility Valves.
   5. Section 40 42 00 – Pipe, Duct and Equipment Insulation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Association of State Highway and Transportation Officials (AASHTO):
      a. M36, Corrugated Steel Pipe, Metallic-Coated, for Sewers and Drains (Equivalent ASTM A760).
      b. M190, Standard Specification for Bituminous Coated Corrugated Metal Culvert Pipe and Pipe Arches.
      c. M252, Standard Specification for Corrugated Polyethylene Drainage Tubing.
      d. M278, Standard Specification for Class PS 46 Polyvinyl Chloride (PVC) Pipe.
      e. M294, Interim Specification for Corrugated Polyethylene Pipe 12 to 24 Inch Diameter.
   2. American Iron and Steel Institute (AISI).
   3. American Society of Mechanical Engineers (ASME):
      a. B16.3, Malleable Iron Threaded Fittings.
      b. B16.5, Pipe Flanges and Flanged Fittings.
      c. B16.9, Factory-Made Wrought Steel Butt-Welding Fittings.
      d. B16.22, Wrought Copper and Bronze Solder - Joint Pressure Fittings.
      e. B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
      f. B36.19, Stainless Steel Pipe.
      g. B40.100, Pressure Gauges and Gauge Attachments.
   4. ASTM International (ASTM):
      a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. A74, Standard Specification for Cast Iron Soil Pipe and Fittings.
      c. A106, Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service.
      d. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      e. A182, Standard Specification for Forged or Rolled Alloy-Steel Pipe Flanges, Forged Fittings, and Valves and Parts for High-Temperature Service.
      f. A197, Standard Specification for Cupola Malleable Iron.
      g. A234, Standard Specification for Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service.
      h. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.

i. A312, Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
j. A518, Standard Specification for Corrosion-Resistant High-Silicon Iron Castings.
k. A536, Standard Specification for Ductile Iron Castings.
l. A587, Standard Specification for Electric-Resistance-Welded Low-Carbon Steel Pipe for the Chemical Industry.
m. A760, Standard Specification for Corrugated Steel Pipe, Metallic-Coated for Sewers and Drains.
n. A774, Standard Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
o. A778, Standard Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
p. B88, Standard Specification for Seamless Copper Water Tube.
q. C14, Standard Specification for Concrete Sewer, Storm Drain, and Culvert Pipe.
r. C76, Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe.
s. C425, Standard Specification for Compression Joints for Vitrified Clay Pipe and Fittings.
t. C443, Standard Specification for Joints for Concrete Pipe and Manholes, Using Rubber Gaskets.
u. C564, Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings.
v. C700, Standard Specification for Vitrified Clay Pipe, Extra Strength, Standard Strength and Perforated.
w. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
x. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
y. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
z. D2513, Standard Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
aa. D2683, Standard Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
bb. D3261, Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
cc. D4101, Standard Specification for Polypropylene Plastic Injection and Extrusion Materials.
dd. F439, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
ee. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.

5. American Water Works Association (AWWA):
   a. B300, Standard for Hypochlorites.
   b. C200, Standard for Steel Water Pipe - 6 IN and Larger.
   c. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 IN through 144 IN.
   d. C208, Standard for Dimensions for Fabricated Steel Water Pipe Fittings.
   e. C606, Standard for Grooved and Shouldered Joints.
   f. C651, Standard for Disinfecting Water Mains.
   g. C800, Standard for Underground Service Line Valves and Fittings.
6. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C110/A21.10, Standard for Ductile-Iron and Gray-Iron Fittings.
   b. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.

c. C115/A21.15, Standard for Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
d. C151/A21.51, Standard for Ductile-Iron Pipe, Centrifugally Cast, for Water.
e. C153/A21.53, Standard for Ductile-Iron Compact Fittings for Water Service.

7. Chlorine Institute, Inc. (CI):
   a. Pamphlet 6, Piping Systems for Dry Chlorine.
8. Cast Iron Soil Pipe Institute (CISPI):
   a. 301, Standard Specification for Hubless Cast Iron Soil Pipe and Fittings for Sanitary and Storm Drain, Waste, and Vent Piping Applications.
9. International Plumbing Code (IPC).
10. National Fire Protection Association (NFPA):
    a. 54, National Fuel Gas Code.
    b. 69, Standard on Explosion Prevention Systems.
11. Underwriters Laboratories, Inc. (UL).

B. Coordinate flange dimensions and drillings between piping, valves, and equipment.

1.3 DEFINITIONS

A. Hazardous Gas Systems: Chlorine gas, sulfur dioxide gas, carbon dioxide gas, lab gases.

B. HPIC: High performance industrial coating.

C. PVDF: Polyvinylidene fluoride.

1.4 SUBMITTALS

A. Shop Drawings:
1. See specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
2. Product technical data including:
   a. Acknowledgement that products submitted meet requirements of standards referenced.
   b. Copies of manufacturer's written directions regarding material handling, delivery, storage and installation.
   c. Separate schedule sheet for each piping system showing compliance of all system components.
      1) Attach technical product data on gaskets, pipe, fittings, and other components.
3. Fabrication and/or Layout Drawings:
   a. Interior piping drawings (minimum scale 1/8 IN equals 1 FT) with information including:
      1) Dimensions of piping from column lines or wall surfaces.
      2) Centerline dimensions of piping.
      3) Centerline elevation and size of intersecting ductwork, conduit/conduit racks, or other potential interferences requiring coordination.
      4) Location and type of pipe supports and anchors.
      5) Locations of valves and valve actuator type.
      6) Details of fittings, tapping locations, equipment connections, flexible expansion joints, connections to equipment, and related appurtenances.
      7) Acknowledgement of valve, equipment and instrument tag numbers.
      8) Provisions for expansion and contraction.
      9) Line slopes and air release vents.
      10) Rough-in data for plumbing fixtures.
   b. Schedule of interconnections to existing piping and method of connection.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
   a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:

1. Qualifications of lab performing disinfection analysis on water systems.
2. Test reports:
    a. Copies of pressure test results on all piping systems.
    b. Reports defining results of dielectric testing and corrective action taken.
    c. Disinfection test report.
    d. Notification of time and date of piping pressure tests.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect pipe coating during handling using methods recommended by manufacturer.
    1. Use of bare cables, chains, hooks, metal bars or narrow skids in contact with coated pipe is not permitted.

B. Prevent damage to pipe during transit.
    1. Repair abrasions, scars, and blemishes.
    2. If repair of satisfactory quality cannot be achieved, replace damaged material immediately.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements
    1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable if not specified in the individual pipe specifications in Division 40:
    1. Insulating unions:
        a. "Dielectric" by Epco.
        b. Or equal.
    2. Dirt strainers (Y type):
        a. Mueller (#351).
        b. Or equal.
    3. Chemical strainers (Y type):
        a. Chemtrol.
        b. Or equal.
    4. Dry disconnect couplings:
        a. Kamlock.
        b. Or equal.
    5. Dielectric flange kit:
        a. PSI.
        b. Or equal.
    6. Pipe saddles (for gage installation):
        a. Dresser Style 91 (steel and ductile iron systems).
        b. Dresser Style 194 (nonmetallic systems).
        c. Or equal.
    7. Flexible Expansion joints:
        a. Mercer.
        b. Or equal.
    8. Flexible Braided Connector:
        a. Flexicraft
        b. Or equal
    9. Dismantling Joint:
        a. Romac DJ400.

b. Or equal.

10. Wide Range Couplings and Alpha Restrained Joint Couplings:
    a. Romac Alpha.
    b. Or equal.

2.2 PIPE SCHEDULES

A. Piping system materials, fittings and appurtenances are subject to requirements of specific pipe schedules located in the Contract Drawings.

2.3 COMPONENTS AND ACCESSORIES

A. Flanges: See individual piping specifications.

B. Gaskets: See individual piping specifications.

C. Nuts, Bolts, Washers:
1. Nuts: ASTM A194, Grade 2H.
2. Bolts: ASTM A193, B7.
3. Washers: ASTM F436.
4. Coating: Paint.
5. Torque: Per manufacturer's recommendations.
    a. Do not torque bolts to specification more than 2 times.
    b. Provide new bolts if more than 2 torque events occur on the same bolts.
6. Project bolts ¼" to ½" beyond nuts.

D. Insulating Components:
1. Dielectric flange kits:
    a. Flat faced.
    b. 1/8 IN thick dielectric gasket, phenolic, non-asbestos.
    c. Suitable for 175 PSI, 210 DEG F.
    d. 1/32 IN wall thickness bolt sleeves.
    e. 1/8 IN thick phenolic insulating washers.
2. Dielectric unions:
    a. Screwed end connections.
    b. Rated at 175 PSI, 210 DEG F.
    c. Provide dielectric gaskets suitable for continuous operation at union rated temperature and pressure.

E. Dirt Strainers:
1. Y-type.
2. Composition bronze.
3. Rated for test pressure and temperature of pipe in which they are installed.
4. 20 mesh Monel screen.
5. Threaded bronze plug in the blowoff outlet.
6. Threaded NPT end connections.

F. Strainers for Chemical Applications:
1. Y-type.
2. Strainers of same material, test pressure, and temperature rating as system in which strainer is placed.

G. Reducers:
1. Furnish appropriate size reducers and reducing fittings to mate pipe to equipment connections.
2. Connection size requirements may change from those shown on Drawings depending on equipment furnished. Additional costs due to connection size changes will be responsibility of Contractor.

H. Protective Coating and Lining:

1. Include pipe, fittings, and appurtenances where coatings, linings, coating, tests and other items are specified.
2. Field coat pipe in accordance with Specification Section 09 96 00.

I. Underground Warning Tape:
1. See Specification Section 10 14 00.

J. Pressure Gages:
1. See Specification Section 01 61 03.

K. Dry Disconnect Couplings:
1. Adapters:
   a. Male adapters: Size shown on Drawings.
   b. Adapters:
      1) Female NPT end connection for sludge and flush applications.
      2) Male NPT end connection for chemical applications.
   c. Construct adapters for sludge applications from cast iron or steel.
   d. Construct adapters for chemical and PVC system applications 3 IN and below from polypropylene.
      1) Above 3 IN size, provide stainless steel units.
2. Couplers:
   a. Built-in valve and spring loaded poppet which close automatically when disconnected.
   b. Designed to remain with only one arm locked in closed position.
   c. Construct couplers for sludge applications fabricated from material utilized for adapters.
   d. Construct couplers for chemical and PVC system applications 3 IN and less from polypropylene with stainless steel arms and pins.
      1) Above 3 IN, provide stainless steel units.
   e. Gasket: Compatible with conveyed liquid.
3. Dust caps: For all adapters.

L. Sacrificial Anode Cathodic Protection:
1. 3 LB magnesium sacrificial anodes, prepackaged in a cloth bag containing 75% hydrated gypsum, 20% bentonite and 5% anhydrous sodium sulphate.
2. TW 600 V or an HMWPE insulated copper lead attached to the anode.

M. Valves:
1. See schematics and details for definition of manual valves used in each system under 4 IN in size.
2. See Specification Section 40 05 51.

N. Flexible Expansion Joints:
1. Materials:
   a. Bellows and Maximum Temperature Rating:
      1) Chemically compatible with fluid in connecting piping
      2) CIP service: Viton, 250 DEG F
      3) Hot Process Air Service: High Temperature EPDM, 300 DEG F
      4) All Other Service: UV-resistant EPDM, 250 DEG F
   b. Flanges:
      1) Outdoor Service: Ductile iron or stainless steel
      2) Indoor Service: Continuation of bellows material
   c. Connecting hardware: 316 stainless steel.
   d. Reinforcing rings: Stainless steel.
2. Flanges to meet ASME B16.5 Class 150
3. Restraint, where required:
   a. Provide restraint limit bolts (control rods) and nuts to restrain joint at test pressure of piping.
   b. Control rod material: 316 stainless steel.

4. Pressure rating at 70 DEGF:
    a. Equal to or greater than test pressure of connecting piping.
    b. 70 PSIG minimum.
5. Single Arch Design
    a. Minimum axial compression: 0.75 IN
    b. Minimum axial extension: 0.50 IN
    c. Minimum lateral deflection: 0.50 IN
    d. Minimum angular deflection: 3.8 DEGREES
6. Double Arch Design
    a. Minimum axial compression: 1.5 IN
    b. Minimum axial extension: 1.0 IN
    c. Minimum lateral deflection: 1.0 IN
    d. Minimum angular deflection: 8.8 DEGREES

O. Flexible Braided Connectors:
1. Materials:
    a. Inner hose: 316/316L stainless steel
    b. Braid: 304/304L or 316/316L stainless steel
    c. Flanges: Carbon Steel, ASME B16.5 Class 150 flat face
    d. Connecting hardware: carbon steel, or 316 stainless steel with dielectric isolating sleeves
2. Pressure rating at 70 DEGF: 200 PSIG minimum.
3. Minimum lateral deflection: 3/8”
4. For all Finished Water service: must meet materials requirements of NSF-61

P. Orifice Plates and Assemblies:
1. Provide a series of orifice plates or a multistage orifice plate assembly to reduce pressure where indicated on the Drawings.
2. Flanges: ANSI 150.
    a. Provide threaded ends for pressure gauge connection.
    b. Maximum face-to-face length: 20-IN
3. Materials:
    a. Orifice plate or assembly:
        1) Carbon steel.
        2) 1/4 IN thick plates.
4. Pressure requirements:
    a. Upstream pressure: 150 PSIG.
    b. Downstream pressure: 0 PSIG.
    c. Provide pressure gauges upstream and downstream of the orifice plates or assembly.

PART 3 - EXECUTION

3.1 INTERIOR AND EXPOSED EXTERIOR PIPING INSTALLATION

A. Install piping in vertical and horizontal alignment as shown on Drawings.

B. Alignment of piping smaller than 4 IN may not be shown; however, install according to Drawing intent and with clearance and allowance for:
1. Expansion and contraction.
2. Operation and access to equipment, doors, windows, hoists, moving equipment.
3. Headroom and walking space for working areas and aisles.
4. System drainage and air removal.

C. Enter and exit through structure walls, floor and ceilings using penetrations and seals specified in Specification Section 01 73 20 and as shown on the Drawings.

D. Install vertical piping runs plumb and horizontal piping runs parallel with structure walls.

E. Pipe Support:

1. Use methods of piping support as shown on Drawings and as required in Specification Section 40 05 07.
2. Select piping supports are shown on the Drawings.
    a. Contractor is responsible for design of support systems not shown on Drawings per Specification Section 40 05 07.
3. Where pipes run parallel and at same elevation or grade, they may be grouped and supported from common trapeze-type hanger, provided hanger rods are increased in size as specified for total supported weight.
    a. The pipe in the group requiring the least maximum distance between supports shall set the distance between trapeze hangers.
4. Size pipe supports with consideration to specific gravity of liquid being piped.

F. Locate and size sleeves and castings required for piping system.
    1. Arrange for chases, recesses, inserts or anchors at proper elevation and location.

G. Use reducing fittings throughout piping systems.
    1. Bushings will not be allowed unless specifically approved.

H. Equipment Drainage and Miscellaneous Piping:
    1. Provide drip pans and piping at equipment where condensation may occur.
    2. Hard pipe stuffing box leakage to nearest floor drain.
    3. Avoid piping over electrical components such as motor control centers, panelboards, etc.
        a. If piping must be routed over electrical equipment, utilize 16 GA, 316 stainless steel drip pan under piping and over full length of electrical equipment.
        b. Hard pipe drainage to nearest floor drain.
    4. Provide drainage for process piping at locations shown on Drawings.
    5. For applications defined above and for other miscellaneous piping, provide 304 stainless steel piping and fittings.
        a. Size to handle application with 3/4 IN being minimum size provided.

I. Unions:
    1. Install in position that will permit valve or equipment to be removed without dismantling adjacent piping.
    2. Mechanical type couplings may serve as unions.
    3. Additional flange unions are not required at flanged connections.

J. Install expansion devices as necessary to allow expansion/contraction movement.

K. Provide full face gaskets on all systems.

L. Anchorage and Blocking:
    1. Block, anchor, or harness exposed piping subjected to forces in which joints are installed to prevent separation of joints and transmission of stress into equipment or structural components not designed to resist those stresses.

M. Equipment Pipe Connections:
    1. Equipment - General:
        a. Exercise care in bolting flanged joints so that there is no restraint on the opposite end of pipe or fitting which would prevent uniform gasket pressure at connection or would cause unnecessary stresses to be transmitted to equipment flanges.
        b. Where push-on joints are used in conjunction with flanged joints, final positioning of push-on joints shall not be made until flange joints have been tightened without strain.
        c. Tighten flange bolts at uniform rate which will result in uniform gasket compression over entire area of joint.
            1) Provide tightening torque in accordance with manufacturer's recommendations.
        d. Support and match flange faces to uniform contact over their entire face area prior to installation of any bolt between the piping flange and equipment connecting flange.
        e. Permit piping connected to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.

f. Align, level, and wedge equipment into place during fitting and alignment of connecting piping.
g. Grout equipment into place prior to final bolting of piping, but not before initial fitting and alignment.
h. To provide maximum flexibility and ease of alignment, assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
    1) Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
    2) Realign as necessary, install flange bolts, and make equipment connection.
i. Provide utility connections to equipment shown on Drawings, scheduled or specified.

2. Plumbing and HVAC equipment:
    a. Make piping connections to plumbing and HVAC equipment, including but not limited to installation of fittings, strainers, pressure reducing valves, flow control valves and relief valves provided with or as integral part of equipment.
    b. Furnish and install sinks, fittings, strainers, pressure reducing valves, flow control valves, pressure relief valves, and shock absorbers that are provided by manufacturer as an integral part of equipment, even when not specified.
    c. For each water supply piping connection to equipment, furnish and install union and gate or angle valve.
        1) Provide wheel handle stop valve at each laboratory sink water supply.
        2) Minimum size: 1/2 IN.
    d. Furnish and install "P" trap for each waste piping connection to equipment if waste is connected directly to building sewer system.
        1) Size trap as required by IPC.
        2) Provide trap guard devices in all floor drains and floor sinks.
    e. Stub piping for equipment, sinks, lavatories, supply and drain fittings, key stops, "P" traps, miscellaneous traps, and miscellaneous brass through wall or floor and cap and protect until such time when later installation is performed.

N. Provide insulating components where dissimilar metals are joined together.

O. Instrument Connections:
    1. See drawing details.

3.2 CONNECTIONS WITH EXISTING PIPING

A. Where connection between new work and existing work is made, use suitable and proper fittings to suit conditions encountered.

B. Undertake connections in fashion which will disturb system as little as possible.

C. Provide suitable equipment and facilities to dewater, drain, and dispose of liquid removed without damage to adjacent property.

D. Where connections to existing systems necessitate employment of past installation methods not currently part of trade practice, utilize necessary special piping components.

E. Where connection involves potable water systems, provide disinfection methods as prescribed in this Specification Section.

F. Once tie-in to each existing system is initiated, continue work continuously until tie-in is made and tested.

3.3 ACCESS PROVISIONS

A. Provide access doors or panels in walls, floors, and ceilings to permit access to valves, piping and piping appurtenances requiring service.

B. Size access panels to allow inspection and removal of items served, minimum 10 x 14 IN size.

C. Fabricate door and frame of minimum 14 GA, stretcher leveled stock, cadmium plated or galvanized after fabrication and fitted with screw driver lock of cam type.

D. Provide with key locks, keyed alike, in public use areas.

E. Furnish panels with prime coat of HPIC. See Specification Section 09 96 00.

F. Style and type as required for material in which door installed.

G. Where door is installed in fire-rated construction, provide door bearing UL label required for condition.

3.4 CATHODIC PROTECTION

A. Isolate, dielectrically, all piping from all other metals including reinforcing bars in concrete slabs, other pipe lines, and miscellaneous metal.

B. Make all connections from wire or cable by Thermit Cadwelding accomplished by operators experienced in this process.

C. Install all cables with a loop and overhead knot around each pipe and slack equal to at least 50% of the straight line length.

D. After cadwelding, coat all exposed metallic surfaces with hot applied tape.

3.5 PRESSURE GAGES

A. Provide at locations shown on the Drawings and as specified.

B. See Specification Section 01 61 03.

3.6 FIELD QUALITY CONTROL

A. Pipe Testing - General:
   1. Test piping systems as follows:
      a. Test exposed, non-insulated piping systems upon completion of system.
      b. Test exposed, insulated piping systems upon completion of system but prior to application of insulation.
      c. Test concealed interior piping systems prior to concealment and, if system is insulated, prior to application of insulation.
      d. Test buried piping (insulated and non-insulated) prior to backfilling and, if insulated, prior to application of insulation.
   2. Isolate equipment which may be damaged by the specified pressure test conditions.
   3. Perform pressure test using calibrated pressure gages and calibrated volumetric measuring equipment to determine leakage rates.
      a. Select each gage so that the specified test pressure falls within the upper half of the gage's range.
      b. Notify the Contracting Officer’s Representative 24 HRS prior to each test.
   4. Completely assemble and test new piping systems prior to connection to existing pipe systems.
   5. Acknowledge satisfactory performance of tests and inspections in writing to Contracting Officer prior to final acceptance.
   6. Bear the cost of all testing and inspecting, locating and remedying of leaks and any necessary retesting and re-examination.

B. Pressure Testing:
   1. Testing medium: Unless otherwise specified in the Drawings, utilize the following test media.
      a. Process systems: Water.
      b. Laboratory gases and natural gas systems: Cylinder nitrogen.
      c. Other liquid systems: Water.
   2. Allowable leakage rates:
      a. Hazardous gas systems, all exposed piping systems, all pressure piping systems and all buried, insulated piping systems which are hydrostatically pressure tested shall have zero leakage goal at the specified test pressure throughout the duration of the test.

b. Non-hazardous gas and air systems which are tested with air shall have a maximum pressure drop of 5% of the specified test pressure throughout the duration of the test.
c. For low pressure (less than 25 PSIG) air testing, the acceptable time for loss of 1 PSIG of air pressure shall be:

PIPE SIZE (IN DIA)	TIME, MINUTES/100 FT
4	0.3
6	0.7
8	1.2
10	1.5
12	1.8
15	2.1
18	2.4
21	3.0
24	3.6
27	4.2
30	4.8
33	5.4
36	6.0
42	7.3
48	7.6

3. Hydrostatic pressure testing methodology:
   a. General:
      1) All joints, including welds, are to be left exposed for examination during the test.
      2) Provide additional temporary supports for piping systems designed for vapor or gas to support the weight of the test water.
      3) Provide temporary restraints for expansion joints for additional pressure load under test.
      4) Isolate equipment in piping system with rated pressure lower than pipe test pressure.
      5) Do not coat or insulate exposed piping until successful performance of pressure test.
   b. Soil, waste, drain and vent systems:
      1) Test at completion of installation of each stack or section of piping by filling system with water and checking joints and fittings for leaks.
      2) Eliminate leaks before proceeding with work or concealing piping.
      3) Minimum test heights shall be 10 FT above highest stack inlet.
   c. High pressure pipe systems:
      1) Applies to:
         a) Piping systems normally exceeding 1,000 PSI working pressure.
      2) Submit pressure testing plan for review and approval by Contracting Officer's Representative minimum 14 days prior to commencing testing.
      3) In-person witness testing of pressure test piping not allowed.
      4) Monitor test pressure remotely via live-feed cameras at all critical viewpoint locations.
      5) Tighten high pressure flange bolts per torque and sequence in accordance with ASME B16.5.

a) Torque all flanges to specified value using torque wrench.
b) Upon reaching final torque, mark all flange bolts with paint/marker.
c) Bolting hardware of Class 900 and larger flanges cannot be torqued to design setting more than twice. Remove and replace bolted hardware as necessary.
d) Contractor to supply 4 sets of additional hardware and gaskets for each high-pressure flange type/class and size.

4. Liquefied propane systems - testing methodology:
   a. Maintain specified test pressure until each joint has been thoroughly examined for leaks by means of soap suds and glycerine.
   b. Wipe joints clean after test.
5. Air testing methodology:
   a. General:
      1) Ensure air is ambient temperature.
   b. Low pressure air testing:
      1) Place plugs in line and inflate to manufacturer's designated seal pressure.
      2) Check plugs for proper sealing.
      3) Introduce low pressure air into sealed line segment until air pressure reaches 4 PSIG greater than ground water or allowable limits of ASTM F1417.
         a) Use test gage conforming to ASME B40.100 with 0 to 15 PSI scale and accuracy of 1% of full range.
      4) Allow 2 minutes for air pressure to stabilize.
      5) After stabilization period (3.5 PSIG minimum pressure in pipe) discontinue air supply to line segment.
      6) Record pressure at beginning and end of test.

C. Dielectric Testing Methods and Criteria:
   1. Provide electrical check between metallic non-ferrous pipe or appurtenances and ferrous elements of construction to assure discontinuity has been maintained.
   2. Wherever electrical contact is demonstrated by such test, locate the point or points of continuity and correct the condition.

3.7 CLEANING, DISINFECTION AND PURGING

A. Cleaning:
   1. Clean interior of piping systems thoroughly before installing.
   2. Maintain pipe in clean condition during installation.
   3. Before jointing piping, thoroughly clean and wipe joint contact surfaces and then properly dress and make joint.
      a. Pig high pressure air piping before connecting to valves or instruments.
   4. At completion of work and prior to Final Acceptance, thoroughly clean work installed under these Specifications.
      a. Clean equipment, fixtures, pipe, valves, and fittings of grease, metal cuttings, and sludge which may have accumulated by operation of system, from testing, or from other causes.
      b. Repair any stoppage or discoloration or other damage to parts of building, its finish, or furnishings, due to failure to properly clean piping system, without cost to Government.
   5. After erection of piping and tubing, but prior to installation of service outlet valves, blow liquefied petroleum gas and digester gas systems clear of free moisture and foreign matter by means of air, nitrogen or carbon dioxide.
      a. Oxygen shall never be used.
   6. Clean chlorine piping in accordance with CI Pamphlet 6.

B. Disinfection of Potable Water Systems:
   1. After favorable performance of pressure test and prior to Final Acceptance, thoroughly flush entire potable water piping system including supply, source and any appurtenant devices and perform disinfection as prescribed.

2. Perform work, including preventative measures during construction, in full compliance with AWWA C651.
3. Perform disinfection using sodium hypochlorite complying with AWWA B300.
4. Flush each segment of system to provide flushing velocity of not less than 2.5 FT per second.
5. Drain flushing water to sanitary sewer.
    a. Do not drain flushing water to receiving stream.
6. Use continuous feed method of application.
    a. Tag system during disinfection procedure to prevent use.
7. After required contact period, flush system to remove traces of heavily chlorinated water.
8. After final flushing and before placing water in service, obtain an independent laboratory approved by the Contracting Officer to collect samples and test for bacteriological quality.
    a. Repeat entire disinfection procedures until satisfactory results are obtained.
9. Secure and deliver to Contracting Officer, satisfactory bacteriological reports on samples taken from system.
    a. Ensure sampling and testing procedures are in full compliance to AWWA C651, local water purveyor and applicable requirements of State of Arizona.

C. Purging Liquefied Petroleum Gas:
1. Existing piping:
    a. Turn off gas supply.
    b. Vent line pressure outdoors.
    c. If section exceeds the following, then remaining gas shall be displaced with an inert gas.
        1) 50 FT for 2-1/2 IN pipe.
        2) 30 FT for 3 IN pipe.
        3) 15 FT for 4 IN pipe.
        4) 10 FT for 6 IN pipe.
        5) Any length for 8 IN or larger pipe.
2. New piping:
    a. Including but not limited to:
        1) All fuel gas piping.
        2) Digesters.
        3) Digester gas equipment.
        4) Fuel gas trains.
    b. Purge air filled system with fuel gas:
        1) Providing piping length is less than:
            a) 30 FT for 3 IN pipe.
            b) 15 FT for 4 IN pipe.
            c) 10 FT for 6 IN pipe.
            d) Any length for 8 IN and larger pipe.
        2) Providing a moderately rapid and continuous flow of fuel gas is introduced.
            a) Introduce fuel gas at one end.
            b) Vent air at opposite end.
        3) Provided fuel gas flow is continuous without interruption until vented gas is free of air.
        4) The point of discharge shall not be left unattended during purging.
    c. If the piping is 3 IN or larger and exceeds lengths stated above.
        1) Purge air with inert gas in accordance with NFPA 54 and NFPA 69.
        2) Purge inert gas with fuel gas.
3. Discharge of purged gases:
    a. Open end of piping shall not discharge into confined spaces or areas where there are sources of ignition.

3.8 LOCATION OF BURIED OBSTACLES

A. Furnish exact location and description of buried utilities encountered and thrust block placement.

B. Reference items to definitive reference point locations such as entrances to buildings, existing structure lines, fire hydrants, and related fixed structures.

C. Include such information as location, elevation, coverage, supports and additional pertinent information.

D. Incorporate information on "As-Recorded" Drawings.

3.9 PIPE INSULATION

A. Insulate pipe and pipe fittings in accordance with Specification Section 40 42 00.

END OF SECTION

SECTION 40 05 07
PIPE SUPPORT SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Pipe support and anchor systems.
   2. Design of Pipe Support Systems as specified.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 35 73 – Delegated Design Procedures.
   2. Section 01 81 10 – Wind and Seismic Design Criteria
   3. Section 03 15 19 – Anchorage to Concrete.
   4. Section 05 50 00 – Metal Fabrications.
   5. Section 09 96 00 – High Performance Industrial Coatings.
   6. Section 40 42 00 – Pipe, Duct and Equipment Insulation.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.3, Process Piping.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.
      b. A123/123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
      c. A153/153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
      d. A276, Standard Specification for Stainless Steel Bars and Shapes.
      e. A575, Standard Specification for Steel Bars, Carbon, Merchant Quality, M-Grades.
      f. A576, Standard Specification for Steel Bars, Carbon, Hot-Wrought, Special Quality.
      g. A917, Standard Specification for Steel Sheet, Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface (General Requirements).
      h. A918, Standard Specification for Steel Sheet, Zinc-Nickel Alloy Coated by the Electrolytic Process for Applications Requiring Designation of the Coating Mass on Each Surface.
      i. B633, Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   3. American Welding Society (AWS):
      a. D1.1, Structural Welding Code - Steel.
      b. D1.6, Structural Welding Code - Stainless Steel.
   4. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-58, Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation.

B. Responsibility:
   1. General piping supports are indicated on the Drawings for pipe 4 inches diameter and larger.
   2. Pipe support details are not indicated on the Drawings for piping 3 inches and smaller, but shall be provided by Contractor.
      a. Incorporate those details with the requirements of this Specification Section to provide the piping support system.
   3. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to design, furnish and install the system of hangers, supports, guidance, anchorage and appurtenances.

C. Each type of pipe hanger or support shall be the product of one manufacturer.

D. Pipe Support Designer Qualifications:
   1. Licensed Professional Engineer registered in the State of Arizona.
   2. Minimum of five years experience designing pipe supports for projects of similar size and complexity.

1.3 SUBMITTALS

A. See Section 01 33 23 Submittal Requirements for the mechanics and administration of the submittal process.

B. Action Submittals:
   1. Shop Drawings:
      a. Scaled drawings showing location, installation, material, loads and forces, and deflection of all hangers and supports.
      b. Analyze each pipe system for all loads and forces on hangers and supports and their reaction forces to the structure to which they are fastened.
      c. Where Contract Documents indicate Contractor is to design pipe support systems, submit detail design calculations and scaled drawings signed by Pipe support designer.
   2. Product data:
      a. Acknowledgement that products meet requirements of referenced standards.
      b. Manufacturer's installation instructions.
      c. Itemized list of wall sleeves, anchors, support devices and all other items related to pipe support system.

C. Informational Submittals:
   1. Pipe support designer qualifications.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Product requirements are to conform with the following salient characteristics:

2.2 MANUFACTURED UNITS

A. General:
   1. Galvanized components:
      a. Hot-dip galvanized components:
         1) General: ASTM 123/123M.
         2) Fasteners and hardware: ASTM 153/153M.
   2. Dissimilar metals protection:
      a. Galvanized-to-galvanized and galvanized-to-aluminum: No protection required.
      b. All other galvanized-to-dissimilar metal connections: Neoprene or nylon pads, shims, grommets, etc.
   3. Fiberglass Reinforced Plastic (FRP) components:
      a. Corrosive:
         1) Material: Polyester.
         2) Channels: similar to Aickinstrut F2000 or F2100.
         3) Pipe Clamps: similar to Aickinstrut FPS or FRPC.
         4) Clevis Hangers: similar to Aickinstrut FMCH.
         5) Beam Clamp: similar to Aickinstrut FMBC.
         6) Column Base: similar to Aickinstrut F2852, F5853 or 5854
      b. Highly Corrosive:
         1) Material: Vinyl ester.
         2) Channels: similar to Aickinstrut F2000 or F2100.
         3) Pipe Clamps: similar to Aickinstrut FPS or FRPC.
         4) Clevis Hangers: similar to Aickinstrut FMCH.

5) Beam Clamp: similar to Aickinstrut FMBC.
6) Column Base: similar to Aickinstrut F2852, F5853 or 5854

B. Hanger Rods:
1. Material:
a. ASTM A36.
b. ASTM A575, Grade M1020.
c. ASTM A576, Grade 1020.
d. Minimum allowable tensile stress of 12,000 psi at 650 degrees F per MSS SP-58.
e. Corrosion resistant: 304 or 316 stainless steel per ASTM A276.
2. Continuously threaded.
3. For galvanized rods: hot-dip galvanized after threads are cut.
4. Load limit:

NOMINAL ROD DIAMETER	MAXIMUM SAFE LOAD, (LBS)
3/8 inches diameter (min)	610
1/2 inches diameter	1,130
5/8 inches diameter	1,810
3/4 inches diameter	2,710
7/8 inches diameter	3,770
1 inches diameter	4,960

C. Hangers:
1. Materials
a. Corrosive areas: 304 stainless steel.
b. Highly corrosive areas: 316 stainless steel.
c. For use directly on copper pipe: Copper plated or PVC coated.
d. For use other than directly on copper pipe: Hot-dip galvanized.
2. Hanger type schedule:

APPLICATION	PIPE SIZE	HANGER TYPE
All except noted	4 inches and less	MSS Type 1 or 12 Similar to Empire Figure 41.
All except noted	Over 4 inches	MSS Type 1 Similar to Empire Figure 11.
Steam, condensate, and hot water	All	MSS Type 43 Similar to Empire Figure 272 w/ spring hanger.
Service in chemical storage areas and as indicated on drawings for corrosion resistance	All	FRP trapeze hangers or clevis hangers as specified below.

D. Concrete Inserts for Hanger Rods:
1. Continuous slots: Similar to Unistrut #P1000.
2. Individual inserts: Similar to ANVIL Figure 281.
3. See Specification Section 03 15 19, Mechanical Anchors.

E. Beam Clamps for Hanger Rods:
1. MSS SP-58, Type 21.
2. Material:

a. Corrosive areas: 304 stainless steel.
b. Highly corrosive areas: 316 stainless steel.
c. All other areas: Hot-dip galvanized steel.

3. Standard duty.
4. Similar to Empire Industries Figure 155.

F. Trapeze Hangers for Suspended Piping:
1. General:
a. Material:
1) Corrosive areas: 304 stainless steel.
2) Highly corrosive areas: 316 stainless steel.
3) All other areas: Hot-dip galvanized steel.
b. Angles, channels, or other structural shapes.
c. Curved roller surfaces at support point corresponding with type of hanger required.
d. See Specification Section 05 50 00.
2. In chemical storage and feed areas and as indicated on the Drawings:
a. Materials: FRP.
b. Aikinstrut fiberglass channel or equal.

G. Vertical Pipe Supports:
1. At base of riser.
a. Material:
1) Corrosive areas: 304 stainless steel.
2) Highly corrosive areas: 316 stainless steel.
3) All other areas: Hot-dip galvanized steel.
2. Lateral movement:
a. Clamps or brackets:
1) MSS SP-58, Type 8 or 42.
2) Similar to Empire Industries Figure 50.

H. Expanding Pipe Supports:
1. Spring hanger type.
2. MSS SP-58, Type 51.

I. Pipe Support Saddle:
1. General:
a. Minimum contact area:
1) 120 Degrees minimum.
2) 180 Degrees for PVC/PE greater than 12 inches
2. For pipe located 3 feet or less from floor elevation, except as otherwise indicated on Drawings.
a. MSS SP-58 Type 38.
b. Material:
1) Corrosive areas: 304 stainless steel.
2) Highly corrosive areas: 316 stainless steel.
3) All other areas: Hot-dip galvanized steel.
c. Similar to Empire Industries Figure 426.

J. Pipe Support Risers/Stanchions:
1. Schedule 40 pipe.
2. Material: Match pipe support saddle.
3. Size: As recommended by saddle manufacturer.

K. Pipe Support Base Plate:
1. 4 inches larger than support.
2. Collar 3/16 inches thickness, circular in shape, and sleeve type connection to pipe.
3. Collar fitted over outside of support pipe and extended 2 inches from floor plate.
4. Collar welded to floor plate.

5. Edges ground smooth.
6. Material: Match pipe support saddle.
7. Provide low carbon stainless steel for welded fabrications.

L. Pipe Covering Protection Saddle:
1. For insulated pipe at point of support.
2. MSS SP-58 Type 40.
3. Material:
   a. Corrosive areas: 304 stainless steel.
   b. Highly corrosive areas: 316 stainless steel.
   c. All other areas: Hot-dip galvanized steel.
4. Stainless steel: Similar to Empire Industries Figure 167.

M. Wall Brackets:
1. For pipe located near walls and 8 feet or more above floor elevation or as otherwise indicated on the Drawings.
2. MSS SP-58, Type 33.
3. Material:
   a. Corrosive areas: 304 stainless steel.
   b. Highly corrosive areas: 316 stainless steel.
   c. All other areas: Hot-dip galvanized steel.
4. Similar to Empire Industries Figure 802.

N. Pipe Anchors:
1. For locations shown on the Drawings.
2. 1/4 inches steel plate construction.
3. Hot-dip galvanized after fabrication.
4. Designed to prevent movement of pipe at point of attachment.

O. Seismic Restraints:
1. Galvanized steel aircraft cables or steel angles or channels.
2. Prestretch steel aircraft cables to establish a certified minimum modulus of elasticity.
   a. Design cable restraints to resist seismic tension loads.
   b. Design steel restraints to resist both tension and compression loads with a minimum safety factor of 2.
3. Design restraint and connection steel assemblies that swivel to the final installation angle.
4. Do not mix cable and steel angle restraints to brace the same system.
5. Clamp steel angles to the threaded hanger rods at the seismic sway restraint locations utilizing a minimum of two ductile iron clamps.
6. Provide transverse bracing at 40 feet-0 inches maximum spacing unless noted otherwise.
7. Provide longitudinal bracing at 80 feet-0 inches maximum spacing unless noted otherwise.
8. Provide fuel gas piping with transverse bracing 20 feet-0 inches on-center maximum and longitudinal bracing 4 0 feet-0 inches on-center maximum.
9. At vertical pipe risers, wherever possible, support the weight of the riser at a point or points above the center of gravity of the riser.
   a. Provide lateral guides at the top and bottom of the riser, and at intermediate points not to exceed 30 feet-0 inches on-center.

P. Pipe Guides:
1. For locations on both sides on each expansion joint or loop.
2. To ensure proper alignment of expanding or contracting pipe.
3. Material:
   a. Corrosive areas: 304 stainless steel.
   b. Highly corrosive areas: 316 stainless steel.
   c. All other areas: Hot-dip galvanized steel.
4. Similar to Empire Industries Figure 255.

2.3 DESIGN REQUIREMENTS

A. Supports capable of supporting the pipe for all service and testing conditions.
   1. Provide 5 to 1 safety factor.

B. Allow free expansion and contraction of the piping to prevent excessive stress resulting from service and testing conditions or from weight transferred from the piping or attached equipment.

C. Design supports and hangers to allow for proper pitch of pipes.

D. For chemical and waste piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.3.
   2. MSS SP-58.
   3. Except where modified by this Specification.

E. For steam and hot and cold water process piping, design, materials of construction and installation of pipe hangers, supports, guides, restraints, and anchors:
   1. ASME B31.1.
   2. MSS SP-58.
   3. See Section 22 05 29 for plumbing applications.

F. Check all physical clearances between piping, support system and structure.
   1. Provide for vertical adjustment after erection.

G. Support vertical pipe runs in pipe chases at base of riser.
   1. Support pipes for lateral movement with clamps or brackets.

H. Place hangers are to be installed on outside of pipe insulation.
   1. Use a pipe covering protection saddle for insulated pipe at support point.
   2. Insulated piping 1-1/2 inches and less:
      a. Provide a 9 inches length of high density perlite or high density calcium silicate at saddle.
   3. Insulated piping over 1-1/2 inches: Provide a 12 inches length of high density perlite or high density calcium silicate at saddle.
   4. See Specification Section 40 42 00.

I. Provide 20 GA pipe saddle for fiberglass and plastic pipe support points to ensure minimum contact width of 4 inches.
   1. Material: match support.

J. Pipe Support Spacing:
   1. General:
      a. Factor loads by specific weight of liquid conveyed if specific weight is greater than water.
      b. Locate pipe supports at maximum spacing scheduled.
      c. Provide at least one support for each length of pipe at each change of direction and at each valve.
   2. Steel, stainless steel, cast-iron, ductile-iron pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/2 and less	5
2 thru 4	10
5 thru 8	15
10 and greater	20

   3. Copper pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
2-1/2 and less	5
3 thru 6	10
8 and greater	15

4. PVC pipe support schedule:

PIPE SIZES - IN	MAXIMUM SPAN - FT
1-1/4 and less	3
1-1/2 thru 3	4
4 and greater	5

* Maximum fluid temperature of 120 degrees F.

5. Support each length and every fitting:
   a. Bell and spigot piping:
      1) At least one hanger.
      2) Applied at bell.
   b. Mechanical coupling joints:
      1) Place hanger within 2 feet of each side of fittings to keep pipes in alignment.
6. Space supports for soil and waste pipe and other piping systems not included above every 5 feet.
7. Provide continuous support for tubing via containment piping.
8. For PVC and FRP piping:
   a. Provide Unistrut Unicushion (or equal) wrap of pipe at each support.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide piping systems exhibiting pulsation, vibration, swaying, or impact with suitable constraints to correct the condition.
   1. Included in this requirement are movements from:
      a. Trap discharge.
      b. Water hammer.
      c. Similar internal forces.

B. Seismic Restraints:
   1. Provide seismic restraints on all piping, with the exception of the following:
      a. Piping less than 1 inch diameter when used for gas and compressed air.
      b. Piping less than 2-1/2 inches diameter for all other cases.
      c. Piping suspended by individual hangers where the distance from the top of the pipe to the bottom of the support for the hanger is 12 inches or less.
      d. Provide fuel gas piping with transverse bracing 20 feet-0 inches on-center maximum and longitudinal bracing 40 feet-0 inches on-center maximum.

C. Weld Supports:
   1. AWS D1.1.
   2. Weld anchors to pipe in accordance with ASME B31.3.
   3. AWS D1.6 for stainless steel supports.

D. Locate piping and pipe supports as to not interfere with open accesses, walkways, platforms, and with maintenance or disassembly of equipment.

E. Inspect hangers for:

1. Design offset.
2. Adequacy of clearance for piping and supports in the hot and cold positions.
3. Guides to permit movement without binding.
4. Adequacy of anchors.

F. Inspect hangers after erection of piping systems and prior to pipe testing and flushing.

G. Anchorage to Concrete - reference Specification Section 03 15 19.

H. Install individual or continuous slot concrete inserts for use with hangers for piping and equipment.
   1. Install concrete inserts as concrete forms are installed.

I. Welding:
   1. Welding rods: ASTM and AWS standards.
   2. Integral attachments:
      a. Include welded-on ears, shoes, plates and angle clips.
      b. Ensure material for integral attachments is of good weldable quality.
   3. Preheating, welding and post-heat treating: ASME B31.3, Chapter V.

J. Field Painting:
   1. Comply with Specification Section 09 96 00.

END OF SECTION

SECTION 40 05 25
PIPE - PREFABRICATED, INSULATED AND JACKETED

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Underground, prefabricated, insulated and jacketed piping with flexible joints.

B. Related Sections include but are not necessarily limited to the following:
   1. Section 31 23 33 - Trenching and Backfilling.
   2. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements
   3. Section 40 05 24 - Pipe - Steel.

1.2 QUALITY ASSURANCE

A. See Section 40 05 00.

B. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B31.1, Power Piping.
   2. ASTM International (ASTM):
      a. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
      b. C272, Standard Test Method for Water Absorption of Core Materials for Sandwich Constructions.
      c. C518, Standard Test Method for Steady-State Thermal Transmission Properties
      d. D638, Standard Test Method for Tensile Properties of Plastics.
      e. D790, Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
      f. D1238, Standard Test Method for Melt Flow Rates of Thermoplastics by Extrusion Plastometer.
      g. D1505, Standard Test Method for Density of Plastics by the Density-Gradient Technique.
      h. D1621, Standard Test Method for Compressive Properties of Rigid Cellular Plastics.
      i. D1622, Standard Test Method for Apparent Density of Rigid Cellular Plastics
      j. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
      k. D2842, Standard Test Method for Water Absorption of Rigid Cellular Plastics
      l. D6226, Standard Test Method for Open Cell Content of Rigid Cellular Plastics.

1.3 SYSTEM DESCRIPTION

A. Provide underground piping for heating water system piping.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Section 40 05 00.
   2. Product technical data including:
      a. Component details.
      b. Location of miscellaneous fittings including anchors and seals.
      c. Field closures.
   3. Provide copy of stress analysis for proposed system in accordance with ASME B31.1.
   4. Factory test report.

B. Contract Closeout Information:

1. Operation and Maintenance Data:
    a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements.
    1. Manufactures listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.
    2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. GF Urecon (Basis of Design).
    2. Or Equal.

C. Submit request for product substitution in accordance with Specification Section 01 33 23.

2.2 MATERIALS

A. Insulation:
    1. Field Applied Half-Shells:
        a. Rigid polyisocyanurate or polyurethane foam
            1) "K" factor: 0.14 to 0.154 BTU IN/SQFT HR DEGF, ASTM C518.
            2) Density: 2.0 pound/CUFT, ASTM D1622.
            3) Compressive strength: 18 to 27 lbs/sqin, ASTM D1621.
            4) Thickness: 2 IN for 4 IN SCH 80 Steel pipe.
            5) Closed cell content: >/= 90% minimum, ASTM D6226.
            6) Water absorption: </=4.0% by volume, ASTM C2842.

B. Jacket:
    1. Jacket may be the following:
        a. Extruded Black High Density Polyethylene Copolymer:
            1) Machine coated, factory applied.
            2) Minimum 2% carbon black, well dispersed.
            3) Density > 59.1 to 59.6 pounds/CUFT as per ASTM D1505.
            4) Melt index of compound < 0.00088 to 0.00033 lb as per ASTM D1238.
            5) Flexural modulus of compound < 160,000 to 110,000 psi as per ASTM D790.
            6) Tensile strength at yield of compound < 4,000 to 3,500 psi as per ASTM D638.
            7) Ultraviolet inhibitors added.
            8) Minimum thickness 125 mils.

        b. Cut and rolled galvanized steel :
            1) Thickness = 18 to 22 gauge.
            2) Service temperature range = cryogenic to 200 DEGF.
            3) Minimum ambient installation temperature = -29 DEGF.
            4) Minimum thickness 0.034 inches.
            5) Ultraviolet inhibitors added.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Observe manufacturer's recommendation for handling, cutting, jointing, installing, and testing.

B. Trenching, Backfilling, and Compaction:
   1. See Section 31 23 33.
   2. Comply with manufacturer's recommendations where they are more stringent.

3.2 FIELD QUALITY CONTROL

A. Tests:
   1. See Section 40 05 00.

B. Manufacturer's Field Service:
   1. Factory-trained field service person present for minimum of three working days including two site visits.
   2. Factory-field service person visits to provide instruction for installation and testing and to verify installation is being performed in accordance with manufacturer's recommendations.

END OF SECTION

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SECTION 40 05 31
PIPE - PLASTIC

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plastic pipe:
      a. PVC.
      b. CPVC.
      c. ABS.
   2. Plastic tubing:
      a. Polyethylene.
      b. Reinforced PVC.
      c. Nylon.
      d. Teflon (PTFE).
   3. Specialized coating systems for plastic pipe

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 01 – Common Work Results for Process Piping.
   2. Section 40 05 07 – Pipe Support Systems.

1.2 QUALITY ASSURANCE

A. See Specification Section 40 05 00.

B. Referenced Standards:
   1. ASTM International (ASTM):
      a. D1784, Standard Classification System and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds.
      b. D1785, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
      c. D2464, Standard Specification for Threaded Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
      d. D2466, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
      e. D2467, Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
      f. D2564, Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems.
      g. F437, Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
      h. F438, Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
      i. F439, Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
      j. F441, Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
      k. F493, Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings.
      l. F593, Standard Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
      m. F656, Standard Specification for Primers for Use in Solvent Cement Joints of Poly(Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
      n. Installation:

1) D2321, Standard Practice for Underground Installation of Thermoplastic Pipe for Sewers and Other Gravity-Flow Applications.

2. NSF International (NSF).
   a. 14, Plastic Piping Components and Related Materials.
   b. 61, Drinking Water System Components – Health Effects.

1.3 SUBMITTALS

A. See Specification Section 40 05 00.

PART 2 - PRODUCTS

2.1 GENERAL

A. Identification
   1. Identify each length of pipe clearly at intervals of 5 feet or less.
      a. Include manufacturer's name and trademark.
      b. Nominal size of pipe, appurtenant information regarding polymer cell classification and critical identifications regarding performance specifications and NSF approvals when applicable.

2.2 PVC PRESSURE PIPING

A. Materials:
   1. Manufacture pipe, fittings and appurtenances from virgin polyvinyl chloride (PVC) compound which meets the requirements of Type 1, Grade 1 (cell classification 12454-B) per ASTM D1784.
   2. Solvent Welded Joints:
      a. Use primer and solvent cement recommended by the PVC pipe manufacturer required for each type of chemicals conveyed.
      b. Primer: ASTM F656.
      c. Solvent cement: ASTM D2564.

B. PVC Pressure Piping (Exposed)
   1. Pipe:
      a. Furnish pipe meeting requirements of ASTM D1785, Schedule 80.
      b. Pipe 2 inches and less to be solvent welded.
      c. Pipe larger than 2 inches may be either flanged or solvent welded unless shown otherwise on Drawings.
   2. Fittings: Provide ASTM D2467 PVC socket type fittings, Schedule 80.
   3. Flanges/Unions:
      a. Furnish flanges and unions at locations shown on Drawings.
      b. Provide either flanges or unions at valves, penetrations through structures and equipment connections.
      c. For pipe larger than 2 inches, provide 150 pound socket type flat-faced PVC flanges.
      d. For pipe 2 inches and less, provide socket type PVC union with elastomeric O-rings.
   4. Flanged connections.
      a. Use flat, full faced gaskets.
      b. Furnish heavy hex head bolts, each with one heavy hex nut, ASTM F593 Type 316 stainless steel.
      c. Use spacers supplied by pipe manufacturer when mating raised-faced flanges to other flanges.
   5. Flexible Couplings:
      a. Provide flexible couplings at locations shown on the Drawings for pipe flexibility and expansion/contraction purposes.
      b. Unless otherwise specified, provide rubber expansion joints as manufactured by General Rubber Corporation, South Hackensack, New Jersey or equal.
   6. Provide coating system per the specification section.

2.3 PLASTIC TUBING

A. General: Provide tubing with fittings and appurtenances as shown on Drawings.

B. Polyethylene/PTFE Tubing:
   1. HDPE or PTFE tubing
   2. Provide tubing with working pressure of 100 psi at 70 degrees F.
   3. Maximum bend radius: 8 IN
   4. Design tubing with a minimum safety factor of 4 to 1 ratio of burst pressure to working pressure at all operating temperatures.
   5. Fittings:
      a. Compression type.
      b. Same material and working pressure as tubing.
      c. Use PE compression type adapters with threaded connection for transition to rigid pipe.

2.4 ELASTOMERS

A. Seals, O-rings and gaskets:
   1. Water and sewage: natural or synthetic rubber.
   2. Hypochlorite: Viton.
   3. Sodium hydroxide (caustic) or Carbon: EPDM.
   4. Citric Acid: Buna-N.

2.5 HIGH PERFORMANCE COATINGS

A. Plastic Piping:
   1. Environment: Outdoor Atmospheric
   2. Surface Preparation:
      a. SP-1 solvent wash, hand sanding, and SP-1 again to remove dust.
   3. Prime Coat:
      a. 3.0 to 4.0 mil Multi-Purpose Epoxy:
         1) Tnemec Series 108 primer or Sherman Williams equivalent.
   4. Finish Coat:
      a. 2.5 to 3.5 mil Aliphatic Acrylic Polyurethane:
         1) Tnemec Series 1095 topcoat Sherman Williams equivalent.
         2) Topcoat to include Titanium Dioxide for UV resistance.
         3) Color per Owner preference.
   5. All coatings from same manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION AND TESTING

A. Inspect pipe materials for defects in material and workmanship.

B. Verify compatibility of pipe and fittings.

C. Pressure testing
   1. 3/8”, 3/4” PVC Tubing, Citric Acid, Alkalinity, Carbon, Sodium Hypochlorite, SCH 80, test at 50 psi for 2-hours.
   2. Sewer Force Main: 3”, 4”, 6” DR-11 and SCH 80, 50 psi for 2-hours
   3. Water pressurized: 90 psi for 2-hours
   4. 4” PVC Carrier Pipe, SCH 80, no pressure test required, water flow test to demonstrate water tight, visual inspection of no leaks

3.2 PVC PRESSURE PIPING (EXPOSED)

A. Installation:
   1. Field threading PVC will not be permitted.

a. Provide threaded connections or attachments by the use of factory molded socket by male threaded adapters.
b. Socket by female threaded adapters are not acceptable.

2. Employ installation and pipe support practices and solvent welding all in compliance to the manufacturer's printed recommendation.
3. Perform installation procedures, handling, thrust restraint, connections, and other appurtenant operations in full compliance to the manufacturer's printed recommendations and in full observance to plan details when more stringent.
4. Pipe Support: See drawings and Section 40 05 07 – Pipe Support Systems.
   a. Continuously support PVC piping at liquid operating temperatures in excess of 100 DEGF.
   b. For vertical piping, band the pipe at intervals to rigidly support load of twice vertical load.
   c. Support riser clamps on spring hangers.
   d. Do not clamp PVC tightly or restrict movement for expansion and contraction.
5. Field Painting Application:
   a. Sand with 80-100 grit sandpaper to scarify surfaces.
   b. Provide prime coat to surfaces indicated to be coated.
   c. Brush, or back-roll as necessary to provide complete coverage.
   d. Apply subsequent coats within time limits required in coating manufacturer’s written instructions.
   e. Touch-Ups:
      1) Touch-up damaged coats using application method and materials provided for initial application of the same coat.
      2) Prepare area requiring touch-up in accordance with the “Preparation” Article of this Section.
   f. Cover all adjacent metal components with masking tape during painting application.

3.3 TUBING

A. Install per drawings and manufacturer’s recommendations.

3.4 PVC/ABS DWV PIPING

A. Installation:
   1. Install in accordance with Drawings and local codes.

END OF SECTION

SECTION 40 05 51
COMMON REQUIREMENTS FOR PROCESS AND UTILITY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Common requirements for all valves and associated appurtenances on the project.

B. Related Sections include, but are not necessarily limited to:
   1. Section 01 61 03 – Equipment - Basic Requirements.
   2. Section 09 96 00 – High Performance Industrial Coatings.
   3. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements.
   4. Section 40 05 52 – Miscellaneous Valves.
   5. Section 40 05 57 – Actuators for Process Valves and Gates.
   6. Section 40 05 61 – Gate Valves.
   7. Section 40 05 62 – Plug Valves.
   8. Section 40 05 63 – Ball Valves.
   9. Section 40 05 64 – Butterfly Valves.
   10. Section 40 05 65 – Globe Valves.

1.2 REFERENCES

A. Definitions:
   1. The following are definitions of abbreviations used in this Specification Section or one of the individual valve sections:
      a. CWP: Cold water working pressure.
      b. SWP: Steam working pressure.
      c. WOG: Water, oil, gas working pressure.
      d. WWP: Water working pressure.

B. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B1.20.1, Pipe Threads, General Purpose.
      b. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
      c. B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
      d. B16.34, Valves-Flanged, Threaded and Welding End.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. D256, Standard Test Methods for Determining the Izod Pendulum Impact Resistance 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. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C207, Standard for Steel Pipe Flanges for Waterworks Service - Sizes 4 inches through 144 inches.
      b. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      c. C504, Standard for Rubber-Seated Butterfly Valves.
      d. C507, Standard for Ball Valves, 6 inches through 48 inches (150 mm through 1200 mm).
      e. C509, Standard for Resilient-Seated Gate Valves for Water Supply Service.

f. C550, Standard for Protective Coatings for Valves and Hydrants.
g. C606, Standard for Grooved and Shouldered Joints.

4. American Water Works Association/American National Standards Institute (AWWA/ANSI):
   a. C111/A21.11, Standard for Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
5. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. MG 1, Motors and Generators.
6. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).

1.3 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings:
      a. Product technical data including:
         1) Acknowledgement that products submitted meet requirements of standards referenced.
         2) Manufacturer's installation instructions.
         3) Valve pressure and temperature rating.
         4) Valve material of construction.
         5) Special linings.
         6) Valve dimensions and weight.
         7) Valve flow coefficient.
      b. See Section 40 05 57 - Actuators for Process Valves and Gates for actuator submittal requirements.
         1) Actuators shall be submitted with their respective value as one submittal.

B. Informational Submittals:
   1. Test reports if required in the individual valve specification.

C. Closeout Submittals:
   1. Operation and Maintenance Data:
      a. Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of the individual valve Specification Sections, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, refer to individual valve Specification Sections for acceptable manufacturers.

2.2 MATERIALS

A. Refer to individual valve Specification Sections.

2.3 FABRICATION

A. Refer to individual valve Specification Sections for specifications of each type of valve used on Project.

B. End Connections:
   1. Provide the type of end connections for valves as shown on the Drawings.
   2. Comply with the following standards:
      a. Threaded: ASME B1.20.1.
      b. Flanged: ASME B16.1, Class 125 unless otherwise noted or AWWA C207.
      c. Bell and spigot or mechanical (gland) type: AWWA/ANSI C111/A21.11.
      d. Soldered: ASME B16.18.
      e. Grooved: Rigid joints per Table 5 of AWWA C606.

C. Nuts, Bolts, and Washers:
   1. Wetted or internal to be bronze or stainless steel.
      a. Exposed to be zinc or cadmium plated.
   2. Buried:
      a. Tee-Head bolts for mechanical joints: Per AWWA/ANSI C111/A21.11.
      b. Other bolts and nuts: ASTM A307 ASTM A193/A194 Grade B8M, Class 1.
      c. Wax Tape Coatings per AWWA C217.
   3. Exposed: Mechanical galvanized ASTM B695, Class 40 ASTM A193/A194 Grade B8M, Class 1.
   4. Heads and dimensions per ASME B1.1.
   5. Threaded per ASME B1.1.
   6. Project ends 1/4 to 1/2 inches beyond nuts.

D. On Insulated Piping: Provide valves with extended stems to permit proper insulation application without interference from handle.

E. Epoxy Interior Coating: Provide epoxy interior coating for all ferrous surfaces in accordance with AWWA C550.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Painting Requirements: Comply with Section 09 96 00 for High Performance Industrial Coatings.

C. Setting Buried Valves:
   1. Locate valves installed in pipe trenches where buried pipe indicated on Drawings.
   2. Set valves and valve boxes plumb.
   3. Place valve boxes directly over valves with top of box set at finished grade.
   4. Install valve in closed position.
   5. Place valve on firm footing in trench to prevent settling and excessive strain on connection to pipe.
   6. After installation, backfill up to top of box for a minimum distance of 4 feet on each side of box.

D. Support exposed valves and piping adjacent to valves independently to eliminate pipe loads being transferred to valve and valve loads being transferred to the piping.

E. For grooved coupling valves, install rigid type couplings or provide separate support to prevent rotation of valve from installed position.

F. Wax Tape Coating System:
   1. After installation, coat all buried nuts and bolts with a wax tape coating system in accordance with:
      a. AWWA C217 NACE International RP0375.
      b. Manufacturer’s printed instructions.
   2. Cut strips of wax tape and apply them around all bolts and nuts so that there are no voids or spaces under the tape.

3. Apply a sufficient amount of tape to completely encapsulate all bare metal.

G. For threaded valves, provide union on one side within 2 feet of valve to allow valve removal.

3.2 FIELD QUALITY CONTROL

A. Wax Tape Coating Testing:
   1. Inspect each wax tape-wrapped component.
      a. Verify primer was applied to substrate surfaces.
      b. Ensure the wax tape has fully encapsulated all portions of the substrate.
      c. Ensure that the wax tape is in full contact with the substrate.
      d. Verify that the wax tape has been applied to the specified thickness.
   2. Do not backfill until the inspection is complete and the wax tape application is approved by the Contracting Officer's Representative.

3.3 ADJUSTMENT

A. See section 40 05 57 for adjustment requirements related to actuators.

3.4 VALVE SCHEDULE

A. The Valve Schedules include tagging and general criteria for:
   1. All valves 2" and larger.
   2. All valves that are powered, regardless of size.

B. Valves shown on the Drawings, but not included in the Valve Schedules, are still the responsibility of the Contractor.

C.

END OF SECTION

SECTION 40 05 57
ACTUATORS FOR PROCESS VALVES AND GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Actuators for valves and gates.
      a. Manual actuators.
      b. Electric actuators.

B. Related Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.
   2. Section 01 81 33 - Cyber Security Requirements.
   3. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   4. Section 40 05 62 – Plug Valves.
   5. Section 40 05 63 – Ball Valves.
   6. Section 40 05 64 – Butterfly Valves.
   7. Section 46 07 53 – Packaged Wastewater Treatment Equipment.

1.2 REFERENCES

A. Definitions:
   1. The following are definitions of abbreviations used in this Section:
      a. CPU: Central Processing Unit.
      b. NRTL: Nationally Recognized Testing Laboratory.
      c. OEM: Original Equipment Manufacturer.
      d. OIT: Operator Interface Terminal.

B. Referenced Standards:
   1. American National Standards Institute/Underwriters Laboratory (ANSI/UL):
      a. 429, UL Standard for Safety Electrically Operated Valves.
      b. 50, UL Standard for Safety Enclosures for Electrical Equipment, Non-Environmental Considerations.
      c. 50E, UL Standard for Safety Enclosures for Electrical Equipment, Environmental Considerations.
   2. ASTM International (ASTM):
      a. A266, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      b. A269, Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A564, Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
      e. A693, Standard Specification for Precipitation-Hardening Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
   3. American Water Works Association (AWWA):
      a. C500, Standard for Metal-Seated Gate Valves for Water Supply Valves.
      b. C541, Standard for Hydraulic and Pneumatic Cylinder and Vane-Type Actuators for Valves and Slide Gates.
      c. C542, Standard for Electric Motor Actuators for Valves and Slide Gates.
      d. C550, Standard for Protective Coatings for Valves and Hydrants.
      e. C560, Standard for Cast-Iron Slide Gates.
      f. C561, Standard for Fabricated Stainless Steel Slide Gates.
      g. C562, Standard for Fabricated Aluminum Slide Gates.

h. C563, Standard for Fabricated Composite Slide Gates.
4. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. MG 1, Motors and Generators.
5. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC).

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: actuator manufacturers must have at least 100 installations with each type of proposed actuators.

1.4 ADMINISTRATIVE REQUIREMENTS

A. Coordination:
   1. Provide actuators that are fully compatible with valve or gate for which it is intended.
   2. Contractor to coordinate valve/gate manufacturer and actuator manufacturer for proper sizing of actuator.
      a. See below for safety factors.
   3. Mounting hardware by actuator manufacturer.
   4. Install actuators at valve/gate manufacturers facility to allow for testing prior to shipping to site.

1.5 SUBMITTALS

A. Action Submittals:
   1. Shop Drawings.
      a. Layout drawings with dimensions.
         1) Include those dimensions necessary for interfacing with valve/gate.
      b. Include wiring and control diagrams for electric, cylinder actuators, and electro-hydraulic actuators.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Torque or thrust output.
      c. Travel speed.
      d. Input power (voltage, phase, frequency).
      e. Input current draw.
      f. Control methodology.
      g. Control Accessories.
      h. Short Circuit Current Rating (SCCR) nameplate marking in accordance with NFPA 70.
         1) Include any required calculations in accordance with Section 01 61 03.
   3. Samples of the factory finish colors available at no additional cost to Owner for selection by Engineer.
   4. Test reports.

B. Informational Submittals:
   1. Manufacturer's installation instructions.
   2. Acknowledgement that the Manufacturer meets the number of installations criteria.
      a. Submit for each different manufacturer.
      b. Submit detailed installation list if requested by Engineer.
   3. Recommended storage procedures.
   4. Certificate of Proper Installation that includes verification from actuator manufacturer that actuators have been installed properly, that all limit switches and position potentiometers have been properly adjusted, and that the actuator responds correctly to the position command.
   5. Test Reports.

C. Closeout Information:

1. Operation and Maintenance Data:
    a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
    b. Lubrication Guide.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
    1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
    1. Manual Valve Actuators:
        a. By valve manufacturer.
    2. For other types of actuators, refer to the individual article for that actuator type for acceptable manufacturers.

2.2 MATERIALS

A. Refer to individual Articles for materials.

2.3 VALVE ACTUATORS

A. Valve Actuators - General:
    1. Refer to Section 01 81 33 - Cyber Security Requirements for cyber security related product requirements.
    2. Provide actuators as shown on Drawings or specified.
    3. Counter-clockwise opening as viewed from the top.
    4. Direction of opening and the word OPEN to be cast in handwheel or valve bonnet.
        a. Paint in a contrasting color such as white.
    5. Size actuator to produce required torque with a maximum pull of 80 pounds at the maximum pressure rating of the valve provided and withstand without damage a pull of 200 pounds on handwheel or chainwheel or 300 foot-pounds torque on the operating nut.
    6. Unless otherwise specified, actuators for valves to be buried, submerged or installed in vaults or manholes shall be sealed to withstand at least 20 FT of submergence.
    7. Valve Lockout Devices:
        a. Device manufactured from same material as valve actuator, preventing access to valve actuator, to accept lock shackle.
    8. Extension stem:
        a. Install where shown or specified.
        b. Solid steel with actuator key and nut, diameter not less than stem of valve actuator shaft.
        c. Pin all stem connections.
        d. Center in valve box or grating opening band with guide bushing.

B. Buried Valve Actuators:
    1. Provide 2 inch standard actuator nuts in accordance with AWWA C500, Section 3.16.
    2. Provide at least 2 tee handle keys for actuator nuts, with 5 feet extension between key and handle.
    3. Extension stem:
        a. Provide for buried valves greater than 4 feet below finish grade.
        b. Extend to within 6 inches of finish grade.

4. Cast Iron Valve Box:
    a. Comply with requirements for valve boxes and covers in Section 33 05 81 - Metallic Castings for Utility Structures.
5. Box base to enclose buried valve gear box or bonnet.
6. Provide concrete pad encasement of valve box as shown on Drawings for all buried valves unless shown otherwise.

C. Exposed Valve Manual Actuators:
1. Provide for all exposed valves not having electric, cylinder or electro-hydraulic actuators.
2. Provide handwheels for gate and globe valves.
    a. Size handwheels for valves in accordance with AWWA C500.
3. Provide lever actuators for plug valves, butterfly valves and ball valves 3 inches diameter and smaller.
    a. Provide lever actuators for butterfly valves with a minimum of five intermediate lock positions between full open and full close.
    b. Provide at least two levers for each type and size of valve furnished.
4. Gear actuators required for plug valves, butterfly valves, and ball valves 4 inches diameter and larger.
5. Provide gearing for gate valves 20 inches and larger in accordance with AWWA C500.
6. Gear actuators to be totally enclosed, permanently lubricated and with sealed bearings.
7. Provide chain actuators for valves 6 feet or higher from finish floor to valve centerline.
    a. Cadmium-plated chain looped to within 3 feet of finish floor.
    b. Equip chain wheels with chain guides to permit rapid operation with reasonable side pull without "gagging" the wheel.
    c. For smaller valves with lever or handle actuators, provide offset tee handles with attached chain for operation from the operating floor.
    d. Provide chain storage device for each chain.
        1) Chain-Away Bucket by Chain Away Corporation.
        2) Chain-Up by Trumbull Manufacturing.
        3) Or equal.
8. Provide cast iron floor stands where shown on Drawings.
    a. Stands to be furnished by valve manufacturer with actuator.
    b. Stands or actuator to include thrust bearings for valve operation and weight of accessories.

D. Submerged Actuators:
1. Install the valve actuator on top of an extension bonnet 3 feet above any adjacent personnel access.
2. Provide flanged, watertight bonnet to valve connection.
3. Provide a top brace support for the bonnet.
    a. Install the brace 6 inches below the top of the wall as shown.
4. Materials:
    a. Extension bonnet: Cast iron ASTM A126 or steel.
    b. Brace and anchor bolts: Type 304 stainless steel.

E. Electric Actuators: See Paragraph 2.6 below.

2.4 ELECTRIC MOTOR ACTUATORS

A. Comply with AWWA C542 as modified herein.

B. Provide actuators with a NRTL label.

C. General:
1. Provide electric motor actuators for valves and gates so indicated: on the Drawings, in valve/gate schedules in the Specifications, or elsewhere in the Contract Documents.
2. Size actuators for 125% of required torque to operate valve/gate under design pressure/head unless specified otherwise.

3. Unless otherwise specified, provide each electric motor actuator with integral control devices for operation, including pushbuttons.
    a. When actuator's integral control station would be 5 feet or more above the nearest operating floor, or when integral control station would be out of reach of facility personnel standing on the nearest operating floor:
        1) Integral control station on actuator is not required but does not need to be removed if integral to the valve.
        2) Provide remotely located control station, with pushbuttons, in accordance with this Section.
4. Locate and orient integral control station for ease of reading and use by personnel standing on nearest operating floor.
5. Locations of remotely located control stations: as shown on the Drawings.
    a. If location of remotely located operator station is not shown or indicated on the Drawings, obtain Engineer's direction on required location, which will be in reasonable proximity to associated actuator.
    b. Locate each remotely located control station approximately 4 feet above associated operating floor and position for ease of reading and operation.
    c. Furnish and install cabling between actuator and remote station if not provided by the actuator manufacturer.
6. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
    a. See Section 01 61 03 for information on how to determine the available fault current, such that, the SCCR rating meets or exceeds the available fault current.

D. Electric Motor Actuators (Standard Duty):
1. Furnish electric actuator integral with valve/gate consisting of:
    a. Motor.
    b. Gearing.
    c. Handwheel.
    d. Limit and torque switches.
    e. Lubricants.
    f. Heating elements.
    g. Wiring.
    h. Terminals for motor power and controls.
    i. Drive nut.
2. Multi-turn:
    a. For butterfly valves, ball valves, plug valves, odor control motorized dampers, and similar, provide quarter turn actuators.
3. Housing/enclosure:
    a. Provide cast iron gear housing and cast iron load bearing enclosure for motor, gearing and control assembly.
    b. Non load bearing enclosure and housing: Aluminum or cast iron.
    c. Rated for area classification shown on Drawings.
    d. Provide O-ring seals for covers and entries.
    e. Terminal and limit switch compartment covers are to be fastened to gear housing by stainless steel fasteners with capture device to prevent loss.
4. Motors:
    a. Provide motors suitable for 480V, 3PH, 60 HZ.
    b. Provide motors that are totally enclosed, high torque design made expressly for valve/gate actuator service and capable of operating the valve/gate under full differential pressure for complete open-close and reverse cycle of travel at least twice in immediate succession without overheating.
    c. Provide motors rated for continuous duty for modulating actuators.
    d. Provide motors in accordance with NEMA MG 1 standards where applicable, with Class F insulation with a Class B temperature rise, and to operate successfully at any voltage within 10% above or below rated voltage.

e. Provide positive method to ensure motor bearings are permanently lubricated.
f. Provide three thermal switches imbedded in windings:
    1) 120 degrees apart.
    2) Provide motor shutdown at high temperature.
g. Motor housing:
    1) Aluminum or cast iron.
    2) Totally enclosed nonventilated with cooling fins.
h. Provide motor capable of operating in any position.
i. Provide motor sealed from gearcase to allow any mounting position.

5. Gearing:
    a. Provide power gearing consisting of heat treated steel helical gears, carburized and hardened alloy steel worm, and alloy bronze worm gear, all grease or oil bath lubricated, designed for 100% overload, and effectively sealed against entrance of foreign matter.
    b. Provide gearing mechanism constructed to permit field changes of reduction gear ratio.
    c. Design actuators so that motor comes up to speed before stem load is encountered in either opening or closing operation.
    d. Limit switch gearings and feedback device reduction gearing:
        1) Steel or bronze.
    e. Support rotating shafts with anti-friction bearings.
    f. Provide separate drive nut/thrust bearing assembly:
        1) Mounted to base of actuator.
        2) High tensile bronze.
        3) Quarter turn actuator: Provide 90 degrees mounting intervals.
        4) Provide grease fitting on drive assembly.
6. Handwheel:
    a. Permanently attached for manual operation.
    b. Positive declutch mechanism to engage and disengage handwheel.
    c. Design such that handwheel does not rotate during motor operation.
    d. Design such that inoperable motor does not prevent manual operation.
    e. Direction of opening and the word OPEN to be cast in handwheel.
        1) Paint in a contrasting color such as white.
7. Limit torque and thrust loads in both closing and opening directions by torque limit switches or equivalent integral hardware and software programming.
    a. Provide torque switches with micrometer adjustment and reference setting indicator.
        1) Assure adjustment variation of approximately 40% in torque setting.
    b. Provide switches having rating of not less than 6 A at 120 Vac and 2.2 A at 115 Vdc.
    c. Provide limit and torque switches with totally sealed contacts.
8. Furnish electric actuator with two geared limit switch assemblies (or equivalent integral hardware and software programming) with each switch assembly having four separate limit switches:
    a. Assure each limit switch assembly is geared to driving mechanism and is independently adjustable to trip at any point at and between the fully open and fully closed valve position.
    b. Provide minimum of two normally open contacts and two normally closed contacts at each end of valve travel.
    c. Provide switches with inductive contact rating of not less than 1.5 A at 120 / 240 Vac, 1.5 A at 24 Vdc.
    d. Limit switches to be fully field adjustable when power is applied to actuator.
9. Size space heating elements to prevent condensation in both motor and geared limit switch compartment(s).
    a. Furnish heating elements rated at 120 Vac with heaters continuously energized.
10. Open-close actuator controls:

a. Provide control assembly with necessary holding relays, reversing starter, control transformers of sufficient capacity to provide control power, space heating element power and valve position transmitter.
b. Sealed, non-intrusive design.
c. Provide pushbutton station with enclosure rated for area classification shown on Drawings with:
1) Open pushbutton.
2) Close pushbutton.
3) Stop pushbutton.
4) Remote/local switch.
5) Full open light.
6) Full close light.
7) Open and close relays as required.
8) Provide control enclosure to accept:
a) Remote open/close control.
9) Provide contacts in control enclosure:
a) Remote status.
b) Full open status.
c) Full close status.
10) Wire all components to an internal terminal strip and include mounted wiring diagram inside enclosure.

11. Additional requirements for modulating valve/gate actuators:
a. Proportional position servo-amplifier installed integral with the actuator control compartment.
b. Positioning of valve: proportional to an input signal.
c. Servo-amplifier adjustments: zero, span, gain, and dead-band.
d. Provide position control as shown on the Drawings that interfaces with the position control/position feedback instrumentation wiring to and from [remote control device] PLC.
12. Input/output protocol. See Paragraph 2.5.
13. Acceptable Manufacturers:
a. Auma Actuators, Inc.
b. Emerson – Bettis.
c. Emerson – Keystone.
d. Flowserve Corporation – Limitorque.
e. Rotork plc.
f. Or equal.

2.5 COMMUNICATIONS PROTOCOL FOR POWERED ACTUATORS

A. Hard Wired
1. Dry contacts for discrete input/output.
2. 4-20 mA for position control/feedback for modulating vales/gates.

2.6 SOURCE QUALITY CONTROL

A. General:
1. Prior to shipping equipment from the production or fabrication facility, perform manufacturer's standard factory tests and inspections and submit documentation of successful completion to Engineer.

B. Standard Duty Electric Actuators:
1. Proof of Design Test: in conformance with AWWA C542 Section 5.2.
2. Performance Test: in conformance with AWWA C542 Section 5.3.

2.7 SPARE ACTUATORS AND PARTS

A. Provide one set of any special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Location and Orientation:
   1. Provide actuators and operators as shown on the Drawings.
   2. When not expressly shown on the Drawings, orient valve actuators so valve operator is in a position reasonably convenient for facility personnel.
      a. Unless otherwise shown, install electric or cylinder actuators above or horizontally adjacent to valve and gear box to optimize access to controls and external handwheel.
   3. When orientation of actuator, operator location, or both are unclear, submit to Engineer a request for interpretation and obtain Engineer's response before furnishing the associated Submittal and in no event, later than purchasing the associated valve and actuator.
   4. Contractor is responsible for costs and delays incurred to remedy valve actuators furnished or installed in inconvenient or difficult-to-access positions and locations unless the Contract Documents require otherwise.
   5. Contractor is not responsible for providing permanent platforms, stairs, or other extraordinary, permanent access measures unless so required by the Contract Documents.

C. Touch Up Painting Requirements:
   1. Repair scuffs and scratches on factory-applied finishes using materials furnished by the actuator manufacturer, applied in accordance with the written instructions of both the actuator manufacturer and the Supplier of the touch-up material(s).

3.2 FIELD QUALITY CONTROL

A. Demonstrate that all powered valves operate properly after installation.

B. See section 01 749 00 for Operator training requirements.

3.3 ADJUSTMENT

A. Adjust valves/gates, actuators, and appurtenant equipment to comply with Section 01 75 00.
   1. Operate valve, open and close at system pressures.

B. For all 120 Vac and 480 Vac electric and electro-hydraulic actuators, employ and pay for services of valve actuator manufacturer's field service representative to:
   1. Inspect valve actuators covered by this Section.
   2. Program/configure actuator integral software.
   3. Supervise adjustments and installation checks:
      a. Open and close valves electrically under local manual and demonstrate that all limit switches are properly adjusted and that switch contacts are functioning properly by verifying the inputs are received at the remote input/output (RIO) panels or local control panel as appropriate.
      b. Position powered modulating valves under local manual control and demonstrate that the valve position feedback potentiometer is properly adjusted and that the feedback signal is received at the RIO panels or local control panel as appropriate.
      c. Simulate a valve position command signal at the RIO panel or local control panel as appropriate and demonstrate that the valve is controlled to the desired position without excessive hunting.
   4. Submit to Government a Certificate of Proper Installation (COPI) from the valve actuator manufacturer that includes:
      a. Verification that the actuators have been installed properly.
      b. Verification that all limit switches and position potentiometers have been properly adjusted.
      c. Verification that the valve actuator responds correctly to the valve position command.

END OF SECTION

SECTION 40 05 59
FABRICATED STAINLESS STEEL SLIDE GATES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Fabricated Stainless Steel Slide Gates.

B. Related Requirements:
   1. Division 00 - Procurement and Contracting Requirements.
   2. Division 01 - General Requirements.
   3. Section 01 61 03 - Equipment - Basic Requirements.
   4. Section 03 41 33 – Precast and Prestressed Concrete
   5. Section 09 96 00 - High Performance Industrial Coatings.
   6. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   7. Section 46 21 40 - Mechanically Cleaned Screens – In Channel Auger

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Water Works Association (AWWA):
      a. C561, Fabricated Stainless Steel Slide Gates.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. Society for Protective Coatings/NACE International (SSPC/NACE):
      a. SP 5/NACE No. 1, White Metal Blast Cleaning.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
   2. See Section 01 61 03.
   3. Product technical data including:
      a. Acknowledgment that products submitted meet the requirements of standards referenced.
      b. Calculations that demonstrate compliance with the deflections, stress and factor of safety specified.
      c. Certified drawings and material specifications for all components.
      d. Test records.
         1) Performance Test
         2) Field Leakage Test

B. Operation and Maintenance Manuals:
   1. See Specification Section 01 33 00 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.

C. Affidavit of Compliance: See AWWA C561.

1.4 WARRANTY

A. The manufacturer will warrant against any defects in material or workmanship to the gate and framework. This warranty will commence upon delivery of the products and will expire on two (2) years fro m substantial completion of the installation of the product.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. RW Gate Company
   2. Whipps
   3. Aquanox / Fontaine
   4. Hydro-Gate (Mueller)
   5. Golden Harvest
   6. Rodney-Hunt – Jash
   7. Waterman
   8. Or approved equal.

2.2 MATERIALS

A. General: Provide gates, stems, lifts and other appurtenances of size, type, material and construction shown on the Contract Drawings and as specified herein.

B. Comply with requirements of Section 01 61 03.

C. Gates: Meet all requirements of AWWA C561 as modified per this Section.
   1. Leakage rate: Must meet AWWA C561 at design seating and unseating head.

D. Materials:
   1. Materials subject to dezincification or dealuminization prohibited.
   2. "L" grades for all welded components.
   3. Thimble, frame, guides, slide, yoke and stem guides:
      a. Stainless steel, Type 304 and Type 304L.
   4. Gear housing:
      a. Cast iron, steel or ductile iron.
   5. Actuator operator box:
      a. Stainless steel, Type 304.
   6. Rising stem thrust nuts:
      a. Stainless steel, Type 304.
   7. Stem couplings:
      a. Stainless steel, Type 304.
   8. Stem guide bushings:
      a. Cast or extruded UV stabilized UHMW-PE.
   9. Stems:
      a. Stainless steel, Type 304.
   10. Seals:
      a. UV stabilized UHMW-PE.
   11. Anchor bolts and fasteners:
      a. Stainless steel, Type 304
   12. Flush-bottom sill retainer:
      a. Stainless steel, Type 304
   13. Wedges and Pressure Pads:
      a. UV stabilized UHMW-PE if required.

E. Fabrication: One-piece frames.
   1. One-piece frame:
      a. Non self-contained
   2. Flush bottom seals:
      a. Bottom: Concrete embedded
      b. Contractor to coordinate concrete embedding sizing requirements with gate manufacturer and precast concrete manufacturer.
      c. Easily replaceable without disassembly of the gate.

3. Side and top seals of gate:
   a. Sides: Per schedule below.
   b. Top: None
   c. Replaceable without removing gate or without dewatering.
4. Wall thimbles: Furnished by gate manufacturer when specified.

2.3 GATE OPERATORS AND LIFTS

A. General:
   1. Provide lifts in accordance with AWWA C541, or as modified in this Section.

B. Non-Rising Stem:
   1. Square nut operator box: flush mounted to finished floor elevation per Drawings.
   2. Provide compatible operating nut key for manual operation.

C. Manual Operators:
   1. Equip the lift mechanism with a pedestal, torque tube, or baseplate, machined and drilled for mounting the lift housing and ready for bolting to the operating floor, top wall mounting bracket, or gate yoke, as shown on Drawings or specified.

2.4 FABRICATION

A. Specified in AWWA C561.

B. Welded Stainless Steel: Passivated after fabrication.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Employ and pay for services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Section.
   2. Supervise adjustments and installation checks.
   3. Provide test equipment, tools, and instruments necessary to accomplish equipment testing.
   4. Conduct initial start-up of equipment, perform operational checks, and supervise acceptance testing.
   5. Provide, through Contractor, a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Owner's personnel.
   6. Instruct Owner's personnel on operation and maintenance of furnished equipment.
   7. Field Leakage Test for Stainless Steel Slide Gates: Test gate under design seating head and adjust to maximum leakage specified.
      a. Minimum leakage test time of 4 hours
      b. Adjust results relative to concurrent pan evaporation rate

3.3 GATE SCHEDULE:

A. The following table is a schedule of the fabricated slide gates.

GATE EQUIPMENT ID#	OPENING WIDTH (IN)	OPENING TO TOP OF GATE (IN)	DESIGN HEAD, (FT) [a] SEATING	DESIGN HEAD, (FT) [a] UNSEATING	OPENING DIRECTION [b]	TYPE OF CLOSURE [c]	TYPE OF LIFT MECHANISM [d]	RISING OR NON-RISING STEM [e]
SG-1011	16	13	1	1	Up Op	Side 1 WM, Side 2 ICM / FB Bottom	SQN -Flush Mount Box	NR

GATE EQUIPMENT ID#	OPENING WIDTH (IN)	OPENING TO TOP OF GATE (IN)	DESIGN HEAD, (FT) [a] SEATING	UNSEATING	OPENING DIRECTION [b]	TYPE OF CLOSURE [c]	TYPE OF LIFT MECHANISM [d]	RISING OR NON-RISING STEM [e]
SG-1012	16	13	1	1	Up Op	ICM Both Sides / FB Bottom	SQN - Flush Mount Box	NR

Abbreviations:

a Design Head: Measured from surface of water to centerline of gate, in feet.
b Opening Direction: Dn Op = Downward Opening; Up Op = Upward Opening.
c Type of Closure: W = Weir Service; FB = Flush Bottom (Embedded); FM = Face Mounted, WM = Wall Mounted, ICM = In Channel Mounted
d Type of Lift Mechanism: Ped = Pedestal; Elec = Electric; Hdwl = Handwheel; Hyd = Hydraulic, CH = Crank Handle, SQN = Square Nut.
e Rising or Nonrising Stem: R = Rising; NR = Nonrising.
f Thimble Required: Wall Thimble is required = YES; Wall Thimble is not required = No.

END OF SECTION

SECTION 40 05 61
GATE VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Gate valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   2. Section 40 05 57 – Actuators for Process Valves and Gates.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
   2. American Water Works Association (AWWA):
      a. C500, Standard for Metal-Seated Gate Valves for Water Supply Service.
      b. C504, Standard for Rubber-Seated Butterfly Valves.
      c. C550, Standard for Protective Epoxy Interior Coatings for Valves and Hydrants.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-9, Spot Facing for Bronze, Iron and Steel Flanges.
      b. SP-70, Cast Iron Gate Valves, Flanged and Threaded Ends.
      c. SP-80, Bronze Gate, Globe, Angle and Check Valves.
   4. NSF International (NSF):
      a. 61, Drinking Water System Components - Health Effects.

1.3 DEFINITIONS

A. OS&Y: Outside Screw and Yoke.

B. NRS: Non-rising Stem.

C. RS: Rising Stem.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 40 05 51.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

2.2 VALVES: WATER (HOT, COLD, HEATING, COOLING, SERVICE, PROCESS, POTABLE, NON-POTABLE, AND WASTEWATER)

A. Resilient Wedge Gate Valves, 2 to 48 inches (Water, Wastewater Application):
   1. Comply with AWWA C509.
   2. Materials:
      a. Stem and stem nut: Bronze.
         1) Wetted bronze parts in low zinc bronze.
         2) Aluminum bronze components: Heat treated per AWWA C504.
      b. Body, gate: Cast iron.
      c. Resilient wedge: Ethylene Propylene Diene Monomer (EPDM).
   3. Design requirements:
      a. Minimum 200 PSIG working pressure.
      b. Buried: NRS, O-ring stem seal, 2 inches square operating nut.
      c. Exposed: OS&Y, stuffing box stem seal, handwheel.
      d. Counter clockwise open rotation.
      e. Fusion bonded epoxy coating interior and exterior except stainless steel and bearing surfaces.
         1) Comply with AWWA C550.
         2) Wetted bronze parts in low zinc bronze.
         3) Aluminum bronze components: Heat treated per AWWA C504.
   4. Manufacturers:
      a. American Flow Control.
      b. Or equal.

2.3 ACCESSORIES

A. Refer to Drawings for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 57 for actuator requirements.

2.4 FABRICATION

A. General:
   1. Provide valves with clear waterways the full diameter of the valve.

B. Spot valves in accordance with MSS SP-9.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 40 05 51.

B. Where larger buried valves utilize smaller bypass valves, provide a second valve box installed over the bypass valve operating nut.

C. Do not install gate valves inverted or with the stems sloped more than 45 degrees from the upright unless the valve was ordered and manufactured specifically for this orientation.

END OF SECTION

SECTION 40 05 62
PLUG VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Plug valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 51 – Common Requirements for Process and Utility Valves.
   2. Section 40 05 57 - Actuators for Process Valves and Gates.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125 and 250.
   2. ASTM International (ASTM):
      a. A126, Standard Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
      b. A536, Standard Specification for Ductile Iron Castings.
      c. D2240, Standard Test Method for Rubber Property-Durometer Hardness.
   3. American Water Works Association (AWWA):
      a. C517 Resilient-Seated Cast-Iron Eccentric Plug Valves

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 40 05 51.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. See Specification Section 40 05 51.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.

2.2 NON-LUBRICATED ECCENTRIC PLUG VALVES (SEWAGE, SLUDGE)

A. Manufacturers:
   1. DeZurik.
   2. Or equal.

B. Materials:
   1. Body: Cast-iron ASTM A126, Class B.
   2. Plug: One or two-piece construction ductile iron, ASTM A536 65-45-12 or cast iron, ASTM A126 Class B.
   3. Plug facing: Grease and/or petroleum-resistant resilient Neoprene or Buna-N compound, 70 Type A durometer hardness per ASTM D2240.
   4. Shaft bearing bushings: Permanently lubricated TFE or Delrin sleeve type stainless steel or bronze.
   5. Valve seats: Welded-in overlay of 90% nickel, (minimum 1/8 inches thick).
   6. Stem seal: per AWWA C517, Section 4.4.7.

2.3 ACCESSORIES

A. Refer to Drawings for type of actuator.
   1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 57 for actuator requirements.

2.4 DESIGN REQUIREMENTS

A. Non-Lubricated Eccentric Plug Valves (Wastewater, Sludge):
   1. Port area:
      a. Valves 4 inches through 20 inches: Equal to or exceed 80% of full pipe area.
      b. Valves greater than 20 inches: 100% equivalent full pipe area.
   2. Valve body: Fitted with bolted bonnet.
   3. End connections: See Specification Section 40 05 51.
   4. Stem seal: Adjustable and replaceable without disassembling valve or bonnet.
   5. Designed for seating drip tight in any flow direction.
   6. Rating:
      a. 1/2 through 12 inches, 175 psi working pressure.
      b. 14 through 36 inches, 150 psi working pressure.
      c. Three-way valves, 125 psi working pressure.
   7. Actuator:
      a. Actuator gearing in enclosure suitable for running in oil with seals on shaft to prevent entry of dirt or water.
      b. Positive identification on actuator indicating valve position.
      c. Adjustable stop to set closing torque.

2.5 FABRICATION

A. See Specification Section 40 05 51.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 40 05 51.

B. Install valves with valve stem horizontal, plug seat on inlet side and with plug rotating up into the open position for valves in horizontal lines.

C. Install valve with actuator above pipe or plug centerline.

END OF SECTION

SECTION 40 05 63
BALL VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Ball valves.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   2. Section 40 05 57 - Actuators for Process Valves and Gates.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A216, Standard Specification for Stee; Castings, Carbon, Suitable for Fusion Welding, for High Temperature Service.
      d. A276, Standard Specification for Stainless Steel Bars and Shapes.
      e. A351, Standard Specification for Castings, Austenitic, for Pressure-Containing Parts.
      f. B637, Standard Specification for Precipitation-Hardening and Cold Worked Nickel Alloy Bars, Forgings, and Forging Stock for Moderate or High Temperature Service.
   2. American Water Works Association (AWWA):
      a. C507, Standard for Ball Valves, 6 inches through 48 inches.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-110, Ball Valves; Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends.

1.3 DEFINITIONS

A. PVDF: Polyvinylidene fluoride.

B. PTFE: Polytetrafluoroethylene.

C. RPTFE: Reinforced PolyTetraFluoroEthylene.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 40 05 51.
   2. Test results for AWWA valves.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient

characteristics are not characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:

1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.

2.2 METALLIC BALL VALVES 1/4 TO 4 INCHES DIAMETER

A. Comply with MSS SP-110.

B. Manufacturers:
   1. Apollo.
   2. Or Equal.

C. Materials (All Stainless Steel):
   1. Body: Three-part stainless steel, ASTM A351 CF8M.
   2. Ball: Stainless steel ASTM A276.
   3. Seats: RPTFE.

D. Design Requirements:
   1. Rated for a minimum of:
      a. 500 psi CWP.
      b. 150 psi of saturated steam.
      c. 29 inches vacuum.
   2. Two-position lockable handle.
   3. Stem with blowout-proof design.
   4. Balancing stop for all applications.
   5. Bodies with mounting pad for applications requiring actuators.

2.3 PLASTIC BALL VALVES: 1/2 INCHES TO 4 INCHES DIAMETER

A. Manufactuers:
   1. Chemtrol/NIBCO.
   2. Or Equal.

B. Materials:
   1. Body, stem, ball, handle, end connectors:
      a. PVC ASTM D1784-12454B or CPVC ASTM D1784-23447-B.
         1) Material to match connecting piping.
   2. Ball Seat: Teflon.
   3. O-rings: Viton

C. Design Requirements:
   1. Rated at 150 psi at 75 degrees F.
   2. Double or "true union" design.
   3. Blocks both directions, upstream and downstream.
   4. Union nut capable of compensating for seat wear.
   5. Body with mounting pad for actuators where required.
   6. Capable of being disconnected at downstream end under full line pressure.
   7. Sodium hypochlorite service:
      a. Provide "vented" ball valves for all service with greater than 5% concentrated sodium hypochlorite.

2.4 ACCESSORIES

A. Refer to Drawings for type of actuators.
   1. Furnish actuator integral with valve.

B. Refer to Specification Section 40 05 57 for actuator requirements.

2.5 SOURCE QUALITY CONTROL

A. Furnish record of test.

B. Product Testing non-AWWA C507 ball valves: MSS SP-110.

2.6 SPARE ACTUATORS AND PARTS

A. Provide one set of any special tools or wrenches required for operation or maintenance for each type valve.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 40 05 51.

END OF SECTION

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SECTION 40 05 64
BUTTERFLY VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. General use butterfly valves.
   2. High performance butterfly valves – water service
   3. High performance butterfly valves – air service

B. Related Sections include but are not necessarily limited to:
   1. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements.
   2. Section 40 05 51 – Common Requirements for Process and Utility Valves.
   3. Section 40 05 57 – Actuators for Process Valves and Gates.

1.2 REFERENCES

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.5, Pipe Flanges and Flanged Fittings - NPS 1/2 Through NPS 24.
   2. ASTM International (ASTM):
      a. A48, Standard Specification for Gray Iron Castings.
      b. A126, Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings.
      c. A276, Standard Specification for Stainless Steel Bars and Shapes.
      d. A395, Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures.
      e. A436, Standard Specification for Austenitic Gray Iron Castings.
      f. A536, Standard Specification for Ductile Iron Castings.
   3. American Water Works Association (AWWA):
      a. C504, Standard for Rubber-Seated Butterfly Valves.
      b. C519, Standard for High-Performance Butterfly Valves – 3 In. through 60 In.
   4. NSF International (NSF).
      a. NSF/ANSI 61 - Drinking Water System Components – Health Effects.

1.3 SUBMITTALS

A. Action Submittals:
   1. See Specification Section 40 05 51.

B. Informational Submittals:
   1. For valves 8 inches and larger, furnish "Affidavit of Compliance" with Government in accordance with AWWA C504 and C519.
   2. For all modulating and control valves:
      a. Cv curves for applicable valve sizes.
      b. X_T curves for applicable valve sizes (air/gas service only).
      c. Associated actuator information (See Section 40 05 57).

C. Closeout Submittals:
   1. Operation and Maintenance Data:
      a. Submit in accordance with Section 01 78 23 - Operation and Maintenance Data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. General Use BFVs (Flanged and MJ):
      a. DeZurik.
      b. Or equal.
   2. General Use BFVs (Grooved):
      a. Victaulic.
      b. Or equal.
   3. High Performance BFVs (Process air service only):
      a. Henry Pratt.
      b. Or equal.
   4. High Performance BFVs (All other service):
      a. DeZurik.
      b. Or equal.

2.2 GENERAL USE BUTTERFLY VALVES

A. For use in all locations, except where high performance butterfly valves are required as indicated in the Valve Schedules located in specification Section 40 05 51.

B. Comply with AWWA C504, except as noted in this Specification Section.

C. Materials:
   1. Valve bodies:
      a. ASTM A126, Class B or ASTM A536 Grade 65-45-12 ductile iron.
   2. Valve shafts:
      a. Shaft and pin material: Type 304 stainless steel.
      b. Bushings/Packing/O-rings: EPDM, Nylatron, RTFE or TFE.
      c. Bearings: Nylatron, Reinforced TFE, or equal.
   3. Valve discs:
      a. Cast iron with welded 304 stainless edge or Type 304 Stainless Steel disk.
   4. Valve seats:
      a. Water: EPDM or Hycar.
         1) EPDM only for valves potentially exposed to chlorinated water.
      b. Compressed air: Teflon, PTFE.
      c. Process air: Peroxide cured EPDM, Viton, RTFE, rated for 300 degrees F minimum or higher if required by service.
      d. Located in valve body.
   5. Shaft bearing: Bronze, TFE-coated stainless steel or reinforced TFE.
   6. Shaft seal in addition to any sealing provided by seat: Suitable synthetic rubber rings or PTFE V-ring suitable for operating conditions.

D. Design Requirements:
   1. Shaft design
      a. Valves 16-inch and less: One-piece.
      b. Valves greater than 16-inch: one-piece or two-piece (stub shaft).
   2. Seat type: Resilient.

3. Body type (exposed and submerged):
   a. Flanged.
      1) Fully tapped anchor lugs drilled per ASME B16.5.
   b. Grooved ends.
      1) Victaulic rolled groove, Type 77, or equal.
   c. Valves 24 inch and greater: short body flanged.
4. Working Pressure Rating (exposed and submerged): See Valve Schedules in Section 40 05 51.

2.3 HIGH PERFORMANCE BUTTERFLY VALVES

A. In locations where reliability is critical, for automated valves that modulate for flow control or actuate periodically in intervals less than 2 hours, high performance butterfly valves with an offset disc design shall be used.
   1. See Valve Schedules located in Section 40 05 51 for identification of high performance butterfly valves.

B. Design Requirements:
   1. Comply with AWWA C519 except as noted herein.
   2. Shaft:
      a. One-piece shaft.
      b. Separate shaft seal.
      c. Minimum shaft diameter to conform to AWWA C519.
   3. Seat located in valve body.
   4. Valve design tested to 1,000,000 cycles.
   5. Bi-directional drip tight seat.
   6. Double-offset disc design to provide 360-degree sealing.
   7. Packing: Multiple v-ring PTFE or braided carbon graphite including anti-extrusion ring.
   8. Throttling Performance:
      a. Valve flow coefficient (Cv) curves must meet the following:

VALVE SIZE	DEGREE OF VALVE OPENING		
	20	50	90
3-IN	15 +/- 5	80 +/- 10	225 +/- 20
4-IN	25 +/- 5	150 +/- 15	410 +/- 25

      b. Valve terminal pressure drop ratio (X_T) must exceed the following:

VALVE SIZE	DEGREE OF VALVE OPENING		
	20	50	90
2-IN TO 8-IN	0.5	0.4	0.2

C. Materials of construction:
   1. Body: Carbon steel – ASTM 216 Grade WCB.
   2. Disc: Type 316 or CF8M stainless steel.
   3. Shaft and pins: 17-4PH stainless steel or Type 316 stainless steel.
   4. Seals:
      a. Water: PTFE.
      b. Process air and high temperature: Graphite rings.
         1) Designed for continuous operation at 300 DEG F.
   5. Backing ring: Stainless steel.
   6. Bushings/Bearings: TFE/Glass liner with a 316 Stainless steel shell.
   7. Seat:
      a. Two part with encapsulated RTFE or PTFE.
         1) Designed for continuous operation at 300 DEG F (process air service).

2) Seat Retainer: Titanium or Nickel-Chromium Alloy (for oxidizing service).
3) Seat Retainer: Match valve body material (for process air service).

8. End connection: Lug-wafer.
   a. Class 250 valves: Flanged at dead ends.

2.4 ACCESSORIES

A. Refer to Drawings and/or Valve Schedules for type of actuators.
   1. Furnish actuator integral with valve.
   2. Provided by valve manufacturer and installed at valve manufacturer's facility.

B. Refer to Section 40 05 57 for actuator requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Section 40 05 51.

END OF SECTION

SECTION 40 05 66
CHECK VALVES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Check valves 2.5-inch diameter and smaller.
   2. Swing check valves, three-inch to 24-inch diameter.
   3. Double door check valves.
   4. Ball check valves, 0.5-inch to two-inch diameter.

B. Related Requirements: Include but are not necessarily limited to:
   1. Section 40 05 51 - Common Requirements for Process and Utility Valves.

1.2 REFERENCES

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250.
   2. American Water Works Association (AWWA):
      a. C508, Standard for Swing-Check Valves for Waterworks Service, 2 in. through 24 in. NPS.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry Inc. (MSS):
      a. SP-71, Gray Iron Swing Check Valves, Flanged and Threaded Ends.
      b. SP-80, Bronze Gate, Globe, Angle and Check Valves.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Valve Manufacturers:
      a. Manufacturer shall be a business regularly engaged in manufacturing and furnishing check valves of the type required and similar equipment.
      b. Manufacturer shall be able to document having furnished not less than 50check valves, of the type required, of size equal to or larger than those required for the Work, during the past five years.
      c. When requested by Contracting Officer's Representative, submit qualifications statement indicating manufacturer's record of manufacturing and furnishing check valves of the types and sizes required and furnish documentation of compliance with qualifications requirements of this Article.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. In accordance with Section 40 05 51.

B. Informational Submittals: Submit the following:
   1. In accordance with Section 40 05 51.
   2. Manufacturer's Instructions:
      a. Manufacturer's written instructions for delivery, handling, storage, installation, and startup.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit in accordance with Section 01 78 23 - Operations and Maintenance Manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the manufacturers listed under the specific valve types are acceptable.

2.2 MATERIALS AND EQUIPMENT – GENERAL

A. For service in potable water applications or water that will be treated to become potable, materials and equipment shall be in conformance with NSF/ANSI 61.

2.3 CHECK VALVES: 2.5 INCHES AND SMALLER

A. Class 125 Bronze Swing Check Valves (Compressed Air, Water):
   1. Comply with MSS SP-80.
   2. Manufacturers:
      a. Nibco T413-V.
      b. Or Equal.

B. Materials
   1. Body, bonnet, disc: Bronze.

C. Design requirements
   1. 125 psi steam to 406 degrees F, 200 psi WOG.
   2. Horizontal swing, renewable disc.

2.4 SWING CHECK VALVES: 3 INCHES TO 24 INCHES

A. Swing Check Valves (Water, Wastewater, Sludge):
   1. Comply with AWWA C508.

B. Manufacturers:
   a. GA Industries.
   b. Or Equal.

C. Materials:
   a. Body and cover: Cast iron.
   b. Seat ring, hinge: Bronze.
   c. Disc:
      1) 3 to 4 inches: Bronze.
      2) 6 to 24 inches: Cast iron with bronze face
   d. Hinge shaft: Stainless steel.
   e. Bearings, connecting hardware: Bronze.

D. Design requirements:
   a. 175 psi working pressure (3 to 12 inches).
   b. 150 psi working pressure (14 to 24 inches).
   c. Furnish with outside weight and lever or lever and spring.

2.5 DOUBLE DOOR CHECK VALVES

A. Process Air
   1. Class 125

B. Manufacturers:
   1. APCO Series 9000
   2. Or Equal.

C. Materials:
   1. Body: Cast iron wafer style.
   2. Doors:
      a. 2 to 12 inches: Aluminum bronze.
      b. 14 to 54 inches: Ductile iron, bronze faced.
   3. Hinge and stop pins: Stainless steel, 316.
   4. Spring: Stainless steel, T316.
   5. Seat: Buna-N

2.6 BALL CHECK VALVES: 1/2 INCHES TO 4 INCHES

A. Manufacturers:
   1. R&G Sloane.
   2. Or equal.

B. Performance Criteria:
   1. Pressure Rating: 150 psi at 73 degrees F.

C. Materials:
   1. Body: PVC
   2. Ball: Glass filled or polypropylene.
   3. Seals: Viton or EPDM.

D. Design Requirements:
   1. Connectors: Double union.

2.7 SOURCE QUALITY CONTROL

A. Factory Tests and Inspections:
   1. Perform manufacturer's standard factory tests and inspections on materials and equipment furnished. Correct defects prior to shipment to the Site.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation – General:
   1. Provide check valves at locations shown and indicated in the Contract Documents.
   2. Install in accordance with the Contract Documents and manufacturer's written instructions. In event of conflict between the Contract Documents and manufacturer's written instructions, obtain written interpretation or clarification from Contracting Officer's Representative.
   3. Comply with:
      a. Section 01 61 03 - Equipment - Basic Requirements.
      b. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements
      c. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   4. Before installing, ensure each check valve is clean and free of dirt and debris.

3.2 FIELD QUALITY CONTROL

A. Field Tests and Inspections:
   1. Promptly after installing, before installing connecting pipe, verify proper and free operation of check valve.
   2. Hydrostatically test check valves together with associated piping.
   3. To extent practical, prior to Substantial Completion, verify proper operation of each installed check valve.

END OF SECTION

SECTION 40 41 13
HEAT TRACING CABLE

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Heat tracing cable as required for heat tracing of pipes as indicated on the Drawings.

B. Related Sections include but are not necessarily limited to:
   1. Section 26 05 00 - Electrical - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data:
      a. Power requirements for each circuit based upon actual length of heat trace and maintained temperature.
      b. Circuit breaker rating based upon inrush current at minimum expected start-up temperature.
      c. Length of heat tape for each pipe size and run.
      d. Coordinate and verify length and Watts/FT of heat tape required based upon pipe size and insulation thickness.
         1) Include the calculations to support the heat tape output.
      e. See Section 26 05 00 for additional requirements.
   2. Fabrication and/or layout drawings:
      a. Wiring diagrams showing physical locations of thermostats and heat trace power supply.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
   1. Test reports: Megger test results.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Shall be stored such that they are not exposed to sunlight or other UV rays.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

B. Subject to compliance with the Contract Documents, the following Manufacturers are acceptable:
   1. Raychem Corp.
   2. Or Approved Equal.

2.2 HEAT TRACING

A. Design Parameters:
   1. Pipe diameter, length and material: See Drawings and relevant piping Specifications.
   2. Flange, valve, pipe support size: See Drawings and relevant piping Specifications.
   3. Pipe insulation type and thickness: See Drawings and relevant piping Specifications.
   4. Temperatures requirements:
      a. Low ambient temperature for the specific location: -20 DEGF.
      b. Start-up temperature (alarm thermostat set point):
         1) Water/wastewater lines: 40 DEGF.
         2) Caustic feed lines: 80 DEGF.
      c. Maintain temperature (power thermostat set point):
         1) Water/wastewater lines: 40 DEGF.
         2) Caustic feed lines: 80 DEGF.
      d. High temperature exposure with power off: 185 DEGF.
   5. Wind factor for the specific location: 10 MPH.
   6. Electrical requirements:
      a. Voltage: 120 V.
      b. Circuit breaker: Field coordinate if other than 20A GFEPCI type.
   7. Safety factor: 10%.

B. Self-regulating or power-limiting parallel circuit construction consisting of an inner core of conductive material between parallel copper bus wires, with inverse temperature - conductivity characteristics with metal overbraid.

C. Thermostats adjustable between 35 and 200 degrees F minimum with maximum differential range of 9 degrees F, furnished complete with NEMA 4 enclosures in all areas, stainless steel temperature bulb and capillary.

D. All necessary or required components and accessories, such as power connection boxes, end seals, straps, tape and fitting brackets.

E. In noncorrosive and nonhazardous locations, insulation shall be Polyolefin.

F. In corrosive, hazardous and hydrocarbon locations insulation shall be Fluoropolymer (Teflon).

PART 3 - EXECUTION

3.1 PREPARATION

A. Install materials after piping has been tested and approved.

3.2 INSTALLATION

A. Insulate and heat trace wet pipe systems as indicated on Drawings.

B. Install materials in accordance with manufacturer's instructions.
   1. Each circuit shall not exceed the manufacturer's recommended maximum length.

C. For Metallic Piping:
   1. Heat tracing shall be installed completely wired.
   2. Cut heat trace to lengths as required and secure to pipe with glass or polyester fiber tape.

D. For Nonmetallic Piping:

1. Allow for extra heat trace output because nonmetallic pipe has a lower heat transfer.
    a. Heat tracing shall be installed completely wired.
2. Cut heat trace to lengths as required and secure to pipe with aluminum tape throughout the length of the trace.

E. Protection and Control Requirements:
1. Protection by a GFEPCI circuit breaker.
    a. Breaker amperage rating shall be coordinated with Contractor when different than the Contract Drawings.
2. Provide an ambient sensing thermostat for power and line sensing thermostat for alarm.
3. The alarm thermostat shall be placed on the opposite end of the circuit from the power thermostat or power connection to allow for annunciation of partial failure of a circuit or the loss of power from a tripped GFEPCI circuit breaker.
4. Provide a monitoring module that monitors the voltage (circuit breaker status) to each circuit.
5. The alarm from the alarm thermostat and monitor module shall be annunciated on the indicated control system.

3.3 TESTING

A. Megger the cables at the manufacturers recommended voltage level three times.
1. Before installation.
2. After attachment to pipe but before insulation is installed.
3. After pipe insulation is installed but before energization.

END OF SECTION

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SECTION 40 42 00
PIPE, DUCT AND EQUIPMENT INSULATION

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Insulation:
      a. Piping insulation.
      b. Equipment insulation.
   2. Adhesives, mastics, sealants, and finishes.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 22 05 03 - Pipe and Pipe Fittings – Plumbing Systems
   2. Section 40 05 07 - Pipe Support Systems.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ASTM International (ASTM):
      a. C177, Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of Guarded-Hot-Plate Apparatus.
      b. C411, Standard Test Method for Hot-Surface Performance of High-Temperature Thermal Insulation.
      c. C423, Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
      d. C553, Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.
      e. C612, Standard Specification for Mineral Fiber Block and Board Thermal Insulation.
      f. D1056, Standard Specification for Flexible Cellular Materials-Sponge or Expanded Rubber.
      g. E96, Standard Test Methods for Water Vapor Transmission of Materials.
      h. F25, Standard Test Method for Sizing and Counting Airborne Particulate Contamination in Cleanrooms and Other Dust-Controlled Areas.
      i. C518, Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.
      j. E84, Standard Test Method for Surface Burning Characteristics of Building Materials.
      k. E119 Standard Method of Fire Tests of Building Construction, 2 Hour Wall Panel Test, 2 Hour External Total Engulfment Test, hose stream evaluation.
      l. E136, Combustion Characteristics of Building Materials in a Vertical Tube Furnace.
      m. E162, Surface Flammability of Materials.
      n. E814, Through-Penetration, 2-Hour Firestop Test.
   2. National Fire Protection Association (NFPA):
      a. 255, Standard Method of Test of Surface Burning Characteristics of Building Materials.
   3. Underwriters Laboratories, Inc. (UL):
      a. 723, Standard for Test for Surface Burning Characteristics of Building Materials.
   4. National Commercial and Industrial Insulation Standards (2013 seventh edition).
      a. Published by Midwest Insulation Contractors Association (MICA).
      b. Endorsed by National Insulation Association (NIA).
      c. MICA plate numbers listed in this specification reference this document.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.
c. Submit manufacturer cut sheets and specifications for insulation materials, adhesives, cement, together with manufacturer's recommended methods of application and coverage for coatings and adhesives.

2. Submit itemized schedule by building of proposed insulation systems showing density, thermal conductivity, thickness, adhesive, jackets and vapor barriers.
3. Certifications: Products will meet the requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Elastomeric insulation:
a. Armacell
b. Or equal.
2. Fiberglass insulation:
a. Johns Manville.
b. Or equal.
3. PVC jacket:
a. Johns Manville.
b. Or equal.
4. Equipment insulation:
a. Johns Manville.
b. Or equal.
5. High density perlite:
a. Johns Manville.
6. High density calcium silicate:
a. Johns Manville.
b. Or equal.

2.2 PIPING INSULATION - ELASTOMERIC

A. General:
1. Insulation fire and smoke hazard ratings for composite (insulation, jacket or facing, and adhesive used to adhere the facing or jacket to the insulation), listed and labeled as tested by procedure ASTM E84, NFPA 255 or UL 723, not exceeding:
a. Flame spread: 25.
b. Smoke developed: 50.
2. Accessories (adhesives, mastics, cements, and tapes: Same component ratings as listed above.
3. Indicate on product labels or their shipping cartons: NRTL certification that flame and smoke ratings do not exceed above requirements.
4. Permanent treatment of jackets or facings to impart flame and smoke safety is required.
a. Water-soluble treatments are prohibited.
5. Insulated shields at pipe support points.

B. Pipe, Fitting, and Valve Insulation:
1. Flexible elastomeric closed cell pipe insulation.

a. Average thermal conductivity not to exceed 0.27 (BTU-IN)/(HR-FT^2-DEGF) at mean temperature of 75 DEGF, temperature range -40 to 220 DEGF; permeability not to exceed 0.05 by ASTM E96; water absorption 3% by ASTM C1763 or ASTM C209 and manufactured without CFCs, HFCs, HCFCs, PBDEs, or formaldehyde.

2. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.3 PIPING INSULATION - FIBERGLASS

A. Pipe and Fitting Insulation:
   1. Preformed fiberglass pipe insulation:
      a. Density: 4 LBS/CUFT.
      b. Temperature rated: 650 DEGF.
      c. Average thermal conductivity not to exceed 0.23 (BTU-IN)/(HR-FT^2-DEGF) at mean temperature of 75 DEGF.
      d. Fire hazard rating:
         1) UL 723, ASTM E84, NFPA 255.
         2) Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Moisture adsorption:
      a. ASTM C553.
      b. Not greater than 5% moisture by volume when exposed to moisture laden air at 120 DEGF and 96% RH.
   3. Fungi and bacteria resistance:
      a. ASTM C665.
      b. Does not breed or promote growth.
      c. Flame attenuated glass fibers bonded with thermosetting resin.
   4. Piping jackets (general applications):
      a. Aluminum: 16 MIL embossed aluminum. Provide for insulated piping installed outdoors.
      b. PVC: Preformed 0.028 IN thick PVC jackets fabricated from B.F. Goodrich PVC sheeting V-66 with proven resistance to ultraviolet degradation when temperatures do not exceed the limits of PVC. Provide on all interior insulated exposed piping.
      c. Piping jacket not required on concealed piping.
   5. Provide minimum insulation thickness conforming to schedules or as shown on the Drawings.

2.4 PIPE INSULATION INSERTS AT HANGERS

A. High Density Perlite:
   1. Pre-formed.
   2. Fire hazard rating:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread: Zero.
      c. Smoke developed: Zero.
   3. Average density: 13 LBS/CUFT.
   4. Compressive strength: 80 PSI to produce 5% compression.
   5. Maximum surface temperature: 1,200 DEGF.

B. High Density Calcium Silicate:
   1. Pre-formed.
   2. Fire hazard rating:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread: Zero.
      c. Smoke developed: Zero.
   3. Average density: 14 LBS/CUFT.
   4. Compressive strength: 100 PSI to produce 5% compression.
   5. Maximum surface temperature: 1,200 DEGF.

2.5 EQUIPMENT INSULATION

A. Insulation for Equipment:
   1. Fire hazard classification:
      a. UL 723, ASTM E84, NFPA 255.
      b. Flame spread not exceeding 25 and smoke developed not exceeding 50.
   2. Provide minimum insulation thickness conforming to Schedules, equipment specifications, or as shown on Drawings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. General:
   1. Consider piping and equipment as exposed, except as otherwise indicated.
   2. Consider piping and equipment in walls, partitions, floors, pipe chases, pipe shafts and duct shafts as concealed.
      a. Consider piping and equipment above ceilings as concealed.
   3. Provide release for insulation application after installation and testing is complete.
      a. Apply insulation on clean, dry surfaces after inspection.
   4. Provide insulation continuous through wall, roof and ceiling openings, pipe hangers, supports and sleeves.
   5. Provide insulation with vapor barrier for piping, and equipment where surfaces may be cooler than surrounding air temperatures.
      a. Provide vapor barrier (0.17 perm-IN; ASTM C553) continuous and unbroken.
      b. Hangers, supports, anchors, and related items that are secured directly to cold surfaces must be adequately insulated and vapor-sealed to prevent condensation.
   6. Apply specified adhesives, mastics and coatings at the manufacturer's recommended coverage per unit volume.

C. Piping Insulation - Elastomeric:
   1. Do not insulate until satisfactory completion of required pressure testing.
   2. Apply insulation to clean, dry surfaces.
   3. Slip insulation on pipe prior to connection.
      a. Whenever the slip-on technique is not possible provide insulation neatly slit and snapped over the pipe.
   4. Fabricate and install fitting cover over insulation according to manufacturer's recommendations.
   5. Seal joints, slits, miter-cuts and other exposed edges of insulation with adhesive, recommended by the insulation manufacturer, to ensure complete vapor barrier.

D. Piping Insulation - Fiberglass:
   1. Apply over clean dry pipe.
      a. Butt all joints together firmly.
   2. Seal joints, slits, miter-cuts and other exposed edges of insulation as recommended by the insulation manufacturer.
   3. Insulate fittings, valves, and flanges with insulation thickness equal to adjacent pipe.
   4. PVC pipe jacket:
      a. Apply jacketing with a minimum of 1 IN overlap.
         1) Weld longitudinal and circumferential seams with adhesives as recommended by manufacturer.
      b. Provide slip-joints every 30 FT and between fittings if distance exceeds 8 FT.
         1) Construct slip-joints by overlapping jacket sections 6 to 10 IN.
      c. Provide pre-molded PVC covers of same material and manufacturer as jacket for fittings, valves, flanges, and related items in insulated piping systems.
   5. Aluminum pipe jacket:

a. Field-applied aluminum jacket with vapor-sealed longitudinal and butt joints.
b. Provide smooth and straight joint with a minimum 2 IN overlap.
c. Secure joints with corrosion-resistant screws spaced 0.25 to 0.50 IN back from edge.
d. Center spacing of screws 5 IN maximum or as required to provide smooth tight-fitted joints.
e. Place joints on least exposed side of piping to obtain neat appearance.

E. Equipment: Install per manufacturer's instructions.

3.2 REPAIR

A. Whenever any factory applied insulation or job-applied insulation is removed or damaged, replace with the same quality of material and workmanship.

3.3 SCHEDULES

A. Refrigeration Lines (suction and liquid):
1. Type: Elastomeric.

B. Pipe, Fittings and Valves:
1. Type: Fiberglass, unless noted otherwise.

APPLICATION	PIPE SIZE	THICKNESS	JACKET
Cold Water (Potable) and Non-Potable Water located in unheated or concealed spaces	1-1/2 IN and less	1 IN	PVC for piping exposed inside building and less than 8 ft. above finished floor. Jacket not required for concealed piping, or pipe higher than 8ft above finished floor.
	Over 1-1/2 IN	1-1/2 IN	
Cold Water (Potable) and Non-Potable Water located in heated spaces	All sizes	Insulation not required	-
Hot Water (domestic), Hot Water Recirculation, and Tepid water (to emergency showers)	1-1/2 IN and less	1 IN	PVC for piping exposed inside building and less than 8 ft. above finished floor. Jacket not required for concealed piping, or pipe higher than 8ft above finished floor.
	Over 1-1/2 IN	1-1/2 IN	
Refrigeration Lines (35 - 60 DEGF)	1 IN and less Over 1 IN	3/4 IN 1 IN	Aluminum outside of building; PVC for exposed piping inside building and less than 8 ft of finished floor. Jacket not required for concealed piping, or pipe higher than 8ft above finished floor.

C. Equipment:

EQUIPMENT	INSULATION SYSTEM
Below drain pans serving cooling coils	1 IN flexible elastomeric closed cell sheet.
Hydropneumatics tanks	Uninsulated

END OF SECTION

SECTION 40 61 13
PROCESS CONTROL SYSTEM GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Basic requirements for complete instrumentation system for process control.

C. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 81 33- Cyber Security Requirements.
   2. Section 40 61 21 – Process Control System Testing.
   3. Section 40 61 43 – Surge Protection Devices for Instrumentation and Control Equipment.
   4. Section 40 62 05 – Computer System Hardware and Ancillaries.
   5. Section 40 63 43 – Programmable Logic Controllers.
   6. Section 40 66 05 – Network Equipment.
   7. Section 40 67 00 - Control System Equipment Panels and Racks.
   8. Section 40 67 63 – Uninterruptible Power Supply.
   9. Section 40 78 00 – Panel Mounted Instruments.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The International Society of Automation (ISA):
      a. 7.0.01, Quality Standard for Instrument Air.
      b. S5.1, Instrumentation Symbols and Identification.
      c. S5.3, Graphic Symbols for Distributed Control/Shared Display Instrumentation, Logic and Computer Systems.
      d. S20, Standard Specification Forms for Process Measurement and Control Instruments, Primary Elements and Control Valves.
      e. 62443-3-3 Security for Industrial Automation and Control Systems, Part 3-3: System Security Requirements and Security Levels
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. National Fire Protection Association (NFPA):
      a. 70, National Electrical Code (NEC).
      b. 79, Electrical Standard for Industrial Machinery
   4. Underwriters Laboratories, Inc. (UL):
      a. 913, Standard for Safety, Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.
   5. National Institute of Standards and Technology (NIST)
      a. SP 800-82, Guide to Industrial Control Systems (ICS) Security

B. Qualifications:
   1. Panel Fabricator:
      a. Experience:
         1) Have satisfactorily fabricated control panels for a minimum of five projects of similar magnitude and function.
      b. Certification:
         1) UL508A & UL698A Certification.

C. Miscellaneous:
   1. Comply with electrical classifications and NEMA enclosure types shown on Drawings.

1.3 DEFINITIONS

A. Calibrate: To standardize a device so that it provides a specified response to known inputs.

B. Hazardous Areas: Class I, II or III areas as defined in NFPA 70.

C. Highly Corrosive and Corrosive Areas: Rooms or areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.

D. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.

1.4 SYSTEM DESCRIPTION

A. Control System Requirements:
   1. This Specification Section provides the general requirements for the control system.
   2. The control system consists of all primary elements, transmitters, switches, controllers, computers, communication devices, recorders, indicators, panels, signal converters, signal boosters, amplifiers, special power supplies, special or shielded cable, special grounding or isolation, auxiliaries, wiring, and other devices required to provide complete control of the plant as specified in the Contract Documents.
   3. Provide all required coordination of instrumentation with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

1.5 SUBMITTALS

A. Shop Drawings:
   1. Submittals shall be original printed material or clear unblemished photocopies of original printed material.
      a. Facsimile information is not acceptable.
   2. Limit the scope of each submittal to one Specification Section.
      a. Each submittal must be submitted under the Specification Section containing requirements of submittal contents.
      b. Do not provide any submittals for Specification Section 40 61 13.
   3. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Equipment catalog cut sheets.
      c. Instrument data sheets:
         1) ISA S20 or approved equal.
         2) Separate data sheet for each instrument type.
      d. Materials of construction.
      e. Minimum and maximum flow ranges.
      f. Pressure loss curves.
      g. Physical limits of components including temperature and pressure limits.
      h. Size and weight.
      i. Electrical power requirements and wiring diagrams.
      j. NEMA rating of housings.
      k. Submittals shall be marked with arrows to show exact features to be provided.
   4. Comprehensive asset inventory of all networked components:
      a. Provide in Excel spreadsheet format.
      b. Coordinate with the Contracting Officer to determine the preferred method of delivery to assure security of information contained in asset inventory.

c. Include:
    1) Device ID.
    2) Manufacturer.
    3) Model Number.
    4) Serial Number.
    5) Device Use description.
    6) Firmware.

5. Network Diagrams:
    a. Provide in VISIO, AUTO CAD, and PDF formats.
    b. Coordinate with the Contracting Officer to determine the preferred method of delivery to assure security of information contained in Network Diagrams.
    c. Logical Network Diagram(s):
        1) Depict information flow through network(s), and include:
            a) Major network devices, subnets, and VLANs.
            b) Include all wireless communication devices.
            c) Include the following information for each networked device:
                (1) Device ID.
                (2) Device description.
                (3) Manufacturer/model number.
                (4) MAC address.
                (5) IP address.
                (6) Ports and Protocols
    d. Physical Network Diagram(s):
        1) Show all network components, ports, protocols, connections and cables.
            a) Include all wireless communication devices.
6. Process connected instrument installation details containing the following minimum information:
    a. Bill of materials providing as a minimum the following information:
        1) Tube material and size.
        2) Connection size.
        3) Fitting size, material, and rating.
        4) Valve type and material.
        5) Instrument description.
        6) Pipe stand size and material.
    b. Tube slope requirements.
    c. Required elevations and dimensions.
7. Comprehensive set of wiring diagrams as specified in Section 40 67 00.
8. Panel fabrication drawings as specified in Section 40 67 00.
9. PLC equipment drawings.
10. Nameplate layout drawings.
11. Drawings, systems, and other elements are represented schematically in accordance with ISA S5.1 and ISA S5.3.
    a. The nomenclature, tag numbers, equipment numbers, panel numbers, and related series identification contained in the Contract Documents shall be employed exclusively throughout submittals.
12. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
    a. Furnish electronic files on Government's designated electronic media.
    b. Drawings in AUTO CAD format.
13. Provide a parameter setting summary sheet for each field configurable device.
14. Certifications:
    a. Documentation verifying that calibration equipment is certified with NIST traceability.
    b. Approvals from independent testing laboratories or approval agencies, such as UL, FM or CSA.
        1) Certification documentation is required for all equipment for which the specifications require independent agency approval.

15. Testing reports: Source quality control reports.

B. Qualifications Submittal:
   1. Documentation verifying contractor/subcontractor adherence to specified certifications and qualifications.

C. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. All Shop Drawings shall be modified with as-built information/corrections.
   3. Instrumentation and Control Equipment Operation and Maintenance Manual Content:
      a. Provide a printed copy of the following sheets following the Equipment Record sheets or ISA Data Sheets.
         1) Loop Check-out Sheet.
         2) Instrument Certification Sheet.
         3) Final Control Element Certification Sheet.
      b. Provide the following detailed information:
         1) Use equipment tag numbers from the Contract Documents to identify equipment and system components.
         2) As-constructed fabrication or layout drawings and wiring diagrams.
         3) As-constructed network asset inventory, and physical and logical network diagrams.
            a) Coordinate with the Contracting Officer to determine the preferred method of delivery to assure security of this information.
      c. Password Summary Report:
         1) Provide a Password Summary Report documenting the administrative password for each device and describing the procedure to change the password for each device. Do not provide the Password Summary Report in electronic format. Provide two hardcopies of the Password Summary Report, each copy in its own sealed envelope.
         2) Provide listing of all temporary usernames setup for each device.
      d. Additional information as required in the associated equipment or system Specification Section.
   4. Warranties: Provide copies of warranties and list of factory authorized service agents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not remove shipping blocks, plugs, caps, and desiccant dryers installed to protect the instrumentation during shipment until the instruments are installed, and permanent connections are made.

PART 2 - PRODUCTS

2.1 NEMA TYPE REQUIREMENTS

A. Provide enclosures/housing for control system components in accordance with the area designations provided on the Drawings.
   1. Areas designated as wet: NEMA Type 4.
   2. Areas designated as wet and/or corrosive, chemical rooms: NEMA Type 4X.
   3. Areas designated as Class I hazardous, Groups A, B, C, or D as defined in NFPA 70:
      a. NEMA Type 7 unless all electrical components within enclosure utilize intrinsically safe circuitry.
         1) Utilize intrinsically safe circuits to the maximum extent practical and as depicted in the Contract Documents.
   4. Either architecturally or non-architecturally finished areas designated as dry, noncorrosive, and nonhazardous: NEMA Type 12.
   5. Areas designated to be subject to temporary submersion: NEMA 6P.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Unless stated otherwise, system operating criteria are as follows:
   1. Performance: All instruments and control devices shall perform in accordance with manufacturer's specifications.

2.3 ACCESSORIES

A. Provide corrosion resistant spacers to maintain 1/4 IN separation between equipment and mounting surface in wet areas, on below grade walls and on walls of liquid containment or processing areas such as Clarifiers, Digesters, Reservoirs, etc.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wherever feasible, use bottom entry for all conduit entry to instruments and junction boxes.

B. Install electrical components per the requirements of the Electrical design.

END OF SECTION

Loop Check-out Sheet

Project Name:		Contracting Officer's Project No. (if applicable):	Page of
Project Owner:		Regulatory Agency Project No. (if applicable):	
HDR Project No.:		Date:	

LEAK AND TERMINATION/CONTINUITY CHECKS

DESCRIPTION	FIELD					CONTROL CAB	
	LEAK CHECK(1)			TERM/CONT CHECK(2)		TERM/CONT CHECK(2)	
	Device Tag No.	Process Conn.	Signal Tube	Device Tag No.	Termination Ident.	Device Tag No.	Termination Ident.

1. Leak check for pneumatic signal tubing to be per ISA-PR7.1.
2. Termination/continuity check includes check at terminated equipment for: (a) correct polarity, (b) appropriate signal generation, transmission and reception, and (c) correct shield & ground terminations.

OPERATOR INTERFACE CHECK-OUT

MONITORING POINTS OBSERVED

PARAMETER TYPE	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.	TAG NO.
PROCESS VAR						
EQUIP STATUS						
ALARM POINT						

OPERATOR CONTROL FUNCTIONS CHECKED

FUNCTION TYPE	TAG NO.	LOCATION	TAG NO.	LOCATION	TAG NO.	LOCATION

FINAL CONFIGURED SETTINGS

TAG NO.	SWITCH & ALARM SP	CONTROLLERS			
		Gain	Reset, rpm	Deriv. (rate), min	PV Set Point

Describe all interlocks checked, equipment started/stopped, valves/operators stroked. Describe modes of operation checked, and location of operator interface (local/remote).

_____

_____

_____

I certify that the control loop referenced on this page has been completely checked and functions in accordance with applicable drawings and specifications.

Certified by:_____ Date:_____
(Work Performed By)

Instrument Certification Sheet

Project Name:	Contracting Officer's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	
Instrument Tag No.	Transmitter/gauge span:
Manufacturer:	Switch set-point:
Model No.	Switch dead band:
Serial No.	Switch range:

TRANSMITTERS AND INDICATORS

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	**INPUT**	**OUTPUT**	**ERROR (% of span)**	**INPUT**	**OUTPUT**	**ERROR (% of span)**
0%						
25%						
50%						
75%						
100%						
Other (if applicable)						
Other (if applicable)						

SWITCHES

	INCREASING INPUT			DECREASING INPUT		
ACTUATION POINT	**INPUT**	**OUTPUT**	**ERROR (% of range)**	**INPUT**	**OUTPUT**	**ERROR (% of range)**
High (Increasing input)						
Low (Decreasing input)						

Maximum allowable error (per Contract Documents): _____

Remarks: _____

_____

_____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by: _____ Date Certified: _____

Final Control Element Certification Sheet

Project Name:	Contracting Officer's Project No. (if applicable):
Project Owner:	Regulatory Agency Project No. (if applicable):
HDR Project No.	Date:
Control Loop No.:	

Tag No.	
Description:	
Manufacturer:	
Model No.	
Serial No.	

Actuator:	Pneumatic: _____ Electric: _____
Positioner:	Direct: _____ Reverse: _____
Positioner:	Input: _____ Output: _____
I/P Converter:	Input: _____ Output: _____
Valve to	_____ on air failure
Valve to	_____ on power failure

I/P CONVERTER

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	OUTPUT	ERROR (% of span)	INPUT	OUTPUT	ERROR (% of span)
0%						
25%						
50%						
75%						
100%						

Specified I/P converter accuracy: _____ % of span.

FINAL CONTROL ELEMENT

	INCREASING INPUT			DECREASING INPUT		
% OF SPAN	INPUT	TRAVEL	ERROR (% of full travel)	INPUT	TRAVEL	ERROR (% of full travel)
0%						
25%						
50%						
75%						
100%						

Remarks: _____

CALIBRATION EQUIPMENT UTILIZED

DEVICE TYPE	MFR/MODEL NO.	ACCURACY	NIST TRACEABILITY?

Certified by:_____ Date Certified:_____

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SECTION 40 61 21
PROCESS CONTROL SYSTEM TESTING

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Requirements for testing of the Process Control System (PCS) hardware prior to shipment to the site for installation.
      a. Inspection.
         1) System hardware operational testing.
         2) System software demonstration.
      b. Factory acceptance test (FAT) records.
   2. Requirements for field testing of the PCS hardware.
      a. Process Control System checkout.
      b. Instrument calibration.
      c. Loop testing/checkout.
      d. Integrated Site Acceptance Test (SAT).

C. Related Sections include but are not necessarily limited to:
   1. Section 40 61 13 - Process Control System General Requirements.
   2. Section 40 63 43 - Programmable Logic Controllers.
   3. Section 40 67 00 - Control System Equipment Panels and Racks.

1.2 SUBMITTALS

A. See Specification Section 40 61 13 - Process Control System General Requirements.

B. Submit factory acceptance test (FAT) procedures not less than 30 calendar days prior to the scheduled start of the FAT. Include the following:
   1. Modular test plans and procedures to allow individual test segments to be repeated if necessary.
   2. Description of individual test segments and steps comprising each segment, particularly the methods and processes to be followed.
   3. Procedures for monitoring, correcting, and retesting variances.
   4. Procedures for controlling and documenting all changes made to the hardware after the start of testing.
   5. Descriptions of test equipment.
   6. Expected results for each segment, including pass/fail criteria.
   7. Documentation record forms to be used to certify results of factory testing.
   8. Block diagrams of the hardware test configuration, such as PLC external communication links, and any test or simulation hardware.

C. Post factory acceptance test:
   1. Final documentation certifying that all Factory tests have passed with satisfactory results.

D. Field Testing Shop Drawings:
   1. Site Acceptance Test (SAT) Plan.
      a. Divide into separate sections based on process systems.
      b. Each section shall include a sequential step-by-step checkout plan.
   2. Typical Loop Checkout Sheets, if other than the form included within contract documents.
   3. Typical Instrument Certification Sheets, if other than the form included within contract documents.

4. Typical Final Control Element Certification Sheets, if other than the form included within contract documents.

E. Contract Closeout Information:
   1. Site Acceptance Test (SAT) Report.
   2. Completed Loop Checkout Sheets.
   3. Completed Instrument Certification Sheets.
   4. Completed Final Control Element Certification Sheets.
   5. All system startup and checkout records, test records, recommendations and information furnished by Manufacturer's representatives during testing and startup, and amended documentation specified herein.

PART 2 - PRODUCTS

2.1 FACTORY ACCEPTANCE TESTING (FAT) GENERAL:

A. Utilize software-based process control simulation and hardware-based I/O simulation panel when conducting the full system test. Software based process simulation shall provide a real time, virtual environment that interfaces with the PLC system applications software and programming to mimic the behavior of the real process equipment and systems that are monitored and controlled by the PLC system, including the capability to force individual or groups of PLC system I/O.

B. Demonstration of communication between processors and to remote I/O racks shall be included in the Test Procedure, where applicable. Test shall include demonstration that communication performance (speed, error rates, failure and recovery) conforms to specified requirements.

C. Any tested segment or function that does not pass in accordance with agreed upon pass/fail criteria shall be retested until the segment or function passes the test.
   1. Pass/fail criteria shall be in accordance with criteria set forth in an approved shop drawing submittal.
   2. The Contractor shall bear all additional travel/accommodation expenses incurred by the Government due to extension of test dates for retesting of failed segments or functions.

D. Notify the Contracting Officer in writing a minimum of 15 calendar days prior to the Factory Tests.
   1. Contracting Officer has the option to witness all required tests.

E. Testing Documentation
   1. Make following documentation available at test site during the tests:
      a. Contract Documents.
      b. Factory Demonstration Testing procedures.
      c. List of equipment to be testing including make, model, and serial number.
      d. Shop Drawing submittal data for equipment being tested.
   2. Contracting Officer reserves the right to review all documentation at any time during testing.

2.2 FAT INSPECTION

A. Inspect all panels, operator interface terminals and cabinets prior to conducting the FAT to verify quality of workmanship and conformance to the Contract Documents and approved Shop Drawings. Completed inspection forms shall be available for review at time of FAT. Inspection shall include, but not be limited to, the following:
   1. Nameplates, warning labels, and tags including correct spelling, color and size of labeling and characters and methods of attachment.
   2. Enclosure surfaces flatness, finish, and color.
   3. Proper operation of doors, catches, and locks.
   4. Wire and cable type, sizes, tagging, color coding and tag placement in readily viewable position/orientation.

5. Wiring runs across hinges properly installed.
6. Proper wiring routing, layout, practices, and grounding.
7. All electrical circuits checked for continuity.
8. Terminal block contact ratings and numbers.
9. Fuses and circuit breakers are correct size and type.
10. Terminal block, fuse, breaker, and other required installed spares.
11. General arrangement and space allocation, including spare usable space in panel and on panel door.
12. PLC equipment (chassis, power supply, power conditioners, processor, adapters, I/O and specialty modules, installed spares, spare usable space) is appropriate.
13. Proper placement, isolation, and labeling of intrinsic safety devices and associated wiring.
14. Equipment and devices are properly installed and secured to subpanels and doors using appropriate methods and in appropriate orientation.
15. Fans, blowers, heaters, air-conditioning units, and other environmental controls are operational, unobstructed, and installed with sufficient clearances recommended by component manufacturers.

2.3 FAT - SYSTEM HARDWARE OPERATIONAL TESTING

A. Assemble and interconnect the relevant portions of the PLC system as a network that mimics the network that is designed to be installed at the Plant site.
   1. As a minimum, the test shall include the following major components:
      a. All control panels that interface with the control network including local control panels, remote control panels, hardwired/relay logic and PLC based panels.
      b. Remote I/O Panels.
      c. Operator Interface Terminals (OITs).
      d. Ethernet Networks.
      e. Uninterruptible Power Supplies.
      f. Network switches, Routers, Firewalls.

B. Packaged systems not present at FAT shall be simulated; communications interfaces shall be simulated to/from vendor confirmed interface registers.

C. All system hardware components and equipment shall be tested to verify proper operation as standalone units. Tests shall include, but not be limited to, the following:
   1. AC/DC power checks.
   2. Power fail/restart tests.
   3. Verification of UPS power to required components.
   4. Diagnostics checks.
   5. Verification that all equipment is functioning properly.
   6. All electrical circuits energized simultaneously and continuously for 48 HRS without failures.
   7. All alarm circuits connected to simulated alarm contacts to verify operation.
   8. All interlock and shutdown circuits checked for operability and proper function by means of simulated contact.
   9. All hardwired input/output devices and components, and all network connected I/O shall be tested to verify operability and basic calibration.
   10. Simulate operation of electronic control and receiving instruments and circuits.
   11. Any other test required to place the PCS equipment in an operating state.
   12. Verify all redundant components fail-over hands-free without interruption of control process.
   13. Verify all servers and networking equipment are in an operating state with no unresolved errors in error logs.
   14. Verify that all components are integrated and communicating for full simulation test including any simulation software if applicable.
   15. Compliance with Contract Documents.

2.4 FAT - SYSTEM SOFTWARE DEMONSTRATION

A. Operator Interfaces:
   1. Prior to the staging and testing of the system, the display environments (Operator Interface Terminals and Human Machine Interfaces) shall have been configured and loaded into the machines, and database parameters linked to the specified fields. Demonstrate displays, faceplates, password/security capabilities, navigation methods, diagnostic/troubleshooting displays, etc.

B. Demonstrate all system software during the FAT (e.g. process monitoring and control, HMI, OIT, historian, alarming, simulation, modeling, utility and security programs) incorporated into the system to implement the various functions and capabilities specified. Demonstrations shall include:
   1. All required historical data capture, storage, retrieval and reporting functions.
   2. All required data management, logging, and trending functions.
   3. All required network, communication and interface functions.
   4. All required device control functions.
   5. All required database management functionality.
   6. All required software support utilities.
   7. All Control System diagnostics, both on-line and off-line.
   8. Correct operation of computations and calculated quantities including totalized values.
   9. Proper operation of all changes to the originally specified Control System that have been negotiated and approved during the implementation period.

C. Demonstrate the proper operation based on simulation of all the analog inputs/outputs and all of the discrete inputs and outputs, as indicated on the I/O list. In addition to testing allocated I/O, all spare I/O points shall also be simulated and tested to the degree possible. Demonstration shall show that the monitoring and control software and configuration and programming associated with the input/output points (hardwired and network connected) performs as intended.
   1. PLC I/O testing shall include, as a minimum, the following:
      a. Simulate a field digital input for each PLC input point at the terminal strip of the control panel and verify PLC response.
      b. Simulate a field analog input for each PLC analog input point at the terminal strip of the control panel and verify PLC response.
      c. Force an output for each PLC digital output point and verify the signal presence at the terminal strip in the control panel.
      d. Simulate an analog output for each PLC analog output point and verify signal presence at the terminal strip in the control panel.

2.5 FAT TEST RECORDS:

A. Maintain records of all factory test results. As a minimum, include the following items:
   1. Name of test procedure.
   2. Date of the test.
   3. Test results for each test segment including a passed/failed indication.
   4. Signatures of individual(s) performing the test and witnesses thereof.

PART 3 - EXECUTION

3.1 GENERAL

A. Maintain accurate daily log of all testing activities, calibration functions, and final set point adjustments.

B. All testing may be witnessed by the Contracting Officer.

3.2 INSTALLATION AND CHECKOUT

A. Provide the following (after successful completion of the Factory Acceptance Test):

1. Check and approve the installation of all Process Control System (PCS) components (including but not limited to control panels, field instruments, networking equipment and racks, patch panels and all cable and wiring interconnects between various equipment, panels and devices) prior to placing the various processes and equipment into operation. As a minimum, include:
    a. Verification and documentation that all field instruments function properly and are properly calibrated.
    b. Testing of all final control actions.

B. Provide services of authorized manufacturer's representatives to check and verify the correctness of the installation and operation of equipment.

3.3 PRE-DEMONSTRATION PERIOD TESTING

A. Instrumentation Calibration:
1. Verify and document that all instruments and control devices are calibrated to provide the performance required by the Contract Documents.
2. Factory furnished calibration certifications are acceptable for the following:
    a. Flow meters.
    b. Pressure sensors utilized with annular sleeve.
    c. Temperature sensors.
3. On-site calibration verification is required for all other instruments, including "smart" transmitters that have been factory calibrated.
    a. Provide calibration checks at 0 %, 25 %, 50 %, 75 % and 100 % of span for pressure transmitters and gages.
        1) Check for both increasing and decreasing input signals to detect hysteresis.
    b. In addition to factory calibration certification, temperature sensors and gages shall be checked at a single point for conformance to required accuracy.
    c. Level transducers/transmitters shall be checked at two points in addition to zero.
    d. Analytical sensors shall be calibrated in accordance with manufacturer's recommendations.
    e. Check operation of all switches to verify actuation occurs in accordance with manufacturer's specified accuracy.
    f. Replace any instrument which cannot be properly adjusted.
4. Mark range, date, set point and calibrator's initials on each instrument by means of blue or black ink on a waterproof tag affixed to the instrument.
5. Calibration equipment shall be certified by an independent agency with traceability to NIST.
    a. Certification shall be up to date.
    b. Use of equipment with expired certifications shall not be permitted.
6. Calibration equipment shall be at least three times more accurate as the device being calibrated.

B. Loop Testing:
1. Utilize the Loop Check-Out Sheet located at the end of Section 40 61 13 (or Contracting Officer approved equivalent) to document on-site calibration checks.
    a. Utilize separate loop checkout form for each loop.
2. Minimum loop checkout requirements:
    a. Use actual signals where available.
    b. Check control signal generation, transmission, reception and response for all inputs and outputs for all control loops under simulated operating conditions by imposing a signal on the loop at the instrument connections.
    c. Closely observe controllers, indicators, transmitters, HMI displays, OIT displays, recorders, alarm and trip units, remote set points, ratio systems, and other components.
        1) Verify that readings at all loop components are in agreement.
        2) Make corrections as required.
        3) Following any corrections, retest the loop.

d. Stroke all control valves, cylinders, drives and connecting linkages from the local control station and from the control room operator interface.
e. Check all interlocks for proper functionality.
f. Record all set point and calibration changes on all affected Contract Documents and turn over to Contracting Officer.

C. Integrated Site Acceptance Test (SAT):
1. Following the testing of each individual loop, perform an integrated Site Acceptance Test (SAT) to verify that all equipment is operating as described in the Contract Documents and equipment manufacturers recommendations. Checks to include:
a. The intended monitoring and control functions of the PCS including all vendor-furnished equipment packaged systems, communications, operator interfaces, statuses, alarms, trends and recording of historical tags.
b. Integrated testing on a system-by-system basis as described in the submitted Site Acceptance Test (SAT) plan sequential step-by-step checkout plan.
1) Documentation with initials of the individuals who perform each test.
2. Provide minimum fifteen (15) day notice to the Contracting Officer prior to commencing the SAT.
3. Promptly address and re-test any malfunctions, issues and incompletions arising during the SAT at no additional expense to Government.

D. At the successful conclusion of all testing specified in this article, submit the “Instrumentation Supplier's Instrumentation Installation Certificate” required in Section 01 75 10 - Checkout and Start-up Procedures.

3.4 DEMONSTRATION PERIOD

A. Demonstrate the functional integrity of the Process Control System for the entire facility in accordance with the demonstration period requirements in Section 01 75 10 - Checkout and Start-up Procedures as evidence of Substantial Completion.

END OF SECTION

SECTION 40 61 43
SURGE PROTECTION DEVICES FOR INSTRUMENTATION AND CONTROL EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Category IC1 SPD - Dedicated 120 VAC circuit, series connection, control panel mounted.
   2. Category IC2 SPD - Individual equipment plug-in device (point of use protection).
   3. Category IC3 SPD - Discrete 120 VAC control signal, control panel mounted.
   4. Category IC4 SPD - Analog instrumentation signal, field mounted.
   5. Category IC5 SPD - Analog instrumentation signal, control panel mounted.
   6. Category IC6 SPD - Combination 120 VAC circuit and analog signal, field mounted.
   7. Category IC7 SPD - Discrete low voltage control signal, control panel mounted.
   8. Category IC8 SPD - Data line, control panel mounted.

C. Related Sections include but are not necessarily limited to:
   1. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   3. Underwriters Laboratories, Inc. (UL):
      a. 497B, Standard for Safety Protectors for Data Communications and Fire-Alarm Circuits.
      b. 1283, Standard for Electromagnetic Interference Filters.
      c. 1363, Standard for Relocatable Power Taps.
      d. 1449, Standard for Surge Protective Devices.

B. Qualifications:
   1. Provide devices for a manufacturer who has been regularly engaged in the development, design, testing, listing and manufacturing of SPDs of the types and ratings required for a period of 10 years or more and whose products have been in satisfactory use in similar service.
   2. Upon request, suppliers or manufacturers shall provide a list of not less than three customer references showing satisfactory operation.

1.3 DEFINITIONS

A. Clamping Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the zero-voltage reference to the peak of the surge when the applied surge is induced at the 90-degree phase angle of the applied system frequency voltage.

B. Let-Through Voltage: The voltage measured at the end of the 6 IN output leads of the SPD and from the system peak voltage to the peak of the surge when the applied surge is induced at the 90-degree phase angle of the applied system frequency voltage.

C. Maximum Continuous Operating Voltage (MCOV): The maximum steady state voltage at which the SPD can operate and meet its specification within its rated temperature.

D. Maximum Surge Current:
   1. The maximum 8 x 20 microsecond surge current pulse the SPD is capable of surviving on a single-impulse basis without suffering either performance degradation or more than 10% deviation of clamping voltage at a specified surge current.
   2. Listed by mode, since number and type of components in any SPD may vary by mode.

E. Protection Modes: This parameter identifies the modes for which the SPD has directly connected protection elements, i.e., line-to-neutral (L-N), line-to-line (L-L), line-to-ground (L-G), neutral-to-ground (N-G).

F. Surge Current per Phase:
   1. The per phase rating is the total surge current capacity connected to a given phase conductor.
   2. For example, a wye system surge current per phase would equal L-N plus L-G; a delta system surge current per phase would equal L-L plus L-G.
      a. The N-G mode is not included in the per phase calculation.

G. System Peak Voltage: The electrical equipment supply voltage sine wave peak (i.e., for a 120 V system the L-N peak voltage is 170 V).

1.4 SUBMITTALS

A. Shop Drawings:
   1. For named products, submit only a catalog cut sheet.
      a. For all other products, submit the data required below.
   2. See Specification Section 40 61 13 for general process control systems requirements.
   3. Product technical data for non-specified models:
      a. Manufacturer's experience.
      b. Standard catalog cut sheet.
      c. Electrical and mechanical drawing showing unit dimensions, weights, mounting provisions, connection details and layout diagram of the unit.
      d. Create a Product Data Sheet for each different model number of SPD provided.
         1) Data in the Product Data Sheet heading:
            a) SPD Type per PART 2 of the Specification.
            b) Manufacturer's Name.
            c) Product model number.
         2) Data in the Product Data Sheet body:
            a) Column one: Specified value/feature of every paragraph of PART 2 of the Specification.
            b) Column two: Manufacturer's certified value confirming the product meets the specified value/feature.
         3) Data in the Product Data Sheet closing:
            a) Signature of the manufacturer's official (printed and signed).
            b) Title of the official.
            c) Date of signature.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 WARRANTY

A. The manufacturer shall provide a minimum of a five-year Limited Warranty from date of shipment against failure when installed in compliance with applicable national/local electrical codes and the manufacturer's installation, operation and maintenance instructions.

B. See Specification Section 01 67 00 – Product Requirements.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers listed in the subsections are acceptable.

2.2 CATEGORY IC1 SPD

A. Approved Products:
   1. Eaton AGPH 12015.
   2. Or Equal.

B. Standards: UL 1449.

C. Design:
   1. General:
      a. Mounted internally to control panels for point-of-use loads.
      b. MOV based or multi-stage hybrid solid-state high-performance suppression system.
      c. Designed for series connection.
      d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
      f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the unit's suppression filter system or power loss in any of the phases.
   2. Operating voltage: 120 VAC.
   3. Operating current: 15 A minimum.
   4. Operating frequency: 45 to 65 Hz.
   5. Modes of protection: All modes, L-N, L-G and N-G.
   6. Maximum continuous operating voltage: Less than 130% of system peak voltage.
   7. Maximum surge current: 20,000 A per phase, 10,000 A per mode minimum.
   8. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10% deviation of the clamping voltage.
   9. Fusing: Optional integral unit level and/or component level short circuit and/or thermal overload protection.
      a. External protection as recommended by manufacturer.
   10. Maximum clamping voltages, dynamic test with voltages measured from the zero-voltage reference and 90 DEG phase angle:

System Voltage	Test Mode	IEEE C62.41.2		UL 1449 (3rd Edition VPRs)
		B Comb. Wave	A Ring Wave	
L-N = 120 V	L-N	400 V	300 V	400 V
	L-G	500 V	400 V	400 V
	N-G	500 V	400 V	500 V

2.3 CATEGORY IC2 SPD

A. Approved Product:
   1. MTL Zone Guardian ZG-43006.
   2. Or Equal.

B. Standards: UL 1283, UL 1363 and UL 1449.

C. Design:
   1. General:
      a. Multi-stage hybrid solid-state high-performance suppression system.
      b. Point of use protection, designed for plug-in devices.
      c. Enclosure: Metallic or impact resistant plastic.
      d. Field connection:
         1) The minimum line cord shall be #14 three conductors, 6 FT in length, with a single piece strain relief NEMA 5-15P plug.
         2) The minimum plug-in strip shall have six single NEMA 5-15R receptacles.
      e. ON/OFF toggle switch.
      f. Device monitoring:
         1) Long-life, solid state, externally visible indicators that monitor the on-line status of the unit's suppression filter system or power loss in any of the phases.
         2) A fuse or circuit breaker status only monitor system is not acceptable.
   2. Operating voltage: 120 VAC.
   3. Modes of protection: All modes, L-N, L-G and N-G.
   4. Maximum continuous operating voltage: Less than 130% of system peak voltage.
   5. Operating frequency: 45 to 65 Hz.
   6. Maximum surge current: 20,000 A per phase, 10,000 A per mode minimum.
   7. Minimum repetitive surge current capacity: 1000 impulses with no degradation of more than 10% deviation of the clamping voltage.
   8. Overcurrent protection: The SPD may contain internal fuses or circuit breaker, but an IEEE B3 combination wave shall not cause the fuse or circuit breaker to open and render the SPD inoperable.
   9. Maximum clamping voltages, dynamic test with voltages measured from the zero-voltage reference and 90 DEG phase angle:

System Voltage	Test Mode	IEEE C62.41.2		UL 1449
		B Comb. Wave	A Ring Wave	
L-N = 120 V	L-N	400 V	300 V	330 V
	L-G	500 V	400 V	400 V
	N-G	500 V	400 V	400 V

   10. EMI-RFI noise rejection: Attenuation greater than 30 dB for frequencies between 100 kHz and 100 MHz

2.4 CATEGORY IC3 SPD

A. Approved Products:
   1. ASCO 205120NF010AN3D0.
   2. Or Equal.

B. Standards: UL 497B or UL 1449.

C. Design:
   1. General:
      a. Mounted internally to control panels for point-of-use loads.

b. Multi-stage hybrid solid-state high-performance suppression system.
c. Designed for series connection.
d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
e. Field connection: Provide unit with external terminal screws for each phase, neutral and ground that will accept #14 through #12 conductors.
f. Device monitoring: Long-life, solid state, externally visible indicators that monitors the on-line status of the unit's suppression filter system or power loss in any of the phases.

2. Operating voltage: 120 VAC.
3. Operating current: 3 A minimum.
4. Operating frequency: 45 to 65 Hz.
5. Modes of protection: L-N, when ground conductor is present L-G and N-G.
6. Maximum continuous operating voltage: Less than 130% of system peak voltage.
7. Maximum surge current: 6000 A per phase, 3000 A per mode minimum.
8. Minimum repetitive surge current capacity:
   a. The SPD shall meet one of the following:
      1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
      2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
      3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
      4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
9. Maximum clamping voltages, measured from the zero-voltage reference:
   a. The SPD shall meet one of the following:
      1) 400A, 10x700 microsecond waveform: 200% of system voltage.
      2) IEEE B3 combination wave: 250% of system voltage.
      3) IEEE B3 ring wave: 200% of system peak voltage.
      4) IEEE A3 ring wave: 200% of system peak voltage.
      5) Mode N-G clamping voltage may be 175% higher than the L-G levels.

2.5 CATEGORY IC4 SPD

A. Approved Products:
1. ASCO 157D036S10KXW5R0, 157D036S10KXW5S0, 157D036S10KXW6M0, or 157D036S10KXW6P0.
2. Or Equal.

B. Standards: None.

C. Design:
1. General:
   a. For protection of field mounted equipment connected to 4-20mA analog signal loops.
   b. Mounted directly to an unused conduit entry on a process transmitter housing.
   c. Multi-stage hybrid solid-state high-performance suppression system.
   d. Designed for series connection.
   e. Enclosure: 1/2 IN to 3/4 IN stainless steel conduit pipe nipple.
2. Operating voltage: 24 VDC or as indicated on the Drawings.
3. Modes of protection: All modes, L-L and L-G.
4. Maximum continuous operating voltage: Less than 130% of system peak voltage.
5. Maximum surge current: 10,000 A.
6. Minimum repetitive surge current capacity:
   a. The SPD shall meet one (1) of the following:
      1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
      2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
      3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
      4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
      5) 10 occurrences of a 10,000 A, 8 x2 0 microsecond waveform.
7. Maximum clamping voltages, L-L:
   a. The SPD shall meet one of the following:
      1) 400 A, 10 x 700 microsecond waveform: 400% of system voltage.
      2) 10,000 A, 8 x 20 microsecond waveform: 400% of system voltage.

3) IEEE B3 combination wave: 250% of system voltage.

8. Maximum clamping voltages, L-G:
   a. The SPD shall meet one of the following:
      1) 400 A, 10 x 700 microsecond waveform: 200% of system voltage.
      2) 10,000 A, 8 x 20 microsecond waveform: 200% of system voltage.
      3) IEEE B3 combination wave: 300% of system voltage.

2.6 CATEGORY IC5 SPD

A. Approved Products:
   1. ASCO 105D036S10KAN3D0 or 175D036S10KAPCN0 with PCB1B base.
   2. Or Equal.

B. Standards: UL 497B.

C. Design:
   1. General:
      a. Mounted internally to control panels for protection of equipment connected to analog signal loops.
      b. Multi-stage hybrid solid-state high-performance suppression system.
      c. Designed for series connection.
      d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      e. Field connection: The unit shall have external terminal screws for line and ground conductors.
   2. Operating voltage: 24 VDC or as indicated on the Drawings.
   3. Modes of protection: All modes, L-L and L-G.
   4. Maximum continuous operating voltage: Less than 130% of system peak voltage.
   5. Maximum surge current: 10,000 A.
   6. Minimum repetitive surge current capacity:
      a. The SPD shall meet one of the following:
         1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
         2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
         3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
         4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
         5) 10 occurrences of a 10,000 A, 8 x 20 microsecond waveform.
   7. Maximum clamping voltages, L-L:
      a. The SPD shall meet one of the following:
         1) 400 A, 10 x 700 microsecond waveform: 400% of system voltage.
         2) 10,000 A, 8 x 20 microsecond waveform: 400% of system voltage.
         3) IEEE B3 combination wave: 225% of system voltage.
   8. Maximum clamping voltages, L-G:
      a. The SPD shall meet one of the following:
         1) 400 A, 10 x 700 microsecond waveform: 200% of system voltage.
         2) 10,000 A, 8 x 20 microsecond waveform: 200% of system voltage.
         3) IEEE B3 combination wave: 300% of system voltage.

2.7 CATEGORY IC6 SPD

A. Approved Products:
   1. ASCO 265120NF015BD4J0.
   2. Or Equal.

B. Product:
   1. Field mounted for protection of field mounted equipment connected to 120 V power and 4 - 20 mA analog signal loops.
   2. Category IC1 and Category IC5 SPDs mounted in a common enclosure.
   3. Enclosure: Metallic or nonmetallic NEMA 4X.

2.8 CATEGORY IC7 SPD

A. Approved Products:
   1. ASCO 105 Series.
   2. Or Equal.

B. Standards: UL 497B.

C. Design:
   1. General:
      a. Mounted internally to control panels for protection of equipment connected to a discrete signal.
      b. Multi-stage hybrid solid-state high-performance suppression system.
      c. Designed for series connection.
      d. Enclosure: Metallic or plastic, flange or DIN rail mounting.
      e. Field connection: Provide unit with external terminal screws for line and ground conductors.
   2. Operating voltage: 24 VDC or 24 VAC or 120 VAC or as indicated on the Drawings.
   3. Modes of protection: All modes:
      a. AC applications: L-N, L-G, N-G
      b. DC applications: POS-NEG, POS-GND, NEG-GND.
   4. Maximum continuous operating voltage: Less than 130% of system peak voltage.
   5. Maximum surge current: 10,000 A.
   6. Minimum repetitive surge current capacity:
      a. The SPD shall meet one of the following:
         1) 1000 occurrences of a 200 A, 10 x 1000 microsecond waveform.
         2) 400 occurrences of a 500 A, 10 x 1000 microsecond waveform.
         3) 100 occurrences of a 400 A, 10 x 700 microsecond waveform.
         4) 100 occurrences of a 2000 A, 8 x 20 microsecond waveform.
         5) 10 occurrences of a 10,000 A, 8 x 20 microsecond waveform.
   7. Maximum clamping voltages, L-L (POS-NEG):
      a. The SPD shall meet one of the following:
         1) 400 A, 10 x 700 microsecond waveform: 400% of system voltage.
         2) 10,000 A, 8 x 20 microsecond waveform: 400% of system voltage.
         3) IEEE B3 combination wave: 250% of system voltage.
   8. Maximum clamping voltages, L-G:
      a. The SPD shall meet one of the following:
         1) 400 A, 10 x 700 microsecond waveform: 200% of system voltage.
         2) 10,000 A, 8 x 20 microsecond waveform: 200% of system voltage.
         3) IEEE B3 combination wave: 300% of system voltage.

2.9 SOURCE QUALITY CONTROL

A. Performance tests to be performed or independently verified by a certified testing laboratory.

B. The SPD are to be tested as a complete SPD system including Integral unit level and/or component level fusing.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

B. Category IC1 SPD:
   1. Provide on the following applications:
      a. Incoming 120 V power to all control panels.
      b. Line side of 120 V power terminals to equipment (e.g., PLCs, transmitters).
   2. Connected in series with the panel's or equipment’s branch circuit.

3. Provide fuse protection as recommended by manufacturer.
4. Flange mount or DIN rail mount in control panel.
5. Connect all SPDs in the panel to the same grounding point.

C. Category IC2 SPD:
1. Provide on the following applications:
   a. All desktop or rack mounted equipment that is cord and plug connected (e.g., computers, printers) except where power is sourced from a UPS.
2. Locate near equipment to be protected.

D. Category IC3 SPD:
1. Provide on the following applications:
   a. 120 V discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
   b. 120 V discrete PLC signals into a control panel from float switches, position switches, etc., where both the device and control panel are mounted outdoors, and the control conductors are routed above grade or underground.
2. Connected in series with the equipment.
3. Provide fuse protection as recommended by manufacturer.
4. Flange mount or DIN rail mount in control panel.
5. Connect all SPDs in the panel to the same grounding point.

E. Category IC4 SPD:
1. Provide on the following applications:
   a. Loop powered transmitter (flow, level, etc.) where the transmitter is mounted outdoors or in a remote building or structure from the control panel and the signal conductors are routed above grade or underground.
   b. Loop powered transmitter (flow, level, etc.) where both the transmitter and control panel are mounted outdoors, and the signal conductors are routed above grade or underground.
2. Connect in series with the equipment.
3. Attach to spare conduit entry of transmitter or inline of conduit at the transmitter.
4. Bond transmitter to a grounded structure or provide a ground rod.
5. Ground shield at control panel end.
6. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.

F. Category IC5 SPD:
1. Provide on the following applications:
   a. Incoming 4-20 mA signals into a control panel from transmitters (flow, level, etc.) where the transmitter is mounted outdoors or in a remote building or structure from the control panel and the signal conductors are routed above grade or underground.
   b. Incoming 4-20 mA signals into a control panel from transmitters (flow, level, etc.) where both the transmitter and control panel are mounted outdoors, and the signal conductors are routed above grade or underground.
2. Connect in series with the equipment.
3. Flange mount or DIN rail mount in control panel.
4. Connect all SPDs in the control panel to the same grounding point.
5. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.

G. Category IC6 SPD:
1. Provide on the following applications:
   a. Outdoor field mounted transmitter (flow, level, etc.) that requires 120 V power and provides a 4-20 mA signal to a control panel where the conductors are routed above grace or underground.
2. Connect in series with the equipment.
3. Mounted adjacent to equipment.
4. Bond transmitter to a grounded structure or provide a ground rod.

5. Ground shield at control panel end.
6. Verify SPDs series resistance and capacitance does not interfere with the transmitters signal.

H. Category IC7 SPD:
1. Provide on the following applications:
   a. Low voltage (e.g., 24 VAC, 24 VDC) discrete PLC signals into a control panel from float switches, position switches, etc., where the device is mounted outdoors or in a remote building or structure from the control panel and where the control conductors are routed above grade or underground.
   b. Low voltage (e.g., 24 VAC, 24 VDC) discrete PLC signals into a control panel from float switches, position switches, etc., where both the device and control panel are mounted outdoors, and the control conductors are routed above grade or underground.
2. Connect in series with the equipment.
3. Flange mount or DIN rail mount in control panel.
4. Connect all SPDs in the control panel to the same grounding point.

END OF SECTION

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SECTION 40 62 05
COMPUTER SYSTEM HARDWARE AND ANCILLARIES

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Computer and HMI hardware requirements, which include, but are not necessarily limited to:
      a. Panel Mounted Operator Interface Terminals (OIT).
      b. Software.
      c. Accessories and Maintenance Materials.

C. Related Sections include, but are not necessarily limited to:
   1. Section 40 61 13 - Process Control Systems General Requirements.
   2. Section 40 61 21 - Process Control System Testing.

1.2 REFERENCES

A. Definitions
   1. HMI: Human Machine Interface.
   2. LCD: Liquid Crystal Display.
   3. OIT: Operator Interface Terminal.
   4. OPC: “OLE for Process Control”, a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.
   5. PC: Personal Computer.
   6. RAID: Redundant Array of Independent Disks, a method of storing the same data in different places on multiple hard disks.
   7. RAM: Random Access Memory.
   8. SCSI: Short for Small Computer System Interface, a parallel interface standard used for attaching peripheral devices to computers.
   9. SDRAM: Synchronous Dynamic RAM.
   10. SNMP: Simple Network Management Protocol, a set of protocols for managing complex networks.
   11. TFT: Thin-Film Transistor, a technology for building LCD screens.

B. Referenced Standards:
   1. National Institute of Standards and Technologies (NIST):
      a. 800-82, Guide to Industrial Control Systems (ICS) Security.
      b. 800-53, Security and Privacy Controls for Federal Information Systems and Organizations.
   2. International Society of Automation (ISA):
      a. ISA-62443, Cybersecurity Certificate Programs.

1.3 SUBMITTALS

A. See Section 40 61 13 - Process Control System General Requirements.

PART 2 - PRODUCTS

2.1 PANEL MOUNTED OPERATOR INTERFACE PANELS (OIT)

A. Manufacturers:
   1. Allen Bradley PanelView Plus 7
   2. Or Equal.

B. Design and Fabrication:
   1. Display: Color graphics.
   2. Touch screen.
   3. 24 VDC power supply.
   4. Real time battery-backed clock, time stamp data.
   5. Communication ports.
   6. Provide password protection to prevent unauthorized entries for a minimum of two levels:
      a. Authorization to operate.
      b. Authorization to adjust setpoints.
      c. Configure automatic log-out to view-only mode after 15 minutes of inactivity.
   7. Operating temperature: 32 degrees F to 131 degrees F.
   8. Humidity: 10 to 90% RH non-condensing.
   9. Accessories: Install port locks on all unused ports.
   10. Configuration software:
      a. Provide latest version of configuration software licensed to the Government.

C. Configuration:
   1. Remove all unused software and services.
   2. Configure inactivity session lock.
   3. Disable operating system automatic updates.
   4. Change default usernames and passwords.
   5. Secure configuration environment with username and password.

2.2 SOFTWARE

A. Provide all software and associated programming/configuration required to meet performance requirements of the Contract Documents.
   1. At substantial completion of the Project:
      a. Turn current licenses for all software over to the Government in the Government's name and install the latest version, upgrade or service pack for all software.
      b. Provide the respective software supplier's Comprehensive Support Contract for all software covering a full one-year warranty period following substantial completion which shall provide no cost software upgrades, service packs and tech support from the software supplier.

B. All software must be latest edition and licensed to the Government.

2.3 ACCESSORIES AND MAINTENANCE MATERIALS

A. Provide all accessories required to furnish a complete computer-based network for the control system to accomplish the requirements of the Drawings and Specifications.

B. Furnish Owner with the following extra materials:
   1. One spare port lock key for each lock type provided.

PART 3 - EXECUTION

3.1 DEMONSTRATION

A. Demonstrate system in accordance with Section 01 75 10 - Checkout and Start-Up Procedures.

3.2 INSTALLATION AND CHECKOUT

A. Provide installation and checkout in accordance with Section 40 61 13 - Process Control System General Requirements and Section 40 61 21 - Process Control System Testing.

END OF SECTION

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SECTION 40 63 43
PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Programmable logic controller (PLC) control system(s), including hardware, documentation, and training.

C. Related Sections include but are not necessarily limited to:
   1. Section 01 75 10 - Checkout and Start-Up Procedures.
   2. Section 01 81 33 - Cyber Security Requirements.
   3. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   4. Section 40 61 13 - Process Control Systems General Requirements.
   5. Section 40 67 00 - Control System Equipment Panels and Racks.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. C37.90.2, Withstand Capability of Relay Systems to Radiated Electromagnetic Interference from Transceivers.
      b. C62.41.2, Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   2. International Electrotechnical Commission (IEC)
      a. IEC 61131-3 Programmable logic controllers
   3. National Electrical Manufacturers Association (NEMA):
      a. ICS 1, Industrial Control and Systems General Requirements.

B. Qualifications:
   1. Installation supervisor shall have had experience in overseeing installation and startup of at least three similar installations within the last five years.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 40 61 13.
   2. Product technical data including:
      a. Results of factory testing or simulation procedures.
      b. Bill of materials.
      c. Drawings containing the following information to be submitted as part of Specification Section 40 67 00 (control panels) submittals:
         1) Arrangement drawings for PLC system components.
         2) Panel and enclosure plans, sections and details.
         3) Access opening locations and required clearances for each panel and enclosure.
         4) Enclosure internal wiring and terminal blocks.
      d. DIP Switch and Jumper Settings, if applicable.
      e. I/O Rack and I/O Module Layout.
      f. Wiring and Interconnection diagrams.
         1) Power Supplies.
         2) I/O Points.
         3) Communications.

g. Catalog cut sheets containing information on PLC components to be submitted as part of these Specification Section submittals.

3. Certifications:
   a. Qualifications of installation supervisor.
4. Software Licenses:
   a. Documentation of all software package licenses being assigned to Contracting Officer.
5. Manufacturer support proposal.

B. Operation and Maintenance Data:
   1. See Specification Section 01 78 23 for requirements for:
      a. The mechanics and administration of the submittal process.
      b. The content of Operation and Maintenance Manuals.
   2. Maintenance procedures.
      a. Include the location and phone numbers of service centers (including 24 HR "hot lines").
      b. Provide specific information including operation and maintenance requirements, troubleshooting guide, parts ordering, field service personnel requests, and service contracts.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Rockwell Automation: Allen-Bradley.
   2. Or Equal.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. See Specification Section 40 61 13.

B. The PLC system shall meet the control requirements of Section 40 61 96 - Process Control Descriptions, Drawings, and Specifications.

C. The PLC system be capable of operating in ambient conditions of 0 to 55 DEGC temperatures and 30 to 95% relative humidity without the need for purging or air conditioning.

D. Environmental Controls:
   1. Furnish circulation fans in solid state control system enclosures.
   2. Over-temperature switches shall be utilized to provide special cooling if required to maintain operating temperatures within the manufacturer's specified range.
   3. Air conditioning applications shall include means of preventing moisture condensation.

E. Where the PLC is utilized to control multiple trains of equipment and where the equipment in each train operates as a unit relatively independent of other equipment trains (e.g., facility with multiple boiler units or filter trains), the PLC components (I/O modules, power supplies, etc.) shall be designed so that the failure of any one component does not affect equipment on all trains. The following shall also apply.
   1. I/O modules shall be segregated on a train basis unless required for safety reasons.
   2. Where several equipment units operate in parallel, but are not considered assigned to a particular equipment train (e.g., multiple raw water pumps or chemical feed pumps all discharging into a common header), the PLC I/O modules associated with each equipment unit shall be assigned so that the failure of any one I/O module will not affect the other parallel unit/s.

2.3 HARDWARE

A. Processor shall include diagnostic indicators for power, mode, low battery, communications ports, and memory and I/O errors.

B. Redundant processors, if specified, shall have seamless fail-over capability

C. I/O modules shall be capable of being replaced while the PLC is on-line and operating.

D. All I/O modules shall have terminal block failure or removal monitoring.

E. Analog output modules shall have a resolution of at least 12 bits.

F. Electrical isolation shall be provided between logical and field device.

G. I/O Module field wiring shall remain undisturbed when removing or replacing an I/O module.

H. Fail-safe state for each I/O channel shall be capable of being defined as on, off or fail-in-place.

I. Power Supply Units:
   a. Electrical service to PLC system shall be 105 to 125 VAC, 60 Hz, ±10 PCT, 1 PH power.

J. All PLC control system components shall be capable of meeting or exceeding electromagnetic interference tests per IEEE C37.90.2.

K. Incorporate the following minimum safety measures:
   1. Watchdog function to monitor:
      a. Internal processor clock failure.
      b. Processor memory failure.
      c. Loss of communication between processor and I/O modules.
      d. Processor ceases to execute logic program.
   2. Safety function wiring: Emergency safety switches shall not be wired into the controller.
   3. Safe wiring:
      a. Unless otherwise specified, activation of alarms and stopping of equipment shall be based on de-energization of rather than the energization of control circuits.
   4. Design PLC system with high noise immunity to prevent occurrence of false logic signals resulting from switching transients, relay and circuit breaker noise or conducted and radiated radio frequency interference.
   5. Operator intervention:
      a. Logic system failure shall not preclude proper operator intervention.
      b. Safety shutdown of equipment or a system shall require manual operator intervention before the equipment or system operation may be reestablished.

2.4 SOFTWARE

A. All software will be furnished and licensed to the Government.
   1. At Substantial Completion, transfer all licenses and media to the Government.
   2. At Substantial Completion, all software must be latest edition and licensed to the Government.
   3. Software shall be lifetime licensed and be OEM supported for at least 5 years from date of license transfer.

B. Programming
   1. Languages supported: All application programming in IEC 61131-3 compliant language.
   2. Program PLC utilizing ladder diagram, function block, or structured text format.
   3. Protect program via removable key switch or password to prevent unauthorized changes. Provide password and/or programming keys to the Government.
   4. Capable of on-line and off-line programming

C. Manufacturer support
   1. Submit a written proposal for a manufacturer support agreement for all products specified herein for a minimum of 12 months starting at final completion of the project. The cost of

this manufacturer support agreement shall not be included in the Contract Price. The support agreement shall be executed in the name of, and for the benefit of, the Contracting Officer. At a minimum, this agreement shall provide the Contracting Officer with:
a. 8 AM to 5 PM, 5 day per week manufacturer telephone support.
b. Access to the manufacturer's technical support website.
c. Software updates and patches.

2.5 COMPONENTS

A. PLC System Central Processor Unit (CPU):
1. The PLC shall have the capability of communicating with other commonly specified PLC and control system protocols such as Modbus/RTU, Modbus/TCP, Profibus, Ethernet/TCP and OPC.
2. CPU shall include capability to modify logic via an Ethernet port without taking processor offline.
3. Memory:
a. Battery-backed RAM.
b. Non-volatile program storage via flash EEPROM:
1) Automatically download to RAM in the event RAM is corrupted.
4. Memory battery backup shall be capable of 180 days memory retention with fresh battery.
a. Provide visual indication of battery status and alarm low battery voltage.
b. Memory battery backup shall be capable of 28 days memory retention after the "Battery Low" indicating LED is on.
5. Plug-in card designed to allow quick field replacement of faulty devices.
a. Provide unit designed for field replacement and expansion of memory without requiring rewiring or use of special tools.
6. 20% minimum spare useable memory capacity after all required programming is in place and operating.
7. Capable of executing all control functions required by the Specifications and Drawings.
8. Built-in three-mode (proportional-integral-derivative) control capabilities.
a. As directly selectable algorithms requiring no user knowledge of programming languages.
9. Lighted status indicators for "RUN".

B. Input/Output (I/O) Modules:
1. Provide plug-in modular-type I/O racks with cables to connect to all other required PLC system components.
2. Provide I/O system with:
a. I/O solid state boards with status lights indicating I/O status.
b. Electric isolation between logic and field device.
c. Capability of withstanding low energy common mode transient to 1000 V without failure.
d. Incorporate noise suppression design.
e. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
f. Capable of being removed and inserted into the I/O rack under power, without affecting any other I/O modules in the rack.
g. Install 20% spare I/O points for each type.
3. Input/output connection requirements:
a. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the I/O enclosure.
b. Prewire I/O modules to terminal blocks.
c. Provide terminal blocks with continuous marking strip.
d. Size terminals to accommodate all active data base points and spares.
e. Provide terminals for individual termination of each signal shield.
f. Field wiring shall not be disturbed when removing or replacing an I/O module.
4. Discrete I/O modules:
a. Interface to ON/OFF devices.

b. I/O status indicator on module front.
c. Voltage rating to match circuit voltage.
d. Output module current rating:
1) Match maximum circuit current draw.
2) Minimum 1.0 continuous A/point for 120 VAC applications.
e. Isolated modules for applications where one module interfaces with devices utilizing different sources of power.

5. Discrete outputs shall be fused:
a. Provide one fuse per common or per isolated output.
b. Provide blown fuse indication.
c. External fusing shall be provided if output module does not possess internal fusing.
d. Fuses provided external to output model shall:
1) Be in accordance with module manufacturer's specifications.
2) Be installed at terminal block.

6. Analog I/O modules:
a. Input modules to accept signals indicated on Drawings or Specifications.
b. Minimum 12 bit resolution.
c. I/O chassis supplied power for powering connected field devices.
d. Differential inputs and outputs.
e. User configurable for desired fault-response state.
f. Provide output signals as indicated on Drawings and Specifications.

7. Communications Modules:
a. Provide communications modules as shown on Drawings.
b. Provide communications modules for each protocol required for a complete communications system as shown on drawings.
c. Multi-port Ethernet modules may not be utilized as a network switch or to bridge networks.

C. Power Supply Units:
1. Provide regulated power units:
a. Designed to operate with PLC system and shall provide power to:
1) All components of PLC system.
2) All two-wire field instruments.
3) Other devices as indicated on Drawings or Specifications.
b. Capable of supplying PLC system when all the specified spare capacity is utilized.
c. Each power supply shall be sized such that it will carry no more than 75% of capacity under normal loads.

2. Electrical service to PLC system is 105 to 125 V, 60 Hz, +1%, 1 PH power.
3. Separate AC circuit breakers shall be provided for each power supply.
4. If the PLC system is field expandable beyond the specified spare capacity, and if such expansion requires power supply modification, note such requirements in the submittals and allow room for power supply modification in the PLC system enclosure.
5. Capable of meeting or exceeding electrical noise tests, NEMA ICS 1-109.60-109.66.
6. Power distribution:
a. Immune to transients and surges resultant from noisy environment.
b. Shall provide constant voltage level DC distribution to all devices.

7. Provide uninterruptible power supply (UPS) to sustain full power to UPS powered loads listed below for a minimum of 10 minutes following loss of primary power and to ensure that the transient power surges and dips do not affect the operation of the PLC system.
a. UPS powered loads:
1) All rack mounted PLC components.
2) Local operator consoles.
3) All power supplies furnished with the PLC and associated loads.
b. Input:
1) 120 VAC +10%.
2) 60 Hz.

3) Line fuse protection.

c. Output:
   1) 120 VAC 5%.
   2) 60 Hz.
   3) Short circuit protected.
   4) Instantaneous transfer time.

d. IEEE C62.41 Class A voltage surges of 6000 V attenuated to less than 50 V on the output.

e. Battery: Maintenance free lead acid.

D. PLC System Enclosure:

1. In accordance with Specification Section 40 67 00 - Control Panels.
2. Component placement:
   a. Mount all controller components within the enclosure to allow maximum convection cooling.
   b. Either install power supplies above all other equipment with manufacturers recommended clearance between the power supply and the enclosure top, or adjacent to other components, but with sufficient spacing for circulation of cooling air.
   c. Locate incoming line devices (isolation or constant voltage transformers, local power disconnects, surge suppressors, etc.) so as to keep power wire runs within an enclosure as short as possible.
   d. If items such as magnetic starters, contactors, relays, and other electromagnetic devices must be located within the same enclosure as the PLC system components, place a barrier with at least 6 IN of separation between the magnetic area and the control area.
   e. Place circulating fans close to major heat generating devices.
   f. Segregate input/output modules into groups of identical type.
3. Wiring and grounding to be in accordance with Specification Section 40 67 00.
4. Termination requirements:
   a. In accordance with Specification Section 40 67 00.
   b. Make connections to I/O subsystem by terminating all field wiring on terminal blocks within the enclosure.
   c. Prewire I/O modules to terminal blocks.
   d. Size terminals to accommodate all active database points and spares.
   e. Provide terminals for individual termination of each signal shield.
   f. Field wiring shall not be disturbed when removing or replacing an I/O module.

2.6 ACCESSORIES

A. Provide all accessories required to install and test a complete PLC control system to accomplish the requirements of the Drawings and Specifications.

B. Provide all programming cables required to configure the PLC logic.

2.7 SOURCE QUALITY CONTROL

A. Perform Factory Acceptance Testing in accordance with Specification Section 40 61 21 - Process Control System Testing.

2.8 MAINTENANCE MATERIALS

A. Furnish the Government with the following extra spares:
1. One spare CPU for every four field CPUs or fraction thereof installed.
2. One spare communication module by type installed in the Plant.
3. One spare I/O card of each card type for every 10 cards or fraction thereof installed.
4. One spare power supply for every 10 power supplies or fraction thereof installed.
5. A set of spare fuses for all installed types.

B. Include a complete bill of materials itemizing each line item with make and model (part) number.

C. Include a complete set of all special tools required to install, maintain and test the PLCs.

PART 3 - EXECUTION

3.1 FUNCTIONALITY

A. Complete System.
   1. Provide interface support with all foreign device interfaces (FDI) communicating with the PLC system.

3.2 INSTALLATION

A. Install PLC control system in accordance with manufacturer's written instructions.

3.3 FIELD QUALITY CONTROL

A. Test system in accordance with Specification Section 40 61 21 - Process Control System Testing.

B. Demonstrate system in accordance with Specification Section 01 75 10 - Checkout and Start-Up Procedures.

3.4 TRAINING

A. Employee of the manufacturer or certified representative to provide (2) sessions of 8 hours of operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.

B. As a minimum, training shall cover:
   1. Hardware overview.
   2. Software overview.
   3. Documentation.
   4. Maintenance.
   5. Trouble shooting.
   6. Operation, e.g., changing set points, passwords, etc.

3.5 DOCUMENTATION

A. Update O&M manuals to reflect as-built conditions.

END OF SECTION

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SECTION 40 66 05
NETWORK EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Computer network requirements, which include, but are not necessarily limited to:
      a. Ethernet Switches.

C. Related Sections include but are not necessarily limited to:
   1. Section 40 61 13 - Process Control Systems General Requirements.
   2. Section 40 61 21 - Process Control System Testing.

1.2 REFERENCES

A. Referenced Standards:
   1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
      a. 802.3, Information Technology - Local and Metropolitan Area Networks - Part 3: Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications.
         1) 802.3u: IEEE Standards for Local and Metropolitan Area Networks: Supplement to Carrier Sense Multiple Access with Collision Detection (CSMA/CD) Access Method and Physical Layer Specifications Media Access Control (MAC) Parameters, Physical Layer, Medium Attachment Units, and Repeater for 100 Mb/s Operation, Type 100BASE-T.
         2) 802.3x: IEEE Standards for Local and Metropolitan Area Networks: Specification for 802.3 Full Duplex Operation.
   2. National Institute of Standards and Technologies (NIST):
      a. 800-82, Guide to Industrial Control Systems (ICS) Security.

1.3 SUBMITTALS

A. See Section 40 61 13 - Process Control System General Requirements.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. See Specification 40 61 13 Process Control System General Requirements.
   2. Product Data:
      a. Network requirements verification plan.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed within the following Articles are acceptable.

2.2 ETHERNET SWITCHES

A. Accessories: “Stack Module” as required to create logical switches and reduce network latency.

B. Provide Ethernet switches as shown on the Drawings and the Schedule herein.

C. Layer 2 –Panel Mounted Ethernet Switches:

1. Manufacturers:
    a. Moxa.
    b. Or equal.
2. Design and fabrication:
    a. Support Ethernet 100/1000 Mbps.
    b. Two backbone ports for connection to multimode fiber via type LC connectors (ST not allowed).
    c. 8 100/1000 Mbps twisted pair ports (RJ45) as required for communication with devices as depicted in the Contract Documents. 8 port minimum.
        1) Unless otherwise noted, provide at least two spare 100/1000 Mbps port (twisted pair) at each Ethernet switch.
    d. Support SNMP v3 and Web based management.
    e. Rapid Spanning Tree Protocol.
    f. IGMP (Internet Group Management Protocol) support for IP multicast filtering to enable switches to automatically route messages only to appropriate ports.
    g. Check all received data for validity.
        1) Discard invalid and defective frames or fragments.
    h. Monitor connected TP/TX line segments for short-circuit or interrupt using regular link test pulses in accordance with IEEE 802.3.
    i. Monitor attached fiber optic lines for open circuit conditions in accordance with IEEE 802.3.
    j. As applicable, meet requirements of IEEE 802.3.
    k. One rack unit (RU) form factor.
    l. Power switch with 120 VAC power input.
    m. Provide dual redundant power supplies.
    n. Provide LED status lights to indicate:
        1) Power: Supply voltage present.
        2) Fault.
        3) Port status.
    o. Environmental rating:
        1) Operating temperature: 32 degrees F to 122 degrees F.
        2) Humidity: 95% relative humidity, non-condensing.
3. Function in self-healing ring structure.
    a. If one section in the ring fails, the ring structure changes to a line structure within 0.5 seconds.
4. DIN Rail mounted.

D. Configuration:
1. All managed switch unused ports shall be administratively disabled. Sticky MAC or similar port configuration shall be utilized to bind ports to MAC address of connected device per NIST 800-82.
2. Layer 3 switches shall be configured using static routes per NIST 800-82 best practices. Routes between VLANS shall be restricted except where required to achieve contract required functionality.
3. Change default usernames and passwords.

2.3 SOURCE QUALITY CONTROL

A. Provide Factory testing if required in section 40 61 21 - Process Control System Testing.

2.4 ACCESSORIES AND MAINTENANCE MATERIALS

A. Provide all accessories required to furnish a complete computer-based network for the control system to accomplish the requirements of the Drawings and Specifications.

B. Furnish Owner with the following extra materials:
1. One spare Ethernet switch of each type utilized.

PART 3 - EXECUTION

3.1 DEMONSTRATION

A. Demonstrate system in accordance with Section 01 75 10 - Checkout and Start-Up Procedures.

3.2 FIELD QUALITY CONTROL

A. Verify network is configured per requirements herein.

B. Submit verification plan.

3.3 INSTALLATION AND CHECKOUT

A. Provide installation and checkout in accordance with Section 40 61 13 - Process Control System General Requirements and Section 40 61 21 - Process Control System Testing.

END OF SECTION

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SECTION 40 67 00
CONTROL SYSTEM EQUIPMENT PANELS AND RACKS

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Requirements for control panels and enclosures utilized as follows:
      a. Unless noted otherwise, all control panels and enclosures housing control components that are specified in Section 40 63 43, Section 40 78 00, or Section 40 61 43.
      b. This Section is only applicable to panels furnished with equipment specified in other specification divisions when so stated in the applicable equipment specification section.

C. Related Sections include but are not necessarily limited to:
   1. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables.
   2. Section 40 61 13 - Process Controls Systems General Requirements.
   3. Section 40 61 21 - Process Control System Testing.
   4. Section 40 61 43 - Surge Protection Devices for Instrumentation and Control Equipment.
   5. Section 40 63 43 - Programmable Logic Controllers.
   6. Section 40 78 00 - Panel Mounted Instruments.

1.2 REFERENCES

A. Definitions
   1. Panel: Control panels or enclosures listed in the schedule included in this Section.
   2. Foreign Voltages: Voltages that may be present in circuits when the panel main power is disconnected.
   3. Intrinsically Safe:
      a. A device, instrument or component that will not produce sparks or thermal effects under normal or abnormal conditions that will ignite a specified gas mixture.
      b. Designed such that electrical and thermal energy limits inherently are at levels incapable of causing ignition.
   4. Intrinsically Safe Circuit: A circuit in which any spark or thermal effect is incapable of causing ignition of a mixture of flammable or combustible material in air under test conditions as prescribed in UL 913.
   5. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.
   6. Instrumentation Cable:
      a. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
      b. Instrumentation cable is typically either TSP (twisted-shielded pair) or TST (twisted-shielded triad) and is used for the transmission of low current or low voltage signals.
   7. Ground Fault Circuit Interrupter (GFCI): A type of device (e.g., circuit breaker or receptacle) which detects an abnormal current flow to ground and opens the circuit preventing a hazardous situation.
   8. Programmable Logic Controller (PLC): A specialized industrial computer using programmed, custom instructions to provide automated monitoring and control functions by interfacing software control strategies to input/output devices.
   9. Remote Terminal Unit (RTU): An industrial data collection device designed for location at a remote site, that communicates data to a host system by using telemetry such as radio, dial-up telephone, or leased lines.

10. Input/Output (I/O): Hardware for the moving of control signals into and/or out of a PLC or RTU.
11. Supervisory Control and Data Acquisition (SCADA): Used in process control applications, where programmable logic controllers (PLCs) perform control functions but are monitored and supervised by computer workstations.
12. Highway Addressable Remote Transducer (HART): A bi-directional communication protocol that provides data access between intelligent field instruments and host systems.
13. Digital Signal Cable: Used for the transmission of digital communication signals between computers, PLCs, RTUs, etc.
14. Uninterruptible Power Supply (UPS): A backup power unit that provides continuous power when the normal power supply is interrupted.
15. Loop Calibrator: Portable testing and measurement tool capable of accurately generating and measuring 4-20mA DC analog signals.

B. Referenced Standards:
1. American National Standards Institute (ANSI).
2. ASTM International (ASTM):
   a. B75, Standard Specification for Seamless Copper Tube.
3. National Electrical Manufacturers Association (NEMA):
   a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   b. ICS 4, Industrial Control and Systems: Terminal Blocks.
4. National Fire Protection Association (NFPA):
   a. 70, National Electrical Code (NEC):
      1) Article 409, Industrial Control Panels.
      2) Article 504, Intrinsically Safe Systems.
5. Underwriters Laboratories, Inc. (UL):
   a. 508A, Standard for Safety Industrial Control Panels.
   b. 698A, Standard for Industrial Control Panels Relating to Hazardous (Classified) Locations.
   c. 913, Standard for Safety Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II, and III, Division 1, Hazardous (Classified) Locations.

1.3 SUBMITTALS

A. See Section 40 61 13.

B. Shop Drawings:
1. Table of contents sheet(s).
2. Legend and abbreviation sheets.
3. Panel exterior layout drawings.
4. Panel interior layout drawings.
5. Bill of Material for each panel.
6. Panel door weight calculation.
7. Electrical load calculations for each panel.
8. Climate control calculations for each panel.
9. Communication network drawing(s).
10. Wiring diagrams.
    a. Drawings containing the following information to be submitted as part of Section 40 67 00 (control panels) submittals:
       1) Arrangement drawings for PLC system components.
       2) Panel and enclosure plans, sections and details.
       3) Access opening locations and required clearances for each panel and enclosure.
       4) Enclosure internal wiring and terminal blocks.

C. Product Data:
1. Manufacturer catalog cut sheets for enclosure, finish, panel devices, control auxiliaries, and accessories.

D. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

E. Informational Submittals:
   1. Unwitnessed Factory Testing confirmation of completion.
   2. Record Drawings:
      a. Updated panel drawings delivered with the panel(s) from the Contractor's factory.
      b. Drawings shall be enclosed in transparent plastic and firmly secured within each panel.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Approved supplier of Industrial Control Panels under provisions of UL 508A or UL 698A.
      a. Entire assembly shall be affixed with a UL 508A or UL 698A label "Listed Enclosed Industrial Control Panel" prior to shipment to the jobsite.
      b. Control panel(s) without an affixed UL 508A or UL 698A label shall be rejected and sent back to the Contractor's factory.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Shop Drawings:
   1. All panel and wiring drawings shall be provided in both hardcopy and softcopy.
      a. Drawings in AUTO CAD format.
      b. Printed on 11 by 17 inches sheets.
   2. Drawings shall include a title block containing the following:
      a. Plant or facility name where panel(s) are to be installed.
      b. Drawing title.
      c. Drawing number.
      d. Revision list with revision number and date
      e. Drawing date.
      f. Drawing scale.
      g. Manufacturer name, address, and telephone number.
   3. Cover sheet for each drawing set shall indicate the following:
      a. Plant or facility name.
      b. Project name.
      c. Submittal description.
      d. Revision number.
      e. Issue date.
   4. Table of contents sheet(s) shall indicate the following for each drawing in the set:
      a. Drawing number.
      b. Drawing title.
      c. Sheet number.
   5. Legend and abbreviation sheets shall indicate the following:
      a. Description of symbols and abbreviations used.
      b. Panel construction notes including enclosure NEMA rating, finish type and color, wire type, wire color strategy, conductor sizes, and wire labeling strategy.
      c. Confirmation that the panel(s) are to be affixed with a UL 508A or UL 698A label prior to shipment from the factory.
   6. Bill of Material for each panel shall include the following component information:
      a. Instrument tag number.
      b. Quantity.
      c. Functional name or description.
      d. Manufacturer.
      e. Complete model number.
      f. Size or rating.
   7. Panel exterior layout drawings to scale and shall indicate the following:

a. Panel materials of construction, dimensions, and total assembled weight.
    1) All dimensions shall be in inches.
b. Panel access openings.
c. Conduit access locations.
    1) Ensure conduit entry locations allow for sufficient bend radius of field cables entering enclosure.
    2) Control panel exterior layout shall identify conduit and cable entry locations.
d. Front view, side views and top view of enclosure.
e. Front panel device layout.
f. Nameplate layout drawings
g. Nameplate schedule:
    1) Nameplate location.
    2) Nameplate dimensions.
    3) Legend which indicates text, letter height and color, background color and nameplate material.
    4) Include exterior legends as per UL requirements.
    5) Short Circuit Current Rating (SCCR) marking per NFPA 70 or statement of exception. Include any required calculations.
h. Alarm annunciator window engraving schedule.
i. Layouts of graphic panels or mosaic displays.
j. Include a statement on the drawings that indicates that the panel has been built as per UL508A or UL698A standards.

8. Panel interior layout drawings shall be drawn to scale and shall indicate the following:
    a. Sub-panel or mounting pan dimensions.
        1) All dimensions shall be in inches.
    b. Interior device layouts indicating dimensioned location of devices.
    c. PLC/RTU general arrangement layouts.
    d. Wire-way locations, purpose, and dimensions. Include center line dimensions for all DIN rail and wire-way.
    e. Terminal strip designations.
    f. Location of external wiring and/or piping connections.
    g. Location of lighting fixtures, switches and receptacles.
    h. Include interior legends as per UL requirements.
9. Wiring diagrams shall consist of the following:
    a. Panel power distribution diagrams.
    b. Control and instrumentation wiring diagrams.
    c. PLC/RTU I/O information:
        1) Model number of I/O module.
        2) Description of I/O module type and function.
        3) Rack and slot number.
        4) Terminal number on module.
        5) Point or channel number.
        6) Programmed point addresses.
        7) Signal function and type.
    d. Internal network connections diagram
    e. Wiring diagrams shall identify each wire as it is to be labeled.
    f. Wiring diagrams shall include line/ rung references.
    g. Relay coils and their associated contacts shall be cross referenced to each other and clearly identified on the drawings.
    h. Wires leaving the sheet shall clearly indicate the continuation sheet and line/ rung references.
10. Communication network drawing(s) shall include:
    a. Network equipment
    b. Interconnections between all network equipment within the panel.
    c. Connection to the plant network.

B. Verify that panel door mounted equipment will not exceed the maximum allowed weight as per manufacturer's specification.
   1. Submit panel door weight calculation. Include weight of computer if using a laptop shelf.

C. Electrical load calculations for each panel:
   1. Panel current draw based on connected load.
   2. SSCR Calculations.
   3. UPS Run time calculations.
   4. DC power supply load calculations.
   5. Climate control calculations for each panel.
   6. Verify that sufficient dissipation and/or generation of heat is provided to maintain interior panel temperatures within the rated operating temperatures of panel components.
   7. Submit control panel heat release calculations (Watts or BTU/HR). Verify results with cooling/heating software. Submit heating and/or cooling equipment as required. Refer to Section 2.1.
   8. Provide temperature monitoring switch when an air conditioner is required by heat release calculations. High Temperature switch shall be wired to a PLC discrete input for temperature monitoring.
   9. Provide temperature monitoring switch when heater is required by heat release calculations. Low temperature switch shall be wired to a PLC discrete input for temperature monitoring.
   10. Air conditioners shall have built-in temperature display.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Enclosures:
      a. Hoffman Engineering Co.
      b. Or Equal.
   2. Panel heaters:
      a. Hoffman Enclosures, Inc.
      b. Or Equal.
   3. Heat exchangers and air conditioners:
      a. Hoffman Engineering Co.
      b. Or Equal.
   4. Cooling fans and exhaust packages:
      a. Hoffman Enclosures, Inc.
      b. Or Equal.
   5. Internal corrosion inhibitors:
      a. Hoffman Enclosures, Inc.; Model A-HCI10E
      b. Or Equal.

2.2 ACCESSORIES

A. Enclosures shall be provided with print pocket mounted on the interior of the door. Free standing enclosures shall have a minimum size print pocket of 12 inches.

B. All field instrument enclosure penetrations shall be plugged using threaded conduit plugs to prevent water or contaminant entry into the enclosure during installation.
   1. Instruments shall maintain manufacturer's rating for the appropriate area designation.
   2. Tape and/or plastic plugs shall not be an acceptable means of preventing water/contaminate intrusion.

2.3 FABRICATION

A. General:

1. Fabricate panels with instrument arrangements and dimensions identified in the Contract Documents.
2. Provide panel(s) with the required enclosure rating per NEMA 250 to meet classifications identified in the Contract Documents.
3. Devices installed in panel openings shall have a NEMA enclosure rating at least equal to the panel enclosure rating.
    a. Devices that cannot be obtained with an adequate NEMA rating shall be installed behind a transparent viewing window.
    b. The window shall maintain the required NEMA rating of the enclosure.
4. Externally mounted components including but not limited to air conditioners, enclosed transformers, external disconnect switches and external surge protector boxes shall match the NEMA rating and be constructed of the same material as the control panel. As an illustrative example, a NEMA 3/3R external enclosed transformer shall not be mounted on a NEMA 4X stainless steel panel.
5. Panel(s) shall be completely assembled at the Contractor's factory.
    a. No fabrication other than correction of minor defects or minor transit damage shall be performed on panels at the jobsite.
6. Painting:
    a. Panels fabricated from steel shall have their internal and external surfaces prepared, cleaned, primed, and painted.
        1) Mechanically abrade all surfaces to remove rust, scale, and surface imperfections.
        2) Provide final surface treatment with 120 grit abrasives or finer, followed by spot putty to fill all voids.
        3) Utilize solvent or chemical methods to clean panel surfaces.
        4) Apply surface conversion of zinc phosphate prior to painting to improve paint adhesion and to increase corrosion resistance.
        5) Electrostatically apply polyester urethane powder coating to all inside and outside surfaces.
        6) Bake powder coating at high temperatures to bond coating to enclosure surface.
            a) Panel interior shall be white with semi-gloss finish.
            b) Panel exterior shall be ANSI #61 gray with flat finish.
        7) Application of alkyd liquid enamel coating shall be allowed in lieu of polyester urethane powder for wall mounted NEMA 1 or NEMA 12 rated panels.
    b. Panels fabricated from stainless steel, aluminum, or fiberglass shall not be painted.
7. Finish opening edges of panel cutouts to smooth and true surface conditions.
    a. Panels fabricated from steel shall have the opening edges finished with the panel exterior paint.
8. Panels shall meet all requirements of UL 508A or UL 698A.
    a. If more than one disconnect switch is required to disconnect all power within a panel or enclosure, provide a cautionary marking with the word "CAUTION" and the following or equivalent, "Risk of Electric Shock-More than one disconnect switch required to de-energize the equipment before servicing."
9. Provide control panel in accordance with NFPA 70, Article 409.
    a. In the event of any conflict between NFPA 70, Article 409 and UL 508A or UL 698A, the more stringent requirement shall apply.
10. Provide equipment or control panels with Short Circuit Current Rating (SCCR) labeling as required by NFPA 70 and other applicable codes.
    a. Determine the SCCR rating by one of the following methods:
        1) Method 1: SCCR rating meets or exceeds the available fault current of the source equipment when indicated on the Drawings.
        2) Method 2: SCCR rating meets or exceeds the source equipment's Amp Interrupting Current (AIC) rating as indicated on the Drawings.
        3) Method 3: SCCR rating meets or exceeds the calculated available short circuit current at the control panel.

b. The source equipment is the switchboard, panelboard, motor control center or similar equipment where the control panel circuit originates.
c. For Method 3, provide calculations justifying the SCCR rating. Utilize source equipment available fault current or AIC rating as indicated on the Drawings.

B. Free-Standing Panels:
1. Welded construction.
2. Completely enclosed, self-supporting, and gasketed, dust-tight.
3. Rolled lip around all sides of enclosure door opening.
4. Seams and corners welded and ground smooth to touch and smooth in visual appearance.
5. Full height, fully gasketed flush pan doors.
6. Full length piano hinges rated for 1.5 times door plus instrument weight.
7. Doors with keyed alike locking handles and three-point catch.
8. Appropriate conduit, wiring, and instrument openings shall be provided.
9. Lifting eyebolts to allow simple, safe rigging and lifting of panel during installation.

C. Wall Mounted Panels:
1. Seams continuously welded and ground smooth.
2. Rolled lip around all sides of enclosure door opening.
3. Gasketed dust tight.
4. Three-point latching mechanism operated by oil tight key-locking handle.
5. Key doors alike.
6. Continuous heavy GA hinge pin on doors.
a. Hinges rated for 1.5 times door plus instrument weight.
7. Front full opening door.
8. Brackets for wall mounting.

D. Internal Panel Wiring:
1. Panel wire duct shall be installed between each row of components, and adjacent to each terminal strip.
a. Route wiring within the panel in wire-duct neatly tied and bundled with tie wraps.
b. Size wire ducts to include a minimum of 20% spare fill capacity.
c. Wire-duct shall have removable snap-on covers and perforated walls for easy wire entrance.
d. Wire-duct shall be constructed of nonmetallic materials with rating in excess of the maximum voltage carried therein.
2. Lay out panel wire-duct on both sides of each terminal strip. Leave one wire-duct empty, so the field wiring has sufficient room for entry into the panel through this wire-way. Designate the other wire-duct for panel wiring.
3. Utilize fiber optic and Ethernet cable management accessories within the panel.
a. Terminate Ethernet cables from the field to RJ45 punch down blocks. Connect Ethernet patch cords from the RJ45 punch down block to the Ethernet switch.
b. Terminate Fiber optic cable from field in fiber optic patch panel. Terminate all fibers within the cable. Connect Fiber optic patch cords from the fiber optic patch panel to the fiber optic Ethernet switch.
4. Wiring shall be installed such that if wires are removed from one device, source of power will not be disrupted to other devices.
5. “Daisy-chaining” of ground cables or power neutrals between equipment is not permitted.
6. Terminate all internal wiring with no more than two (2) conductors per terminal block point. For terminal strips designated for field wiring, only one side of the terminal strip shall be used for panel wiring.
7. Splicing and tapping of wires permitted only at terminal blocks.
8. Wire bundles to doors shall be secured at each end so that bending or twisting will be around longitudinal axis of wire.
a. Protect bend area with sleeve.
9. Arrange wiring neatly, cut to proper length, with surplus wire removed.
a. Arrange wiring with sufficient clearance.

b. Provide abrasion protection for wire bundles that pass through openings or across edges of sheet metal.

10. To eliminate noise coupling or interference, AC power and control circuits shall be routed separate from analog signal cables, low voltage control circuits, and communications cables and digital signal cables.
    a. Separate by at least 6 inches, except at unavoidable crossover points and at device terminations.
    b. All wiring shall be bundled and supported by straps.
11. Separation of intrinsically safe circuit conductors and non-intrinsically safe circuit conductors:
    a. Secure conductors so that any intrinsically safe circuit conductor that might come loose from a terminal is unlikely to come into contact with another terminal.
    b. Separate non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by one of the following methods:
        1) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by at least 2 inches (50 mm).
        2) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of a grounded metal partition 0.0359 inches (0.91 mm) or thicker.
        3) Separation of non-intrinsically safe circuit conductors from intrinsically safe circuit conductors by use of an approved insulating partition that extends to within 0.0625 inches (1.5 mm) of the enclosure walls.
        4) Where either (1) all of the intrinsically safe circuit conductors or (2) all of the non-intrinsically safe circuit conductors are in grounded metal-sheathed or metal-clad cables where the sheathing or cladding is capable of carrying fault current to ground.
    c. Blue wire-duct shall be used for wires carrying intrinsically safe circuit conductors.
12. Separate different intrinsically safe circuit conductors from each other by one of the following means:
    a. The conductors of each circuit are within a grounded metal shield.
    b. The conductors of each circuit have insulation with a minimum thickness of 0.01 inches (0.25 mm).
13. Provide minimum clearance of 0.125 inches (3 mm) between uninsulated parts of intrinsically safe field wiring conductors connected to terminals and grounded metal or other conducting parts.
14. Wiring to pilot devices or rotary switches shall be individually bundled and installed with a "flexible loop" of sufficient length to permit the component to be removed from panel for maintenance without removing terminations.
15. Conductors for AC and DC circuits shall be type MTW stranded copper listed for operation with 600 V at 90 degrees C.
    a. Conductor size shall be as required for load and 16 AWG minimum.
    b. Internal panel wiring color code:
        1) AC circuits:
            a) Power wiring: Black.
            b) Control interconnections: Red.
            c) Neutral: White.
            d) Ground: Green.
        2) Low voltage DC circuits:
            a) Power wiring: Dark Blue(+) and White with Blue stripe.
            b) Control interconnections: Dark Blue.
        3) Foreign voltage circuits: Yellow.
        4) Annunciator circuits: Red.
        5) Intrinsically safe circuits: Light Blue.
16. Analog signal cables shall be of 600 V insulation, stranded copper, twisted-shielded pairs.
    a. Conductor size: 18 AWG minimum.

b. Terminate shield drain conductors to ground only at one end of the cable.

17. High precision 250 ohm resistors with 0.25 % accuracy shall be used where 4 - 20 mA DC analog signals are converted to 1 - 5 VDC signals.
    a. Resistors located at terminal strips.
    b. Resistors terminated using individual terminal blocks and with no other conductors.
    c. Resistor leads shall be un-insulated and of sufficient length to allow test or calibration equipment (e.g., HART communicator, loop calibrator) to be properly attached to the circuit with clamped test leads.
18. Analog signals for devices in separate enclosures shall not be wired in series.
    a. Loop isolators shall be used where analog signals are transmitted between control enclosures.
19. Wire and cable identification:
    a. Wire and cables numbered and tagged at each termination.

E. Grounding Requirements:
1. Equipment grounding conductors shall be separated from incoming power conductors at the point of entry.
2. Minimize grounding conductor length within the enclosure by locating the ground reference point as close as practical to the incoming power point of entry.
3. Bond electrical racks, chassis and machine elements to a central ground bus.
    a. Nonconductive materials, such as paint, shall be removed from the area where the equipment contacts the enclosure.
4. Bond the enclosure to the ground bus. Bonded connections shall be free of paint and debris.
5. It is imperative that good electrical connections are made at the point between the ground bus and enclosure.
6. Panel-mounted devices shall be bonded to the panel enclosure or the panel grounding system by means of locknuts or pressure mounting methods.
7. Sub-panels and doors shall be bonded to ground.
8. Associated apparatus (connected to intrinsically safe circuits) and associated cable shields:
    a. Ground in accordance with the associated control drawing (drawing provided for the intrinsically safe circuit and which contains manufacturer's entity parameters).

F. Termination Requirements:
1. Wiring to circuits external to the panel connected to interposing terminal blocks.
2. Terminal blocks rigidly mounted on DIN rail mounting channels.
3. Electrical connections to terminal blocks shall be terminated with a proper torque tool as per manufacturer terminal block instructions. Terminating conductors without a torque tool can result in improper and unsafe installation.
4. Terminal strips located to provide adequate space for entrance and termination of the field conductors.
5. One side of each strip of terminal blocks reserved exclusively for the termination of field conductors.
6. Terminal block markings:
    a. Marking shall be the same as associated wire marking.
    b. Legible, machine-printed markings.
    c. Markings as identified in the shop drawings.
    d. Terminal block markings shall follow a consecutive numbering sequence. Terminal block numbers with a random numbering sequence are not acceptable.
7. Terminal block mechanical characteristics, and electrical characteristics shall be in accordance with NEMA ICS 4.
8. Terminal blocks with continuous marking strips.
    a. Each terminal block shall be identified with machine printed labels.
9. Terminals shall facilitate wire sizes as follows:
    a. 120 VAC applications: Conductor size 12 AWG minimum.
    b. Other: Conductor size 14 AWG minimum.
10. Analog signal cable shield drain conductors shall be individually terminated.

11. Install minimum of 20 % spare terminals.
12. Fused terminal blocks shall be used in the following circuits:
    a. Control voltage is used to energize a solenoid valve.
    b. DC power is connected to 2-wire, loop-powered instruments.
13. Fused terminal blocks shall be provided with blown fuse indicators.
14. When control circuits require more than one field conductor connected to a single wiring point, a sufficient number of terminal points shall be connected internally to allow termination of only one field conductor per terminal block.
15. DIN rail mounting channels shall be installed along full length of the terminal strip areas to facilitate future expansion.
16. Connections to devices with screw type terminals shall be made using spade-tongue, insulated, compression terminators.
17. Intrinsically safe circuit termination:
    a. Provide at least 0.25 inches (6 mm) clearance between two terminals for connection of field wiring of different intrinsically safe circuits, unless this clearance is permitted to be reduced by the control drawing this is provided for the intrinsically safe circuit and which contains manufacturer's entity parameters.
    b. Identify intrinsically safe circuits at terminal and junction locations in a manner that is intended to prevent unintentional interference with the circuits during testing and servicing as required by NEC, Article 504.
    c. Terminal blocks used for intrinsically safe wires shall be blue.

G. Component Mounting and Placement:
1. Components shall be installed per manufacturer instructions.
2. Mount and wire so removal or replacement may be accomplished without interruption of service to adjacent devices.
3. Locate all devices mounted inside enclosures so terminals and adjustment devices are readily accessible without use of special tools and with terminal markings clearly visible.
4. Control relays and other control auxiliaries shall be mounted on DIN rail mounting channels where practical.
5. Front panel devices shall be mounted within a range of 40 to 70 inches above the finished floor, unless otherwise shown in the Contract Documents.
6. PLC/RTU and I/O rack installation:
    a. Located such that the LED indicators and switches are readily visible with the panel door open.
    b. Located such that repair and/or replacement of component can be accomplished without the need to remove wire terminations or other installed components.
7. Locate power supplies with sufficient spacing for circulation of air.
8. Where components such as magnetic starters, contactors, relays, and other electromagnetic devices are installed within the same enclosure as the PLC/RTU system components, provide a barrier of at least 6 inches of separation between the "power area containing the electromagnetic devices" and the "control area".
9. Components mounted in the panel interior shall be fastened to an interior sub-panel using machine screws.
    a. Fastening devices shall not project through the outer surface of the panel enclosure.
10. Excess mounting space of at least 20 % for component types listed below to facilitate future expansion:
    a. Fuse holders.
    b. Circuit breakers.
    c. Control relays.
    d. Time delay relays.
    e. Intrinsically safe barriers and relays.
11. Components installed on sub-panels shall be provides with a minimum spacing between component and wire duct of 1 inch.
    a. Minimum of 2 inches separation between terminal strips and wire ducts.
12. Pneumatic tubes and appurtenances:

a. Connect panel air piping and tubing penetrations with bulkhead fittings.
b. Pneumatic control tubing shall be 1/4 inches OD.
   1) Tubing material: Either soft annealed ASTM B75 copper or flame-resistant polyethylene.
c. Main headers within panels shall be minimum 1 inch.
d. Compression-type pressure fittings.
e. Equip panel instrument leads with ball type isolation valve.
f. Route tubing neatly and mount securely.
g. Do not route tubing in front of or in wire ducting.
h. Code terminal plates.
i. Pneumatic devices shall be served by a dual function filter regulator.

H. Power Distribution:
1. Control panels powered by voltage greater than 120 VAC (nominal) main incoming power shall be provided with a disconnect switch mounted within the enclosure.
   a. Disconnect switch shall be interlocked with the enclosure door(s).
   b. Disconnect switches that supply motor loads shall comply with NEC Code part IX of article 430.
2. Main incoming power circuits shall be protected with a thermal magnetic circuit breaker.
   a. Limit load to maximum of 80 % of circuit breaker rating.
3. Component types listed below shall be individually fused so that they may be individually de-energized for maintenance:
   a. PLC/RTU power supply modules.
   b. Single-loop controllers.
   c. Operator interface terminals/HMI.
   d. DC power supplies.
4. Each control panel with PLC/RTU components shall be furnished with power protection in the form of a double conversion UPS.
5. Equip each panel with necessary power supplies with ratings required for installed equipment and with minimum 25 % spare capacity.
6. Constant voltage transformers, balancing potentiometers, and rectifiers as necessary for specific instrument requirements.
7. Circuit breakers and fuses shall be used to protect equipment powered inside and outside enclosure
   a. Circuit breakers shall be UL489.
   b. UL489 circuit breaker shall be finger safe.
   c. Fuses shall be 1/4 x 1-1/4 inches size.

I. Internal Panel Lighting and Service Receptacles:
1. Panels less than or equal to 4 feet wide:
   a. One electrical GFCI duplex receptacle.
   b. One LED light fixture with manual switch(es).
2. Panels or panel faces greater than 4 feet wide:
   a. One duplex electrical GFCI receptacle per 6 feet of length.
   b. Continuous LED lighting strip with manual switches.

J. Environmental Controls:
1. Indoor panels located in a designated electrical room or control room:
   a. Thermostat controlled cooling fans with exhaust louvers if required to maintain temperature inside panel(s) below the maximum operating temperature rating of the internal components.
   b. Internal corrosion inhibitors.
2. Indoor panels not located within a designated electrical room or control room:
   a. Thermostat controlled heaters to maintain temperature approximately 10 degrees F above ambient for condensation prevention inside the panels.

b. Automatically controlled, closed-loop heat exchangers or closed-loop air conditioners where required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel(s).
c. Internal corrosion inhibitors.

3. Outdoor panels:
   a. Outdoor temperature range of 0 degrees F through 120 degrees F.
   b. Thermostat controlled heaters to maintain temperature approximately 10 degrees F above ambient dew point for condensation prevention inside the panels.
   c. Thermostat controlled closed-loop heat exchangers or closed-loop air conditioners if required to maintain temperature inside each enclosure below the maximum operating temperature rating of the components inside the panel.
   d. Internal corrosion inhibitors.
4. Environmental control components:
   a. Panel heaters:
      1) Thermostat controlled.
      2) Fan driven.
      3) Components mounted in an anodized aluminum housing.
      4) Designed for sub-panel mounting.
      5) Powered from 120 VAC and protected with a dedicated circuit breaker.
   b. Cooling fans and exhaust packages:
      1) Cooling fan with louver or grill and replaceable filter.
      2) Designed to be mounted within a panel cutout to provide positive airflow through the panel.
      3) Cooling fan and exhaust louvers shall be designed and listed to maintain a NEMA 12 enclosure rating.
      4) Fitted with replaceable, high-density foam or synthetic fiber.
      5) Cooling fan controlled with a separately mounted thermostat with bi-metal sensor and adjustable dial for temperature setting.
      6) Powered from 120 VAC and protected with a dedicated circuit breaker.
   c. Heat exchangers and air conditioners:
      1) Dual-loop design to isolate panel interior air from exterior air.
      2) Thermostat controlled.
      3) Operate from 120 VAC and protected with a dedicated circuit breaker.
   d. Internal corrosion inhibitors:
      1) Contains chemical which vaporizes and condenses on surfaces in the enclosure.
      2) Inhibitor shall be applied in accordance with manufacturer instructions for the enclosure volume.
      3) Inhibitor shall be applied in the panel(s) prior to shipment from the Contractor's factory.

2.4 UNWITNESSED FACTORY TESTING

A. Inspect and test entire panel assembly to verify readiness for shipment or readiness for the Contracting Officer to attend factory testing if specified in Section 40 61 21 - Process Control System Testing.

B. Location: Panel fabricator's factory.

C. Tests shall be fully documented and signed by the panel fabricator's factory supervisor.

D. The panel shop shall fully test the control panel for correct wiring.
   1. Each I/O point shall be checked by measuring or connecting circuits at the field terminal blocks.

E. Burn-in test: Panel(s) shall be fully energized for a minimum period of 48 hours.

F. A PLC Central Processing Unit (CPU) shall be obtained and connected to the panel(s) if necessary for testing purposes.

G. Testing equipment (such as digital multi-meters, analog loop calibrators, and laptop computers with PLC programming software) shall be used as required for testing.

H. The following functions shall be tested as a minimum:
   1. Verify functions of the panel(s) required by the Contract Documents.
   2. Correctness of wiring from all panel field terminals to all I/O points and to all panel components.
   3. Simulate and test each discrete signal at the field terminal strips.
   4. Simulate and test each analog signal using loop calibrators.
   5. Correct operation of communications between PLC system Central Processing Units (CPUs) and Remote I/O bases.
   6. Correct operation of single-loop controllers (including digital communication to microprocessor based devices).
   7. Correct operation of all digital communication devices.
   8. Verify online and offline diagnostic tests and procedures.

I. Deficiencies shall be corrected prior to requesting the Contracting Officer to attend factory testing if specified, or prior to shipment from the Contractor's factory.

2.5 SOURCE QUALITY CONTROL

A. Perform Factory Acceptance Testing as specified in Section 40 61 21 - Process Control System Testing.

2.6 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Quantity of 25 % replacement lamps for each type installed (minimum of 12 of each type).
   2. Minimum 12 replacement filters for each type installed.
   3. 1 QT of exterior finish touch-up paint.
   4. One complete set of replacement corrosion inhibitors in sealed packages for each panel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install freestanding panels on 4 inches high concrete housekeeping pads.

B. Anchor panels in a manner to prevent the enclosure from racking, which may cause the access doors to become misaligned.

C. Obtain approved panel layouts prior to installation of conduits.

D. Install products in accordance with manufacturer's instructions.

END OF SECTION

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SECTION 40 67 63
UNINTERRUPTIBLE POWER SUPPLY

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Uninterruptible Power Supplies (UPS).

C. Related Sections include but are not necessarily limited to:
   1. Section 40 61 13 - Process Control Systems General Requirements.

1.2 REFERENCES

A. Referenced Standards:
   1. Federal Communications Commission (FCC):
      a. Code of Federal Regulations, 47 CFR 15, Radio Frequency Devices.
   2. Underwriters Laboratories, Inc. (UL):
      a. 1778, Standard for Uninterruptible Power Supply Equipment.

1.3 SUBMITTALS

A. See Section 40 61 13 for general process control system submittal requirements.

B. Shop Drawings:
   1. Provide load calculations and manufacturer's runtime chart to substantiate UPS sizing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with the Contract Documents, the manufacturers listed in the applicable Articles below are acceptable.

B. Provide similar components from the same manufacturer for uniformity of appearance, operations, and maintenance.

2.2 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

A. Manufacturers:
   1. APC Smart-UPS.
   2. Or Equal.

B. Design and fabrication:
   1. Double conversion, true online type.
   2. Tower or Rack type format as specified in the schedule.
   3. Waveform: Pure sine wave.
   4. Power factor correction.
   5. Minimum 10 minutes power ride through of 100% of connected load without incoming power.
      a. Provide extended battery or batteries as necessary to achieve the specified battery run time.
   6. For UPS and related components located within a server rack, install UPS and battery components at bottom of cabinet.
   7. Frequency range: 45-65 Hz.

8. Input protection:
    a. Fuse or circuit breaker.
9. Output voltage regulation:
    a. ±1% online.
    b. ±2% on battery mode.
10. Battery: Sealed, lead-acid; maintenance free.
11. Three stage battery charging for prolonged battery life.
12. Battery over discharge protection.
13. Input power cord.
14. Output receptacles.
15. Efficiency:
    a. Normal mode, minimum: 89%.
    b. Efficiency mode, minimum: 95%.
    c. Battery mode, minimum: 83%.
16. Operating temperature: 32 to 104 degrees F.
17. Relative humidity: 5-95% non-condensing.
18. Integral bypass to automatically bypass UPS on selected fault conditions.
19. Front panel indication of UPS status and alarm conditions.
    a. UPS Fault.
    b. UPS on battery.
    c. UPS is online and operating normally.
    d. Battery low.
    e. UPS in bypass.
20. Utilize alarm contacts to enable remote annunciation of the following conditions.
    a. UPS Fault.
    b. UPS on battery.
    c. Low battery.
    d. UPS in bypass.
    e. UPS batteries disconnected.
    f. UPS overload.
    g. UPS high temperature.
    h. Battery over voltage
21. Accessories:
    a. Communications Modules
        1) Provide an Ethernet communications module for network connectivity.
22. Agency Approvals:
    a. Safety: UL 1778.
    b. Emissions: FCC Part 15 (Class A).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. Test UPS to verify the UPS switches power upon incoming AC power loss correctly while keeping all UPS powered loads online.

B. Perform testing of the UPS to determine if each UPS is sized correctly to maintain the specified run time.

END OF SECTION

SECTION 40 68 63
CONFIGURATION OF HMI SOFTWARE AND REPORTS

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Configuration requirements for Human Machine Interface (HMI) and reports, which includes but is not necessarily limited to:
      a. Specific software functional descriptions.
      b. Graphics requirements.
      c. HMI functionality requirements.
      d. Plant overview screens.
      e. Process overview screens.
      f. Detail displays.
      g. Trend displays.
      h. PLC hardware/HMI status screen.
      i. Alarm monitoring.
      j. Configuration standards and conventions.
      k. Screen configuration review meetings.
      l. Coordination.

C. Related Requirements:
   1. Section 40 61 13 - Process Control Systems General Requirements.
   2. Section 40 61 21 - Process Control System Testing.

1.2 REFERENCES

A. Definitions
   1. HMI: Human Machine Interface.
   2. I/O: Input/Output.
   3. OLE: Object Linking and Embedding, a document standard developed by Microsoft that enables the creation of an object with one application and the linking or embedding of the object in a second application.
   4. OPC: "OLE for Process Control"; a software standard utilizing a client/server model that makes interoperability possible between automation/control applications and field systems/devices.
   5. PC: Personal Computer.
   6. PLC: Programmable Logic Controller.

B. Referenced Standards:
   1. American National Standards Institute/The International Society of Automation (ANSI/ISA):
      a. 101.01-2015, Human Machine Interfaces for Process Automation Systems.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Software Configuration Standards and Conventions document.
   2. Shop Drawings:
      a. Graphic screen displays; provide in actual colors utilized.
      b. Native file format of the HMI Configuration including tag database and graphic screens.

c. Sample reports.

B. Informational Submittals: Submit the following:
1. Certifications:
a. Qualifications of programmer(s).
2. Results of factory testing procedures.
3. Proposed training agendas and schedule.

C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Record Documentation:
a. Software Configuration Standards and Conventions - final version.

1.4 QUALITY ASSURANCE

A. Qualifications:
1. Programmer(s) shall have had experience in HMI software configuration and installation for at least two projects of similar size and complexity in the past five years.
a. At least one of the two projects must have used the HMI software being utilized for this project.

1.5 ADMINISTRATIVE REQUIREMENTS

A. Software Functional Requirements:
1. General functional requirements for system configuration are indicated on the Drawings and described in the Specifications.
2. The information presented herein and indicated on the Drawings illustrates the general functional intent of the system and may not be sufficient to fully configure the system.
3. The Contractor is responsible for determining what additional information may be required to complete the configuration tasks, and for obtaining this information from the Government.

B. Available Process Values:
1. All process alarm, equipment status, and process variable values shall be available at any HMI.
2. If communications to a particular I/O point has failed for any reason, then wherever that data is displayed, the software shall post a visual indication that the point is not valid.

C. Text Presentation:
1. In general, use mixed or title case lettering rather than uppercase.
a. If a paragraph is required, do not capitalize each word. Single words or short phrases may be capitalized.
2. Avoid abbreviations and acronyms unless part of normal operator language.
3. Do not underline for emphasis; reserve underlined text for hyperlinks.
4. Display text in horizontal orientation unless unavoidable or for clarity.

D. Command Entry:
1. Utilize multiple input actions for commands that result in direct action to the process; do not allow a single inadvertent input action to result in a direct action to the process.
2. Where a command entry requires multiple selections by the operator, selections shall be followed by confirmation of the entire list of actions before the command is executed (e.g. selecting new recipe and confirming additive sources and product destinations.)
3. If the selection lists of options are long; construct groupings to allow for easier navigation, scanning and identification of desired selection.
4. Either provide a method for canceling a command change during the change process, or have means for recovering quickly to the prior configuration, or both.
5. Provide feedback for all entries that are outside of an expected range. If an input is critical, acceptable limits on entry shall be enforced.

E. Buttons:
   1. Buttons that interact directly with the process shall be visually distinct from buttons that provide navigation linkages or launch applications.
   2. Any buttons that are currently unavailable shall remain visible. A text color and button background change shall indicate their temporary unavailability.
   3. Provide feedback confirmation for button execution.

F. Data Entry and Presentation:
   1. Provide the capability for manual entry of surrogate data and other variables, which must then be available for display and use in reports.
      a. Operator-entered commands from any of the operator workstations must be logged to the specific user account by the computer servers.
      b. In cases where error avoidance techniques are employed to enforce limits on data entry, utilize methods to clarify reason for rejection.
   2. Suppress leading zeroes on whole numbers, but use leading zeroes for numbers between -1 and 1.
   3. Make engineering units available for operator reference.
   4. Utilize no more or fewer display digits than is commensurate with the accuracy of the displayed value.

G. Provide comprehensive on-line help for all development functions.

H. System Failure:
   1. Failure of any PLC, remote I/O hardware, or network communication link must be individually alarmed at HMIs.
   2. Unless otherwise specified, each alarm must be specific to a single point of failure.

I. All process related functions, calculations, timers, and numeric manipulations shall be accomplished in the PLC hardware and not in the HMI.
   1. The HMI shall function as a monitoring system, not as a process controller.
   2. The HMI shall transfer data to the PLC system and the PLC system shall perform all control algorithms.

1.6 SECURITY

A. Fully integrate security into the SCADA system to allow only users with appropriate security levels access to individual parts of the system.

B. Include a minimum of four user categories that will determine appropriate access levels:
   1. Guest
   2. Operator.
   3. Supervisor.
   4. Administrator. Access to HMI configuration and system settings.

C. Each user shall have their own unique user ID and password combination and be assigned to either operator or supervisor user categories.
   1. Guest category shall only have view-only mode with no control or set point adjustment permissions.
   2. Users shall be configured within the HMI environment.

D. Remove all default user names and passwords. Any required configuration or service accounts shall be coordinated with the Government. Service accounts and configurations accounts to be submitted to the Government during close-out as required by 40 61 13.

PART 2 - PRODUCTS

2.1 SPECIFIC SOFTWARE FUNCTIONAL DESCRIPTIONS

A. Specific functional requirements for various software control blocks within the computer system are as specified in this subsection.

B. Descriptions are general and are not intended to fully indicate the complete functionality of the system.
   1. Monitoring of process values:
      a. Process values derived from analog process variable signals must be historically archived.
         1) Present analog values within context; i.e. provide indication of where each displayed value fits within normal operating range, and how it compares to process and alarm set points.
            a) Consider the use of sparklines for critical analog values to provide more context and situational awareness.
               (1) Final determination of where sparklines are to be used, and how each analog value is to be displayed shall be made at the HMI Screen Configuration Review Meeting(s) with the Government.
         2) Store all historical data with time and date of occurrence.
         3) Make values available for use in reports.
         4) Assign high and low alarms to process values as defined below and otherwise deemed appropriate.
      b. Provide capability for computer server(s) to retrieve real-time values from the PLC system at adjustable time periods.
      c. Alarm limits:
         1) Set per direction from the Government.
         2) An operator having proper security authorization must be able to enable, disable, and adjust the set point of any individual alarm.

C. Provide the four levels of graphic screen displays per ANSI/ISA-101.01 and as described below:
   1. Level 1 – Overview Display:
      a. One display to provide continuous overview or summary of key parameters, alarms, calculated process conditions and operator's entire span of control.
      b. Separate overview display for all operating modes, for example start-up and shutdown.
      c. Display all top priority alarms including the indication of acknowledgement status.
         1) Locate to convey functional relationship (i.e. locate adjacent to associated equipment or device).
      d. Display actual values, abnormal status and severity of deviation for key process parameters that depict health of high-level process areas.
      e. Display embedded trends on important parameters.
      f. Orient the operator to the existence, severity, location and direction of change of abnormal process conditions.
      g. In general, do not use for performing control functions (e.g. controller set point changes)
   2. Level 2 – High Level Displays (system and subsystem overviews):
      a. Serves as the operator's primary operating display during normal operations for routine changes and monitoring.
      b. Include process unit overviews or primary displays for every major system.
      c. Provide easy navigation to the more detailed level 3 and 4 displays.
      d. Enable operator to perform tasks using a limited number of displays and minimal navigation.
      e. Display all top and middle priority alarms for the specific system or subsystem.
         1) Provide notification of the existence of low priority alarms within the relevant process so that the Operator knows to navigate to a Level 3 screen, if so desired, for more information.
      f. Provide enough information and controllers within the main control interface to control the system under most conditions.
      g. Contain the primary controllers for the specific process area.
      h. Display task-specific information for start-up and/or shutdown.
   3. Level 3 – System/Subsystem Detail Displays:
      a. Typically contain more detail than associated level 2 displays.

b. Used by the operator to perform non-routine operations such as lineup changes, equipment switching, or complex routing tasks.
c. Provide sufficient information to facilitate process diagnostics.
d. Task based: enable the operator to perform tasks using a limited number of displays and minimal navigation.
e. Contain control loops and indicators for process equipment.
f. Display alarms of all priorities.
g. Display status of various interlocks for depicted equipment.
h. Utilize pop-up control screens.

4. Level 4 – Diagnostic Displays:
   a. Make available all system information.
   b. Not intended for process or system control, although functionality to perform control may exist in these displays (such as point details).
   c. May utilize faceplates or popups to display system information.
      1) Provide timeout period after which popup closes without any user interaction.
         a) Provide the operator with capability to override any configured timeout period.
      2) Design popups so as not to cover or obscure important parts of HMI display.
      3) All presentation and interaction methods to be consistent with other HMI displays.
   d. Provide operating procedures for individual pieces of equipment.
   e. Provide help information for equipment control and diagnostics.
   f. Contain detailed safety shut downs.
   g. Contain interlock and permissive information.

D. HMI operator interface functionality shall include:
   1. Indication of process variables.
   2. Configuration of control loop parameters (e.g., set points, gains, etc.).
   3. Adjustment of controller output.
   4. Display of real time and historical process trends.
   5. Selector switch and pushbutton station controls.
   6. System and process status indicators.
   7. Graphic representation of plant operations with interactive status and measurement symbols.
   8. Annunciation.

E. Graphics:
   1. Color use:
      a. Do not utilize color alone as the sole discriminator of important status conditions.
      b. Do not utilize colors designated for alarms for other purposes.
      c. Utilize bright colors to draw attention to abnormal situations; do not use bright colors to designate normal conditions (e.g. equipment run status or valve position status).
      d. Unless directed otherwise, utilize gray background and muted colors to minimize screen glare and reflection.
   2. Dragging the mouse over designated process areas of screen shall allow the operator to select predetermined processes or equipment and drill down to site-specific detail screens.
      a. Provide a graphical response, such as the use borders or shading, to help the Operator easily identify clickable screen content.
   3. Critical “overview” information such as tank levels, flows and pressures shall be indicated through data fields or animation effects such as level fills or color change.
   4. All monitored and or controlled process equipment shall utilize color highlighting or shading to indicate status changes.
   5. Tank and vessel levels shall be indicated with a tabular data field, sparklines, and by graphic “fill” simulating a rising or falling level within the tank or vessel.
   6. Provide the ability to “drill down” to detail screens or graphics.
      a. Clicking on a device or process area shall generate a detail graphic or pop-up window to access specific data or control functions.
      b. All operator adjustments (e.g., set point adjustment, mode selection) shall be accomplished via a pop-up display, and shall not be allowed on the process screen.

7. Unless otherwise directed, utilize software manufacturer's standard symbol library.

F. Navigation:
   1. Minimize operator keystroke/equivalent actions.
      a. Single keystroke access from graphic to group display or other custom graphic displays.
   2. Utilize consistent and distinct visual display symbols for navigation targets.
   3. Utilize navigation bar on every screen.
      a. Navigation bar to include navigation functions, active alarm notification, security functions, current date/time display, "PRINT SCREEN" pushbutton, and other functions as required and as agreed upon at the Screen Configuration Review Meetings.
   4. Maximum access times/clicks listed below:

METRIC	DISPLAY TYPE	MAXIMUM ACCESS TIMES/CLICKS
Access to alarm displays	Alarm summary	1 second
	Alarm lists (e.g. suppressed alarms)	5 seconds
Navigation	Critical displays	1-2 clicks
	Non-critical displays	3 clicks
	Alarm summary	1 click
	System diagnostics	1-2 clicks

G. Trend Displays:
   1. Provide real-time display of trend charts for selected values.
      a. Values to be selected for trend displays shall be identified during review meetings with the Government.
      b. Label the axis of each trend chart with appropriate engineering units.
   2. Capable of displaying multiple points per display.
   3. Operator shall be able to select/adjust any desired sample time interval.
   4. In addition to providing configuration for trend displays of selected values, provide capability for easy access to real time and historical trend information for any variable TAG defined within the SCADA application; i.e. provide ad hoc trend screen functionality.
      a. As a minimum, provide the following:
         1) Provide capability for the user to define trend scenarios.
         2) Provide a button to open a dialog window to select multiple variable TAGS and save them as a trend scenario for future use.
         3) Provide a pull-down menu to allow the user to open saved trend scenarios.
         4) Provide a button to allow the user to select real-time or historical trends.
         5) Provide a button to save displayed trend info to a file for export to external software applications (such as Microsoft Excel).
         6) Provide a Print Trend button to allow user to print current trend.
   5. Utilize Historical Data Server(s) to collect and manage data.

H. Bar Charts:
   1. Utilize moving pointers for bar charts where used to show relative positions and/or values.

I. PLC Hardware/HMI Status Screen:
   1. Provide a status screen to depict status conditions and diagnostic information for all major networked equipment.
   2. Depict communication status for all networked communicating devices, such as PLC processors, Ethernet switches, PCs, and radios.

J. Alarm Monitoring:
   1. Provide standard alarm screen functionality to ensure flexibility and quick access to live alarms, alarm history and alarm grouping parameters.
      a. As a minimum, include the following features and functionality:
         1) An Alarm Screen header bar to head all alarm pages and reside below the Navigation Bar.
         2) Buttons to dynamically switch between Alarm Summary and Alarm History.
         3) A menu to allow user to select and open historical alarm archives.
            a) Utilize a time-date stamp file structure.
         4) Pull-down menu bar to select operator configured alarm groups.
         5) Capability to sort alarms by priority and to define priority for all system alarms.
         6) Capability to filter or group alarms.
   2. Analog alarms:
      a. The SCADA software shall monitor analog and discrete variables and calculated conditions, and determine if the variable is in an alarm condition.
      b. For each Analog Tag, an alarm for each of the following conditions shall be assignable:
         1) Low-low.
         2) Low.
         3) High.
         4) High-high.
         5) Deviation low.
         6) Deviation high.
         7) Rate of change.
      c. Provide adjustable dead bands and delay timers for all analog alarms.
   3. Present alarms in order of:
      a. Priority.
      b. Time of occurrence.
      c. Non-acknowledged presented ahead of acknowledged.
   4. Utilize single keystroke or pushbutton to:
      a. Acknowledge alarms.
   5. Alarm list presented to operator shall include:
      a. Time of occurrence.
      b. Time of acknowledgement.
      c. Description.
      d. Acknowledgement status.
   6. Alarm list printed by either of the following:
      a. On command.
      b. Periodically.
   7. Audible alarming capability for user selected alarms.

2.2 SOURCE QUALITY CONTROL

A. Include performance test of HMI software in factory with the overall PLC System test.
   1. Reference Section 40 61 21 for requirements.

PART 3 - EXECUTION

3.1 CONFIGURATION REQUIREMENTS

A. Provide all programming and configuration required for all HMIs furnished under this Contract:

3.2 CONFIGURATION STANDARDS AND CONVENTIONS

A. Prepare and submit a “Software Configuration Standards and Conventions” document.
   1. Submit for review and approval prior to commencing with software configuration.
   2. Prior to submitting the initial draft document, the Contractor must meet with the Government to review the Government’s standards and conventions.

3. Contractor is responsible for scheduling and facilitating the standards and conventions review meeting with the Government.
    a. Contractor is responsible for generating the meeting agenda and issuing meeting minutes.
    b. Meeting will be held at a site designated by the Government.
4. Follow the principles contained in ANSI/ISA-101.01 unless directed otherwise by the Government or Government's Representative.
5. Describe and define such items as:
    a. Proposed graphic display process colors/representations.
    b. Color standards for "ON," "OFF," "RUNNING", "OPEN", "CLOSED", and "ALARM" conditions.
    c. Font type and size.
    d. Alarm handling conventions.
        1) Include defining alarm priorities and how they are to be represented graphically (e.g. color and symbol).
    e. Methods for navigation between displays.
    f. Address usage/naming/tagging conventions.
    g. Security setup.
    h. Content of Level 1, Level 2, Level 3 and Level 4 graphics.
6. Historical setup including data logging by I/O type (including alarms, events and process data), data retention, and data purge.
7. In addition to submitting the initial document for review, submit an updated version of the document as part of the Operation and Maintenance Manuals.
    a. Revise this document to include any additional standards that are established throughout the configuration process.

3.3 SCREEN CONFIGURATION REVIEW MEETINGS

A. Conduct a minimum of two configuration conferences with the Government to review and discuss system configuration programming and related topics.
    1. The purpose of the conferences will be to discuss, in detail, how each I/O point will be handled and the types, quantities, hierarchies, and functioning of display screens.
    2. Review of the Government's existing systems, standards, conventions, file and tag naming requirements, font type and size requirements, and reporting requirements must be part of each conference.
    3. Review the navigation bar to be utilized.
    4. Conferences will be held in at a site designated by the Government.
    5. Each screen will be reviewed at each conference.
        a. If required, to review all screens, each conference will occur on multiple days.
    6. Submit 10 color copies of printed screens via shop drawing submittal process 10 calendar days before each conference.
    7. Bring equipment to project screens on wall or provide multiple monitors for viewing by attendees.

B. Proposed graphic screens and report formats must be reviewed with the Government throughout the configuration process.

3.4 COORDINATION

A. Coordinate as required with other contractors and vendors to seamlessly integrate all HMI monitoring and control functions.
    1. To the greatest extent possible, integrate graphics presentation for all systems into screens utilizing one common HMI software.

B. Examples of systems that utilize separate application software packages and thus require coordination include, but are not necessarily limited to:
    1. Generator Controls.
    2. Digital Metering Package.

3. Distributed UPS System.
4. Pre-purchased control systems.
5. Vendor-furnished packaged systems.

3.5 FIELD QUALITY CONTROL

A. Provide monitoring and control functions at the HMI(s) as specified within these Contract Documents for all vendor-furnished control systems.
   1. Provide all required coordination with the suppliers of the vendor-furnished control systems to enable seamless integration of the Plant Process Control System with the vendor-furnished controls.

3.6 DEMONSTRATION

A. Demonstrate system in accordance with Section 01 75 00.

B. On-Site Training:
   1. Provide employee of the System Integrator to provide 4hours of hands-on operation and maintenance training at the Project site after the system has successfully undergone all field testing and acceptance procedures.
      a. As a minimum, training shall cover:
         1) Hardware overview.
         2) Software overview.
         3) Maintenance.
         4) Troubleshooting.
         5) Operation, e.g., changing set points, passwords, etc.
      b. Provide printed materials for each trainee in attendance.

END OF SECTION

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SECTION 40 78 00
PANEL MOUNTED INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Contractor shall verify that the requirements and items listed in this specification have been incorporated and addressed by the System Supplier for the Packaged Wastewater Treatment Equipment, Package Sewage Pumping Station, and Temporary Lab Trailer.

B. Section Includes:
   1. Pilot devices:
      a. Selector switches.
      b. Pushbuttons.
      c. Indicating lights.
   2. Relays/timers:
      a. Control relay.
      b. Time delay relays.
   3. Termination equipment:
      a. Terminal blocks.
      b. Fuse holders.
   4. Power supplies:
      a. DC power supplies.
      b. Isolation transformers.
   5. Voltage surge protection devices.
   6. Running time indicator.
   7. Intrinsic Safety Isolators.
   8. Alarm Beacons.
   9. Horns.

C. Related Sections include but are not necessarily limited to:
   1. Section 26 43 13 - Surge Protection Devices for Low-Voltage Electrical Power Circuits.
   2. Section 40 61 13 - Process Control Systems General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. The International Society of Automation (ISA):
      a. S18.1, Annunciator Sequences and Specifications.
      b. ANSI/ISA-12.02.02-2014, Recommendations for the Preparation, Content, and Organization of Intrinsic Safety Control Drawings.
   2. National Electrical Manufacturers Association (NEMA):
      a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
      b. ICS 2, Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts.

B. Miscellaneous:
   1. Assure units comply with electrical area classifications and NEMA enclosure type shown on Drawings.

1.3 SUBMITTALS

A. Shop Drawings:
   1. Control Drawings for intrinsically safe systems:
      a. Print on 8-1/2 x 11 IN sheets.
      b. In accordance with recommendations of ANSI/ISA-12.02.02-2014.
      c. One control drawing per sheet.

d. Identify model numbers of both the associated apparatus and the intrinsically safe apparatus.
e. Include wiring diagram showing interconnections of the intrinsically safe apparatus and the associated apparatus.
f. Provide entity parameters for both the associated apparatus and the intrinsically safe apparatus.
g. Identify line of demarcation between classified (hazardous) and unclassified (nonhazardous) locations and identify equipment that is installed in each location.
h. Identify hazardous areas by class, groups, and divisions.
i. Show maximum nonhazardous location voltage that may be used with the associated apparatus.
j. Include any specific conditions that are necessary to maintain the intrinsic safety protection.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturers listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers listed in the subsections are acceptable.

2.2 PILOT DEVICES

A. Selector Switches:
1. Manufacturers:
a. Eaton.
b. Or Equal.
2. Design and fabrication:
a. Heavy-duty type.
b. Oiltight.
c. Rotary cam units conforming to NEMA ICS 2-216.22.
d. Mounting hole: 30.5 MM (Unless otherwise Mounted)
e. Supply switches having number of positions required with contact blocks to fulfill functions shown and specified. At a minimum provide DPDT contact blocks with two normally open (NO) and two normally closed (NC) contacts.
f. UL listed.
g. Maintained contact type.
h. Lever type operators.
i. Black colored operators.
j. Designed with cam and contact block with approximate area of 2 IN SQ.
k. Legend plate marked per Contract Documents.
l. Contact block requirements:
1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
2) Wet or outside locations: Hermetically sealed contact blocks.

B. Pushbuttons:
   1. Manufacturers:
      a. Eaton.
      b. Or Equal.
   2. Materials:
      a. Backing diaphragm: Buna-N.
   3. Design and fabrication:
      a. Heavy-duty type.
      b. Oiltight.
      c. Conforming to NEMA ICS 2-216.22.
      d. Mounting hole: 30.5 MM.
      e. Diaphragm backed.
      f. UL listed.
      g. Emergency stop pushbuttons to have mushroom head operator and two sets of maintained normally open (NO) and normally closed (NC) contacts. Emergency stop pushbutton shall be NEMA 4X rated. E-stops shall be push to engage and twist and pull to release.
      h. Non-illuminated type:
         1) Momentary contact with necessary contact blocks.
         2) Molded, solid color melamine buttons.
         3) Standard flush operators with half shroud.
         4) Green colored buttons for START or ON and red color for STOP or OFF.
         5) Appropriate contact blocks to fulfill functions shown or specified. At a minimum provide DPDT contact blocks with two normally open (NO) and two normally closed (NC) contacts.
      i. Contact block requirements:
         1) Dry and indoor locations: Standard contact blocks rated for 10 A continuous current.
         2) Wet or outside locations: Hermetically sealed contact blocks.
         3) Legend plate marked per Contract Documents.
      j. Illuminating type:
         1) Momentary contact with necessary contact blocks.
         2) Serves as both pushbutton control and indicating light.
         3) Green colored lenses for start or on and red for STOP or OFF.
         4) Resistor-type full voltage light unit with lens and panel gasket.
         5) Legend plate marked per Contract Documents.
         6) Appropriate contact blocks to fulfill functions shown or specified.

C. Indicating Lights:
   1. Manufacturers:
      a. Eaton.
      b. Or Equal.
   2. Design and fabrication:
      a. Heavy duty.
      b. Oiltight.
      c. Type allowing replacement of bulb without removal from control panel.
      d. LED.
      e. UL listed.
      f. 24 V lamp.
      g. Legend plate marked per Contract Documents.
      h. Nominal 2 IN SQ face.
      i. Mounting hole: 30.5 MM.
      j. Push-to-test indicating lights.
      k. Plastic lens.

l. Color code lights as follows:
   1) Green: ON or running; valve open.
   2) Amber: Standby; auto mode; ready.
   3) Red: OFF or stopped; valve closed.
   4) White: Power ON.

2.3 RELAYS/TIMERS

A. Control Relays:
   1. Manufacturers:
      a. Magnacraft/ Schneider 782 series with 70-782EL11-1 socket
      b. Or Equal.
   2. Design and fabrication:
      a. Plug-in general purpose ice cube relay.
      b. Blade connector type.
      c. Switching capacity: 10 A.
      d. Contact material: Silver cadmium oxide.
      e. Provide relays with a minimum of 4 DPDT contacts.
      f. Coil voltage: 24 VDC.
      g. Relay sockets are DIN rail mounted.
      h. Internal neon or LED indicator is lit when coil is energized.
      i. Clear polycarbonate dust cover with clip fastener.
      j. Check button.
      k. Temperature rise:
         1) Coil: 85 DEGF max.
         2) Contact: 65 DEGF max.
      l. Insulation resistance: 100 Meg min.
      m. Frequency response: 1800 operations/hour.
      n. Operating temperature: -20 to +150 DEGF.
      o. Life expectancy:
         1) Electrical: 500,000 operations or more.
         2) Mechanical: 50,000,000 operations or more.
      p. UL listed.
      q. Socket
         1) DIN rail mounted
         2) 300 VAC, 10 A rating
         3) Shall separate coil terminals on one side and form C contacts.
         4) Terminations shall be finger safe and form c contacts in an elevated step configuration.

B. Time Delay Relays:
   1. Manufacturers:
      a. Rockwell Automation (Allen Bradley) Bulletin 700-HNC.
      b. Or Equal.
   2. Design and fabrication:
      a. Melt design test and performance requirements of NEMA ICS 2-218.
      b. Heavy-duty.
      c. Solid-state construction.
      d. DPDT contacts.
      e. External adjusting dial.
      f. Auxiliary relays as required to perform functions specified or shown on Drawings.
      g. Operates on 117 VAC (±10%) power source.
      h. Contact rating: A150 per NEMA ICS 2-125.
      i. Furnish with "on" and "timing out" indicators.

2.4 TERMINATION EQUIPMENT

A. Terminal Blocks:

1. Manufacturers:
    a. Phoenix Contact UT-4.
    b. Or Equal.
2. Design and fabrication:
    a. Modular type feed-through with screw compression clamp.
    b. Screws: Stainless steel.
    c. Current bar: Nickel-plated copper allow.
    d. Thermoplastic insulation rated for -40 to +90 DEGC.
    e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
    f. Install end sections and end stops at each end of terminal strip.
    g. Install machine-printed terminal markers on both sides of block.
    h. Spacing: 6 MM.
    i. Wire size: 22-12 AWG.
    j. Rated voltage: 600 V.
    k. Din rail mounting.
    l. UL listed.
3. Standard-type block:
    a. Rated current: 30 A.
    b. Color: Gray body.
4. Bladed-type block:
    a. Terminal block with knife blade disconnect which connects or isolated the two (2) sides of the block.
    b. Rated current: 10 A.
    c. Color:
        1) Panel control voltage leaves enclosure - normal: Gray body, orange switch.
        2) Foreign voltage entering enclosure: Orange body, orange switch.
5. Grounded-type block:
    a. Electrically grounded to mounting rail.
    b. Use to terminal ground wires and analog cable shields.
    c. Color: Green and yellow body.

B. Fuse Holders:
1. Manufacturers:
    a. Phoenix Contact.
    b. Or Equal.
2. Design and fabrication:
    a. Modular-type with screw compression clamp.
    b. Screws: Stainless steel.
    c. Current bar: Nickel-plated copper alloy.
    d. Thermoplastic insulation rated for -40 to +105 DEGC.
    e. Wire insertion area: Funnel-shaped to guide all conductor strands into terminal.
    f. Blocks can be ganged for multi-pole operation.
    g. Install end sections and end stops at each end of terminal strip.
    h. Install machine-printed terminal markers on both sides of block.
    i. Spacing: 9.1 MM.
    j. Wire size: 30-12 AWG.
    k. Rated voltage: 300 V.
    l. Rated current: 12 A.
    m. Fuse size: 1/4 x 1-1/4.
    n. Blown fuse indication.
    o. DIN rail mounting.
    p. UL listed.

2.5 POWER SUPPLIES

A. DC Power Supplies:
1. Manufacturers:

a. Phoenix Contact.
b. Or Equal.

2. Design and fabrication:
   a. Converts 120 VAC input to DC power at required voltage.
   b. DIN rail mount with enclosure (i.e., not open frame).
   c. Switching type.
   d. Provide redundant 24VDC modules with diode redundancy module for automatic switchover to standby module on failure of primary module.
   e. Hardwire module fault dry contact to associated PLC input for alarm at Plant SCADA.
   f. AC input: 120 VAC ±15%, nominal 60 Hz.
   g. Efficiency: Minimum 86%.
   h. Rated mean time between failure (MTBF): 500,000 HRS.
   i. Voltage regulation:
      1) Static: Less than 1.0% V_{out}.
      2) Dynamic: ±2% V_{out} overall.
   j. Output ripple/noise: Less than 100 mV peak to peak (20 MHz).
   k. Overload, short circuit and open circuit protection.
   l. Temperature rating: 0 to 60 DEGC full rated, derated linearly to 50% at 70 DEGC.
   m. Humidity rating: Up to 90%, non-condensing.
   n. LED status indication for DC power.
   o. UL listed.
3. Redundancy Module: Required
4. Sizing: 125% of maximum load per power supply.

2.6 VOLTAGE SURGE PROTECTION DEVICES

A. See Specification Section 26 43 13.

2.7 RUNNING TIME INDICATORS

A. Acceptable Manufacturer:
   1. Eagle Signal Controls.
   2. Or Equal.

B. Design and Fabrication:
   1. Six-digit wheels including a 1/10 digit.
   2. Non-reset type.
   3. Time range in hours.
   4. Automatic recycle at zero.
   5. Accuracy: 1%.
   6. Sealed against dirt and moisture.
   7. Tamper-proof.

2.8 INTRINSIC SAFETY ISOLATORS

A. Manufacturers:
   1. Phoenix Contact.
   2. Or Equal.

B. Design and fabrication:
   1. Utilize in all circuits required to be intrinsically safe.
   2. All instruments installed in hazardous locations per Section 40 67 00 shall be provided with intrinsic safety isolators.
   3. DIN rail mountable.
   4. Provide galvanic isolation; use of passive zener diode type barriers is not permitted.
   5. Limit voltage and current so that no spark or thermal effect can cause a potentially explosive atmosphere to ignite.
   6. Provide redundant 24Vdc power supplies in accordance with Paragraph 2.5 A of this Specification. Power supplies shall be installed in the same enclosure as the intrinsic safety

isolators. Power supplies shall be sized based on the active load of the associated loop powered field instruments.
7. Furnish and install in accordance with requirements of NEC Article 504, Intrinsically Safe Systems.
8. Certified to be in accordance with latest edition of UL 913 for application.
9. Operating temperature: 0 to 122 DEGF.

2.9 ALARM BEACONS

A. Manufacturers:
1. Edwards Signaling.
2. Or Equal.

B. Design and fabrication:
1. LED beacons with snap-on high impact polycarbonate base.
2. NEMA 4X enclosure.
3. 24 VDC powered.
4. Beacon shall be suitable for indoor and outdoor installations and shall be panel or conduit mountable.
5. Beacon housing shall be capable of withstanding vibration.
6. Dual-mode design which shall be field adjustable between steady-on OR flashing mode by changing a dipswitch inside the beacon housing.
7. Shatter resistant polycarbonate red lens.
8. For outdoor locations provide manufacturer supplied gasket kit Edwards Signaling cat. no. GSK-KIT for weatherproofing.
9. For wall mount installations provide manufacturer supplied wall mount bracket Edwards Signaling cat. no. WBR.
10. For panel mount installations provide manufacturer supplied mounting accessories.
11. UL listed.

2.10 HORNS

A. Manufacturers:
1. Edwards Signaling.
2. Or Equal.

B. Design and fabrication:
1. PLC compatible model.
2. NEMA 4X enclosure.
3. Volume adjustable.
4. Coded or sustained tones.
5. Shall be completely assembled. NO site assembly required.
6. Corrosion resistant finish.
7. Designed for semi-flush panel mount.
8. Manufacturer supplied mounting accessories.
9. Minimum 100 dBa sound at 10 FT.
10. 120 VAC powered.
11. Beacon shall be suitable for indoor and outdoor installations and shall be panel or conduit mountable.
12. Beacon housing shall be capable of withstanding vibration.
13. Dual-mode design which shall be field adjustable between steady-on OR flashing mode by changing a dipswitch inside the beacon housing.
14. Shatter resistant polycarbonate red lens.
15. For outdoor locations provide manufacturer supplied gasket kit Edwards Signaling cat. no. GSK-KIT for weatherproofing.
16. For wall mount installations provide manufacturer supplied wall mount bracket Edwards Signaling cat. no. WBR.
17. For panel mount installations provide manufacturer supplied mounting accessories.

18. UL listed.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

END OF SECTION

SECTION 41 22 13

CRANES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Tripod cranes
   2. Gantry cranes

B. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 33 32 13 – Package Sewage Pumping Station
   3. Section 46 21 20 – Mechanically Cleaned Screens In-Channel Auger

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Bearing Manufacturers Association (ABMA).
   2. American Society of Mechanical Engineers (ASME):
      a. B30.11, Safety Code for Underhung Cranes and Monorail Systems.
      b. B30.16, Safety Code for Overhead Hoists.
   3. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Acknowledgement that products submitted meet requirements of standards referenced.
      b. Shop drawings complete with all dimensions, anchor bolts or other mounting devices required for installation, and protective coating.
      c. Capacities, weights, and performance data.
      d. Manufacturer's recommended procedures for storage, handling and installation.
      e. Coordination Drawings indicating requirements for mechanical equipment with respect to headroom equipment centerline and laydown.
   3. Load test results.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
   2. Warranties:
      a. There shall be a minimum system warranty of one year (12 months) from the date of Final Acceptance by the National Park Service as issued upon overall project completion.

1.4 SYSTEM DESCRIPTION

A. Tripod cranes shall be used for the installation and removal of equipment specifically in:
   1. Influent lift station
   2. Filtrate lift station

B. Gantry crane shall be used for the installation and removal of equipment specifically in:
   1. Screening Vault

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Tripod Crane:
      a. Wallace
      b. Or Equal.
   2. Gantry Crane and Hoist:
      a. Harrington
      b. Or Equal.

2.2 MATERIAL

A. Cranes shall be hot-dipped galvanized.

B. All crane hardware components shall be fabricated from AISI 304/304L/316 stainless steel.

2.3 FUNCTIONALITY

A. Gantry Crane:
   1. Lift Capacity: Crane and hoists shall have a variable lifting capacity, with a minimum capacity of 2000 lbs at all positions used to access equipment in locations shown on the Contract Drawings.
   2. Hook Height:
      a. Hook height shall be adjustable by moving hoist up or down with adjustment chain and laterally along top beam of gantry crane of manual chain pull.
      b. Minimum height under beam: 10 FT (when assembled)
   3. Width:
      a. Minimum: 6 FT
      b. Maximum: 10 FT
   4. Wheels:
      a. Provide minimum 4 wheels for lateral movement of gantry crane.

b. At least two wheels must be lockable.

5. Quantity:
   a. Provide one (1) complete gantry crane assembly that shall be compatible with lifting equipment at each the following area per Contract Drawings:
      1) Screening Vault

B. Tripod Crane:
1. Lift Capacity:
   a. Crane and hoists shall have a variable lifting capacity, with a minimum capacity of 500 lbs at all positions used to access equipment in locations shown on the Contract Drawings.
2. Hook Height:
   a. Hook height: Minimum height under crown: 20 FT
3. Winch Location:
   a. Lifting winches shall be located such that the center point of the drive shaft is behind the centerline of the mast.
4. Portability:
   a. Crane shall fold down or break down into portable components, with individual component or total crane weight not to exceed 50 pounds.
5. Quantity:
   a. Provide one (1) complete tripod crane assembly that shall be compatible with lifting equipment at each of the following areas per Contract Drawings:
      1) Influent lift station.
      2) Filtrate lift station.

C. Nametag: Cranes shall be labelled with a non-corrosive metal identification plate labelled or imprinted with the manufacturer's name, model number and serial number.

2.4 HOIST AND TROLLEY

A. Manual Geared Trolleys:
1. Sized to attach to top beam of gantry crane.
2. Rated capacity: 2,000 LBS
3. Geared by directional operation via chain drive
4. Wheels:
   a. Fabricated of hardened steel or cast iron.
5. Wheels shall have uniform surface hardness and be capable of carrying maximum applied load.
6. Trolley shall be geared to provide hand chain driven locomotion.
7. Gearing:
   a. Machined and heat-treated.
   b. Hoist gear box shall be in accordance with AGMA 6013-A.
      1) Provide means for adequate lubrication of gearing.

B. Manual Chain Hoists:
1. Length: 20 FT
2. Self-closing hooks on top and bottom
3. Overhaul ration: Maximum 50
4. Comply with ASME B30.16 and ASME HST-2. Welding shall comply with AWS D14.1/D14.1M.
5. Hooks:

a. Provide latch-type hooks, free to rotate through 360 degrees under all loading conditions. Hooks shall be heat-treated, drop forged steel.

6. Hoisting Chain:
   a. Hardened alloy steel.
   b. Corrosion resistant
7. Lift Wheel:
   a. Machined and heat-treated alloy steel with hardened steel chain guides.
8. Gearing:
   a. Machined and heat-treated. Hoist gear box shall be in accordance with AGMA 6013-A. Provide means for adequate lubrication of gearing.
9. Load Brake:
   a. Hoist shall include Weston-type load brake, providing instant brake and release action for positive control of load.
10. Provide overload protection device preventing lifting of loads beyond rated capacity.
11. Housing and Covers: Cast aluminum.
    a. Factory powder or epoxy coated
12. Provide supports, fasteners, brackets, chain container, and necessary accessories.

2.5 WINCH

A. Winch shall be manual.

B. Winch shall have a Quick Disconnect cable anchor, and a positive load holding mechanical brake able to stop and hold the load automatically when operation is halted.

C. The winch shall be provided by the tripod crane manufacturer. The winch reel shall be supplied with and hold the amount of wire to remove the equipment.

2.6 WIRE ROPE

A. Wire rope construction shall be 7 x 19 type 304 stainless steel cable and shall have a minimum working load limit as required to lift the equipment it services.

B. The rope shall be with swivel hook and swaged ball fitting. Hooks and swaged ball fitting shall be heat treated drop forged type 304/316 stainless steel.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Assemble cranes at locations specified in the Contract Drawings per manufacturer's instructions.

B. The Contractor shall coordinate the location of cranes with the provided equipment to ensure complete removal and installation functionality of the equipment is provided.

3.2 FIELD QUALITY CONTROL

A. The requirements for the Quality Control Plan are defined in Specification Section 01 40 00 Quality Control.

END OF SECTION

SECTION 43 21 00
PUMPING EQUIPMENT - BASIC REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Basic requirements for all pumping equipment.

B. Related Specification Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment - Basic Requirements.
   2. Section 09 96 00 - High Performance Industrial Coatings.
   3. Section 33 32 12 – Package Sewage Pumping Station

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. ANSI/Hydraulic Institute (ANSI/HI):
      a. 9.6.3, Rotodynamic (Centrifugal and Vertical) Pumps – Guideline for Allowable Operating Region.
      b. 9.6.4, Rotodynamic Pumps for Vibration Measurements and Allowable Values.
      c. 9.6.6, Rotodynamic Pumps for Pump Piping.
      d. 11.6, Rotodynamic Submersible Pump for Hydraulic Performance, Hydrostatic Pressure, Mechanical, and Electrical Acceptance Tests.
      e. 14.6, Rotodynamic Pumps for Hydraulic Performance Acceptance Tests.

B. Coordinate all mechanical seal systems specified to ensure pump and seal compatibility.

C. Pump/motor and VFD coordination: See Specification Section 01 61 03.

1.3 DEFINITIONS

A. The abbreviations used in this section are defined as follows:
   1. AOR: Allowable Operating Range.
   2. BEP: Best Efficiency Point.
   3. IPS: Iron Pipe Size.
   4. NPSH3: Net Positive Suction Head for 3% head loss.
   5. POR: Preferred Operating Range.
   6. TDH: Total Dynamic Head.
   7. TEFC: Totally Enclosed Fan Cooled.
   8. VFD: Variable Frequency Drive.

B. Pump Service Category: Pump or pumps having identical names (not tag numbers) used for specific pumping service.

1.4 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 61 03.
   2. Product technical data including:
      a. Performance data and curves with flow (GPM), head (FT), horsepower, hydraulic efficiency, rotating speed (RPM), AOR, BEP, POR, NPSH3 requirements, minimum bowl submergence requirements for vertical mixed flow, axial and turbine pumps.
      b. Pump accessory data.
      c. Bearing supports, shafting details and lubrication provisions.
         1) Bearing life calculations.
         2) Critical speed calculations.
      d. Solids passage information.

3. Certifications:
    a. Certified pump performance curves as described in the SOURCE QUALITY CONTROL Article.
    b. Verification of Primary and Secondary conditions in POR and AOR.
4. Test reports:
    a. Factory hydrostatic test as specified in individual specification sections.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
    a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

C. Informational Submittals:
1. Certifications:
    a. Provide a written statement that manufacturer's equipment has been installed properly, started up and is ready for operation by Contracting Officer's personnel.

D. Anchorage calculations per Section 01 81 10

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor’s proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
1. Manufacturer listed, and other manufacturers not listed, but capable of meeting the requirements of this Specification Section, are expected to provide complete information showing full compliance with the specified salient characteristics.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Pumps:
    a. See individual pump Specification Sections.
2. Mechanical seals:
    a. See individual pump Specification Sections.
    b. If not specified in pump Specification Section:
        1) Garlock.
        2) Or Equal.

2.2 CENTRIFUGAL PUMP DESIGN

A. Provide units with increasing head characteristics from the end run out portion of the curve to:
1. Shut-off condition.
2. For Mixed flow, Axial Flow and Propeller pumps to the right-hand edge of the AOR.
3. All pumps except those for sewage service shall comply with NSF-61.

2.3 ACCESSORIES

A. See Specification Section 01 61 03.

B. Each Unit:
1. Lifting eye bolts or lugs.
2. Plugged gage cock connection at suction and discharge nozzles.
3. Tapped and plugged openings for casing and bearing housing vents and drains.
4. Fittings for properly adding flushing lubricant.
5. Pressure relief fittings for grease lubrication.

C. Mechanical Seals:

1. Provide as specified in the narrow-scope pump sections.
2. Provide stationary balanced O-ring type.
3. Provide water lubrication - cooling.
4. Materials:
    a. Provide as specified in narrow-scope pump sections
    b. If not included in narrow-scope pump sections use the following materials:
        1) Metal parts except springs: 316 stainless steel.
        2) Springs: Hastelloy C.
        3) Seal faces: Unfilled carbon graphite versus silica-free Grade 99.5 ceramic.
        4) Elastomers: Viton.

2.4 FABRICATION

A. Pump Support:
1. Design base to support weight of drive, shafting and pump.
2. Comply with HI vibration limitations.
3. Mount horizontal pump, motor and coupling on single piece drip lip type baseplate.
4. Mount vertical pumps on single piece pedestal baseplate.
5. Fabricate to withstand all operating loads transmitted from the pump and drive.
6. On vertically configured end suction centrifugal pumps when supplied with a fabricated steel mounting frame and suction elbow, the suction elbow shall be a long radius reducing elbow with greater than 50% area reduction to comply with Table 9.6.6.3.2 of ANSI/HI 9.6.6 standard for straight pipe lengths.

2.5 SOURCE QUALITY CONTROL

A. Verification primary design condition in POR.

B. Verification secondary design condition in AOR.

C. Factory hydrostatic test all pumps at 150% of shut-off head for a minimum of five minutes.

D. If specifically required in the individual pump specification sections, provide factory tests:
1. All units:
    a. Conduct tests in accordance with HI.
        1) Shut-off head and design condition: Positive unilateral performance tolerance meeting Grade 1U per ANSI/HI 14.6 for Rotodynamic Pumps.
        2) Shut-off head and design conditions: Positive unilateral performance tolerances meeting Grade 1U per ANSI/HI 11.6 for Rotodynamic Submersible Pumps.
2. All pumps:
    a. Head (FT) versus flow (GPM) pump curves:
        1) Efficiencies along curve.
        2) Brake horsepower along each curve.
3. Results certified by a registered professional engineer.

E. Statically and dynamically balance each pump per ANSI/HI standards.
1. If specifically required in the individual pump specification sections or in Specification Section 01 61 03, field vibration test pumps:
    a. To meet requirements of ANSI/HI 9.6.4 for Rotodynamic Pumps at any point on the pumps and motor.

F. To meet requirements of ANSI/HI 11.6 for Submersible Pumps.

PART 3 - EXECUTION

3.1 INSTALLATION

A. See Specification Section 01 61 03.

B. Floor or Pad-Mounted Units (Non-Submersible):

1. Align vertically and horizontally level, wedge and plumb units to match piping interfaces.
2. Assure no unnecessary stresses are transmitted to equipment flanges.
3. Tighten flange bolts at uniform rate and manufacturer's recommended torque for uniform gasket compression.
    a. For ASME B16.5 Class 900 flanged connections: Do not torque bolts more than two times.
        1) Mark each bolt with a single line after bolt has been torqued.
        2) If bolt has been torqued two times, replace all hardware on flange prior to subsequent tightening.
4. Support and match flange faces to uniform contact over entire face area prior to bolting pipe flange and equipment.
5. Permit piping connecting to equipment to freely move in directions parallel to longitudinal centerline when and while bolts in connection flange are tightened.
6. Grout equipment into place prior to final bolting of piping but not before initial fitting and alignment.
7. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
    a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
    b. Realign as necessary, install flange bolts and make equipment connection.
8. Field paint units as defined in Specification Section 09 96 00.
9. Provide pressure gage, visible from grade or operating floor, on discharge of all pumps and on suction and discharge of all non-submersible units.

C. Submersible Units:
1. Assemble connecting piping with gaskets in place and minimum of four bolts per joint installed and tightened.
    a. Test alignment by loosening flange bolts to see if there is any change in relationship of piping flange with equipment connecting flange.
    b. Realign as necessary, install flange bolts and make equipment connection.
2. Field paint units as defined in Specification Section 09 96 00.
3. Provide discharge pressure gage visible from grade or operating floor.

3.2 EQUIPMENT VIBRATION MONITORING AND TESTING PROGRAM:

A. Provide vibration testing on all rotating and reciprocating equipment having driver 50 HP and greater.

B. Additional requirements for vibration monitoring and testing equipment at 25 DegC:
1. Requirements for analyzer:
    a. Frequency range: 10 Hz to 20kHz
    b. Frequency accuracy: 0.02 percent
    c. Non-integrated spectral amplitude accuracy: 5 percent, 3Hz to 65 kHz
    d. Single integrated spectral amplitude accuracy: 5 percent, 10 Hz to 20kHz
    e. Supports measurements of acceleration, velocity, displacement, envelop demodulation for bearing defect detection.
    f. Capable of two-place computer balancing
2. Requirements for vibration sensor at 25 DegC:
    a. Sensitivity: ±5 percent = 100 mV/g
    b. Acceleration range: ±50 g
    c. Amplitude nonlinearity: ±1 percent
    d. Frequency response: ±10 Hz to 7 kHz (±3 dB)
    e. Permanently attach vibration test and monitoring mounting pads to mechanical equipment at location recommended by the equipment manufacturer or as recommended by the testing firm
3. Acceptability of equipment conditions, except pumps, based on ISO 1940-1 Balance Quality Grade G2.5 criteria

C. Acceptability of pumping equipment to be based on current ANSI/HI criteria:
   1. ANSI/HI 9.6.4-2022 for all pumps

D. Repair or replace equipment shown to be out of range of acceptable tolerance until the equipment meets or exceeds acceptability standards

E. Utilize a Contracting Officer approved testing agency to perform vibration monitoring and testing on the following equipment:
   1. RSPH Pumphouse:
      a. PMP-52211 and PMP-52212

F. Permanently attach vibration test and monitoring mounting pads to the equipment at locations recommended by the equipment manufacturer or as recommended by the vibration testing agency.

G. Utilize mounting pads suitable for permanent installation and for incorporation into a predictive maintenance program.

H. For variable speed equipment provide vibration testing at 1 Hz increments of VFD speed throughout entire operating range.

I. Diagnosis to include, but is not limited to the following:
   1. Unbalance
   2. Misalignment
   3. Bent shaft
   4. Journal bearing related problems
   5. Rolling contract bearing problems
   6. Mechanical looseness
   7. Resonance
   8. Foundation flexibility
   9. Electrically induced problems
   10. Pump problems
   11. Fan problems
   12. Coupling problems
   13. Drive belt problems
   14. Gear problems
   15. Electric motor induced vibration from VFD or VFD carrier frequency
   16. Natural frequency of the installed equipment

J. Provide machinery condition diagnosis based on an acceptable machinery vibration severity guide or machinery fault guide analysis provided by the testing agency, ISO 1940 Balance Quality Grade 6.3 as a minimum.

K. Tolerances for pumping equipment shall be per HI published standards.

L. Immediately notify Contracting Officer if equipment is shown to be out of range of the specified tolerance until the equipment meets the specified normal operating range required in the machinery fault guide analysis.

M. Document testing with written report.
   1. Report to include initial testing results, acceptance criteria, corrective action taken to meet acceptance, verification of corrective action and acceptance report and baseline.
   2. Natural frequency of installed equipment utilizing and impact hammer.

N. Report to include graphical plots of vibration signature for each test point at a scale which illustrates all vibration levels greater than 0.025 ips RMS.

O. Electrical Equipment and Connections Testing Program:
   1. Perform testing on Electrical equipment and connections in accordance with the Electrical specifications requirements.
   2. Testing of motors:

a. After installation and prior to energizing the motor, perform inspections and tests per NETA ATS 7.15 for all motors.
b. Verify motor has been lubricated.
c. Bump motor to check for correct rotation.

3. Immediately notify Contracting Officer if equipment shown to be out of range of the acceptable tolerance until the equipment meets or exceed acceptability standards.

P. Other Testing:
1. Perform tests and inspections not specifically listed but required to verify equipment is safe to energize and operate.
2. Subbase that supports the equipment base and that is made in the form of a cast iron or steel structure that has supporting beams, legs, and cross members that are cast, welded, or bolted shall be tested for a natural frequency of vibration after equipment is mounted.
a. The ratio of the natural frequency of the structure to the frequency of the disturbing force shall not be between 0.5 and 1.5.
b. Immediately notify Contracting Officer if equipment shown to be out of range of the acceptable tolerance.

Q. Infrared Thermography Testing Program:
1. Perform infrared thermography testing for equipment specified in other Divisions during the Equipment Demonstration Period.
a. Perform on rotating and reciprocating equipment having drivers 50 HP or greater.
2. Additional requirements for infrared thermography monitoring and testing equipment:
a. Temperature range: -10 to 350 DegC
b. Accuracy: ±2 percent or 2 DegC, whichever is greater
c. Repeatability: ±1 percent or 1 DegC, whichever is greater
d. Temperature indication resolution: 0.1 DegC
e. Minimum focus distance: 0.3 meters
f. Output in color palettes: JPEG, BMP, or other digital format compatible with Windows
3. Perform inspection per ASTM E1934.
a. Operate VFD driven equipment at 100 percent speed during thermographic inspection.
4. Acceptability of electrical connections and components based on temperature comparison between components and ambient air temperatures not greater than 10 DegC per ASTM E1934.
5. Acceptability of motors and equipment bearings based on temperature rise not greater than 5 DegC above the equipment and/or bearing manufacturer’s published criteria.
6. Immediately notify Contracting Officer if equipment shown to be out of range of the acceptable tolerance.

3.3 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:
1. Inspect equipment covered by this Specification Section.
2. Supervise pre-start adjustments and installation checks.
3. Conduct initial start-up of equipment and perform operational checks.
4. Provide performance testing and vibration testing that meet Hydraulic Institute standards, with written statement of correct installation supplied by manufacturer.

END OF SECTION

SECTION 43 23 31.29
PUMPING EQUIPMENT - VERTICAL INLINE CENTRIFUGAL PUMPS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes the following pumps:
   1. Potable Water Booster Pump (PMP-8011)

B. Related Sections include, but are not necessarily limited to:
   1. Section 01 61 03 – Equipment – Basic Requirements.
   2. Section 01 79 00 – Demonstration and Training.
   3. Section 26 29 23 – Variable Frequency Drives – Low Voltage
   4. Section 40 05 00 - Pipe and Pipe Fittings - Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Society of Mechanical Engineers (ASME):
      a. B16.1, Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, 250, and 300.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Specification Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. Product technical data including:
      a. Complete fabrication and assembly drawings, together with detailed specifications and data covering materials, drive unit, parts, devices, and accessories forming a part of the equipment furnished. The data and specifications for each unit shall include:
         1) Complete performance curves showing capacity versus head, NPSH required, pump efficiency, wire to water efficiency, and pump input power.
            a) Include exact values at primary and secondary operating conditions.
         2) Type and model.
         3) Tag number.
         4) Pump location.
         5) Rotative speed.
         6) Suction nozzle size.
         7) Discharge nozzle size.
         8) Net weight of pump only.
         9) Net weight with motor, baseplate, and coupling.
         10) Coupling data.
         11) Shop painting data.
         12) Base and anchor bolt details.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Specification Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Data submittals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied. If the specified salient

characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements.

1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.

B. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Grundfos
   2. Or Equal.

C. Submit request for substitution in accordance with Specification Section 01 33 23.

2.2 PERFORMANCE AND DESIGN REQUIREMENTS

A. Site Conditions:
   1. North Rim TWWTP Elevation: 8328.00 FT.

B. Performance Parameters:
   a. Booster Pump
      1) Primary design condition: 36 GPM at 97 FT TDH.
         a) Shutoff head (minimum): 185 FT TDH.
      2) NPSHr at primary design condition (maximum): 5 FT.
      3) Speed (maximum): 4,000 RPM.
      4) Drive: Variable frequency.
      5) Motor horsepower (maximum): 3 HP.
      6) Suction Flange: Stainless Steel, ANSI Class 150.
      7) Discharge flange: Stainless Steel, ANSI Class 150.
   2. Provide pumps with increasing head characteristics from secondary design conditions to shutoff condition.
   3. Provide motor with temperature switch for all pumps.

2.3 COMPONENTS

A. Suction/Discharge Base:
   1. Cast iron, ASTM 80-55-06.

B. Impellers:
   1. Type: Enclosed.
   2. Material: 304 SS.
   3. Wear Rings: 304 SS.
   4. Secure to shaft by means of a split cone and nut design.

C. Impeller Wear Rings:
   1. 304 SS.

D. Shaft:
   1. Stainless Steel AISI 431.

E. Mechanical Seals:
   1. Type: Cartridge.
   2. Seal replacement shall be possible without removal of pump components other than coupling guard, motor couplings, motor seal, and seal cover.

F. Intermediate Bearing Journals:
   1. Silicon Carbide.

G. Chamber Bushings:
   1. Graphite filled PTFE.

H. O-rings:
   1. EPDM or FKM.

I. Data Plates:
   1. Provide stainless steel data plate securely attached to pump.
   2. Include manufacturer's name, pump size and type, serial number, speed, impeller diameter, capacity and head rating at the primary design condition, and other pertinent data.

J. Motors:
   1. Reduced voltage starting, solid shaft, squirrel cage, induction type.
   2. Inverter Duty.
   3. 460 V, 60 Hz, 3 PH.
   4. TEFC type.
   5. Motor temperature switch (thermostatic type)
   6. Size motor to drive pump continuously over the complete head - capacity range without the load exceeding the nameplate rating.
   7. Design motor for 85 Deg C ambient.

2.4 MAINTENANCE MATERIALS

A. Extra Materials:
   1. Furnish the Government the following extra parts for each pump service category:
      a) Wearing rings: One sets.
      b) Mechanical Seal: One cartridge.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions.

3.2 FIELD QUALITY CONTROL

A. See Section 01 79 00 for operator training requirements.

END OF SECTION

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SECTION 46 07 53

PACKAGED WASTEWATER TREATMENT EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes requirements for a packaged, skidded Equalization Tank System, Membrane Bioreactor (MBR) System, and Closed Vessel Medium Pressure Ultraviolet Disinfection System (UV System), as well as ancillary components for wastewater treatment.
   1. The System Supplier shall provide:
      a. Systems that are a complete pre-engineered system for use with domestic wastewater including:
         1) One (1) Equalization Tank System consisting of inlet screen, tankage, diffused air system and ancillary conveyance equipment.
         2) Two (2) Packaged Immersed Membrane Bioreactor Systems that utilize activated sludge for biological treatment and submerged ultrafiltration membrane units for solids separation.
         3) One (1) UV Disinfection Skid where the UV reactors are used to disinfect treated MBR System permeate and control effluent flow and hydraulics through tankage and other instrumentation means.
   2. The System Supplier shall conform to the basis of design performance specifications contained within this section. Contractor is responsible for all effort and costs associated with design, submission of drawings, addressing review comments and finalizing design to demonstrate to the Contracting Officer that the system provided is equivalent to the basis of design contract drawings if a different manufacturer from the basis of design is proposed; no extension of contract period of performance will be granted.
   3. The System must fit within the site space allocated on the Contract Drawings.
   4. Equipment included in the System shall conform to this Section only, unless otherwise specified.

B. Related Sections include but are not necessarily limited to:
   1. Section 01 61 03 - Equipment – Basic Requirements.
   2. Section 01 81 33 - Cyber Security Requirements.
   3. Section 05 50 00 - Metal Fabrications.
   4. Section 26 05 00 – Common Work Results for Electrical.
   5. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables.
   6. Section 26 29 23 – Variable Frequency Drives – Low Voltage.
   7. Section 40 05 00 – Pipe and Pipe Fittings – Basic Requirements.
   8. Section 40 05 07 - Pipe Support Systems.
   9. Section 40 05 51 - Common Requirements for Process and Utility Valves.
   10. Section 40 05 62 - Plug Valves.
   11. Section 40 05 66 - Check Valves.
   12. Section 40 61 13 – Process Control System General Requirements.
   13. Section 40 63 43 – Programmable Logic Controllers.
   14. Section 40 66 05 – Network Equipment
   15. Section 40 67 00 – Control System Equipment Panels and Racks.
   16. Section 40 67 63 – Uninterruptible Power Supply
   17. Section 40 68 63 – Configuration of HMI Software and Reports
   18. Section 40 78 00 – Panel Mounted Instruments

1.2 REFERENCES

A. Referenced Standards:
   1. The Society for Protective Coatings/ NACE International (SSPC/ NACE):

a. SP 10/ NACE No. 2, Near-White Blast Cleaning.

1.3 QUALITY ASSURANCE

1. System Supplier shall provide (4) references for a packaged mobile plant with ADF flows in excess of this project, that has been commissioned within the last (2) years.
2. System Supplier shall provide (3) additional references for packaged mobile MBR plants between 5,000 and 50,000 GPD.
   a. These projects must have been commissioned within the last 36 months.
3. System Supplier to submit (5) references for skid-based closed vessel UV Systems of similar flow range and capacity that have been completed within the last (4) years.
4. System Supplier shall provide a project manager who has had experience managing the design, engineering, fabrication and commissioning of at least four (4) packaged MBR's for the System Supplier.
5. System supplier shall be regularly engaged in the manufacture of packaged wastewater treatment systems for not less than five years.
   a. The Term "regularly" shall mean an average of one (1) packaged MBR shall have been completed every 30-60 days
6. Structural design of the system shall be accomplished by a civil or structural engineer registered in the State of Arizona.
7. Equipment furnished under this Section shall be supplied by a single System Supplier who has been regularly engaged in the design and manufacture of such equipment for at least ten (10) years under the same ownership and management team.
   a. The System Supplier shall demonstrate to the satisfaction of the Engineer that the quality is equal to equipment made by those manufacturers specifically named herein.

B. For any tanks that are to be stripe or fully coated for chemical immersion purposes, the System Supplier must have a licensed or certified Coatings Applicator on staff.

C. Supplier's Factory Acceptance Testing:
   1. System Supplier shall submit the Factory Acceptance Protocols and Record Forms in accordance with Section 2.11.

1.4 DESCRIPTION OF WORK

A. This Section specifies the requirements for the furnishing of all process equipment required for one complete factory assembled and fully off-site factory bench tested complete system together to include: equalization tank system, two submerged ultrafiltration MBR system, and one closed vessel medium pressure UV treatment system for the treatment of wastewater.

B. The System Supplier shall furnish the Packaged Systems as described in this specification, inclusive of all skid-mounted equipment and ancillary equipment, factory installed and calibrated instrumentation, scope-specific chemical and piping systems, controls, electrical, tankage, internal inter-connection piping for tanks and equipment, and overall System controls integration.

C. The System Supplier shall design the treatment system as described in this specification.
   1. All interconnecting piping for influent wastewater, overflows, waste activated sludge, chemicals, secondary effluent, and power and signal conduits shall be the responsibility of the Contractor.

D. See Sections 3.3 Shipping, and 3.4 Delivery, Storage, and Handling for information regarding System shipment

E. The Contractor shall furnish all labor, rigging, materials, and incidentals required for the installation of the Packaged System in accordance with the installation instructions provided by the System Supplier.
   1. Once installed, the System shall be complete and operational with all control equipment, accessories, access platforms, ladders/stairs and services as specified herein and described in the Contract Documents.

1.5 PROJECT CONDITIONS

A. Unless otherwise specified in the Contract, the Package System shall be designed to operate continuously for the following site conditions:
   1. Ambient Temperature: 33 degrees F to 110 degrees F
      a. Operating Temperature, Seismic Conditions, Wind Load, and Snow Load: See specification section 01 81 10.
   2. Relative humidity: 20 to 100 percent
   3. Approximate Site Elevation: 8328.0
      a. See Contract Drawings for specific pad elevations.

1.6 GENERAL

A. Influent to packaged treatment system: raw sewage screened through either a mechanical perforated screen or, in the event of a bypass, a 1.5-inch manual bar screen.
   1. Pumps required for conveyance of influent sewage to the treatment system are not grinder or shredder type.

B. MBR system redundancy: design such that the MBR System can continue processing incoming wastewater at peak flows while any one (1) membrane unit or associated equipment is out of service.

C. UV System redundancy: Design such that the System can continue processing at peak flows while any one (1) reactor is out of service.

D. All underground piping and interconnects shall be constructed by the Contractor in strict compliance with the approved System layout.
   1. Internal process piping, electrical, and signal wiring that completes the System as an operational unit shall be furnished by the System Supplier.

E. Contractor shall coordinate alignment of all underground utilities with final locations of inlet and outlet connections on equipment provided by System Supplier.

F. Contractor shall coordinate electrical service connections with equipment electrical service entrances provided by System Supplier.

G. Provide all mechanical systems, equipment, electrical, instrumentation, controls, and appurtenances rated for outdoor exposure in accordance with the ambient conditions of the site location, unless otherwise specified, covered by an awning, or enclosed in a building.

1.7 SUBMITTALS

A. Refer to Section 01 81 33 - Cyber Security Requirements for required cyber security related submittals.

B. Action submittals
   1. Shop Drawings:
      a. See Section 01 33 23.
      b. Requirements in Section 01 61 03.
      c. Requirements in Section 26 29 23.
      d. Requirements in Section 40 61 13.
      e. Submit from System Supplier:
         1) Dimensioned plan, elevation, and section view drawings of the entire System, with pipeline tie-points (connection points to exterior piping) labeled and numbered with dimensions in X,Y,Z coordinates for coordination with civil engineering site plans and underground piping layout.
         2) Process drawings, including process flow diagram(s), piping and instrumentation diagrams, influent and effluent specifications, and capacities of major equipment such as pumps and blowers. P&IDs shall be signed and sealed by a registered professional engineer.

3) All equipment product data, including motor data and cut sheets, describing all equipment proposed for use in each System.
4) Elementary and connection wiring diagrams, clearly showing external connections to other equipment.
5) Stamped anchorage calcs for each structure, stamped by a structural engineer licensed in the State of Arizona.
6) Control narratives.
7) HMI screens.
8) Local audio and visual alarm system tied into HMI's.

2. Submit Shop Drawing for units and all mechanical, electrical, and instrumentation components, complete, in single, coordinated submittal.
   a. Provide separate tabs for each major section of work being provided.
   b. Short Circuit Current Rating (SCCR) nameplate marking per NFPA 70.
      1) Include any required calculations per Section 01 61 03.

C. Informational Submittals
1. Manufacturer's Qualifications.
2. Certifications:
   a. Provide Contracting Officer with a written certification that station has been installed properly and started up and is ready for operation by Contracting Officer's personnel.

D. Close-out Submittals
1. Operation and Maintenance Manuals:
   a. See Section 01 78 23 for requirements for:
      1) The mechanics and administration of the submittal process.
      2) The content of Operation and Maintenance Manuals.
   b. System Supplied shall provide additional Operations and Maintenance information on seasonal winterization of MBR units, disinfection requirements, dosing pumps, and all other equipment affected by seasonal operation.

1.8 CYBER SECURITY REQUIREMENTS

A. Refer to Section 01 81 33 Cyber Security Requirements for full requirements.

B. The supplier agrees to assist in cybersecurity basic hygiene practices as dictated by best practices included in these specifications, government regulation at time of bid, and as provided by the Contracting Officer's cybersecurity team.
1. At a minimum, the supplier shall coordinate with the Contracting Officer and assign IP addresses and subnet masking, utilization of managed switches with unused ports disabled, provide all equipment with the latest firmware at time of field installation and coordinate with Contracting Officer to remove default usernames and passwords, and to remove contractor passwords at time of system acceptance.

C. The Contracting Officer shall have full and unrestricted access to upgrade, modify, or change the software, networking, firmware or other areas of micro-processor-based systems.

D. Remote access appliances for interaction with programmable devices will not be accepted during construction or operation.

E. Contractor laptops utilized for programming and startup of programmable devices must not utilize cellular connections for any purpose while connected to Contracting Officer's network.
1. All laptops must have current antimalware definitions when allowed on-site.

1.9 SHIPPING

A. Per Section 01 61 03.

B. Preparation for shipment:
1. All materials shall be suitably packaged and braced to protect against damage during transit, handling, and unloading.

2. System Supplier shall package equipment, be responsible for, and make good, any and all damage until the equipment is delivered to the job site.
3. Accessories shall be packaged in a crate or boxes with Packing Slips.
4. A packing list, listing the contents of each container, shall be placed in a moisture proof envelope and securely fastened to the outside of the container.
5. Provide match marked stickers on all items removed or disassembled post Factory Acceptance Testing (FAT) allowing for the immediate identification of matching components for reassembly by the Installer.
6. Provide written storage procedures for all equipment.
7. Provide lifting lugs or picking points for the Contractor to lift the load using spreader bars, or other equipment.

C. Equipment removed from System after Factory Acceptance Testing are authorized only for the following purposes:
1. Items removed for the purposes of keeping system under maximum width, height, and length restrictions for transportation to site.
2. Items removed and repackaged for the purposes of maintaining integrity of calibration or quality.
3. Unions, flanges or hardware may be loosened/removed for the purpose of providing flexibility during shipment to avoid damaging components.

1.10 DELIVERY, STORAGE, AND HANDLING

A. System Supplier to coordinate with Contractor regarding construction schedule to minimize handling and on-site storage of equipment.

B. System Supplier to coordinate with Contractor regarding foundation and concrete slab design and completeness prior to delivery.

C. Contractor shall unload packaged skids directly to their final location upon delivery acceptance.

D. Contractor shall use non-marring, non-carbon steel slings for loading, unloading and handling units to prevent rope or cable damage to surfaces and protective wrappings.

E. Contractor to protect system components from the elements during installation.
1. Minimum protection includes cover, ventilation, and proper stacking to prevent warping of aeration system piping and accessories.
2. Unload diffuser materials directly into the aeration basins and cover in accordance with manufacturer’s recommendations.
3. Covering system to protect materials from UV radiation.
4. Install membrane modules into the membrane chambers just prior to Site Acceptance Testing and clean water testing; membrane modules must remain fully submerged at all times following initial submergence in water to maintain material composure.

F. The System Supplier shall supply competent, qualified field service technician(s) to thoroughly check and inspect the System at delivery, to support equipment installation, and to make necessary adjustments.
1. Equipment installation support is limited to 8hrs.
2. This may be remote or onsite support provided by System Supplier staff.

G. Breakdown and Cataloging of Equipment (Bill of Lading and Packing Slips)
1. Prior to shipping the system, equipment that exceeds shipping height or width restrictions shall be removed and cataloged in a Packing Slip that will be sent with the system.
2. A Bill of Lading shall identify the equipment (crates, pallets, tanks, etc.) that are shipped on each truck to the site.
3. System Supplier shall provide delivery scheduling services to the Contractor per direction from Owner.

H. System Loading and Unloading

1. Axle based tanks are detailed from the trailer and lowered using the onboard hydraulics and air supply from the trailer
2. Crates and pallets that are delivered with the system can be lifted by forklifts, a grade-all, or a crane.
3. UV System can be expected to be lifted by a crane using a spreader bar. Crates and pallets that are delivered with the system can be lifted by forklifts, a grade-all, or a crane.

I. Offloading at Site
   1. Provide an Installation Guide for specific offloading details.
   2. Membrane Storage During Construction/Installation
      a. Membranes
         1) If membranes are installed after arrival, they must be submerged completely in clean water at all times. If the membranes are not installed and remain in their packaging, they must be stored in a temperature-controlled environment for storage (40-90°F – refer to manufacturer's manual).
   3. Equipment Storage
      a. Provide an Operation and Maintenance Manual that details storage and maintenance for each piece of equipment.

1.11 SYSTEM DEGREE OF COMPLETENESS

A. Provide a system which is fully factory designed, built, integrated and tested as one complete system in automatic operation mode prior to shipping.
   1. System Supplier-provided equipment is to be factory tested in automatic mode, and testing protocols outlined in section 2.11 below.
   2. All equipment is to be fully integrated including industry standard valves, maintenance/service connections, and hardware to allow for the easy repair/replacement of equipment in the future.
   3. Factory supplied equipment in crates for the Owner to install in lieu of factory integration is not permitted.
   4. All sensory equipment (including but not limited to instrumentation) within process tankage must have factory provided and sensory specific slide rails with 304SS pull cables. Slide rails must allow for sensory equipment to be examined and cleaned at the top of the slide rail. Loose sensory equipment placed into tanks will not be permitted.

B. The following are the only exceptions to the degree of completeness allowed;
   1. Inlet Line on Equalization Tank
      a. Flanged connection at skid edge for the inlet of screened sanitary sewer.
   2. Oulet Line on Equalization Tank
      a. Flanged connection at pump discharge of screened sanitary sewer from the transfer pump.
   3. Inlet Line on MBR System
      a. Flanged connection at skid edge for the inlet of wastewater
   4. Process Line
      a. Flanged connections at skid edge for the addition of external process tanks as determined by the System Supplier's process calculations.
   5. Effluent Line on MBR System
      a. Flanged connection at skid edge for the discharge of wastewater effluent from the clearwell chamber.
   6. WAS
      a. Flanged or threaded connection at skid edge for the pressurized discharge of waste activated sludge.
   7. Chemical Connections
      a. Inlet (suction side) connections for all chemical pump systems. These may be threaded, compression or flanged depending on pump/piping size.
   8. Inlet Line on UV Disinfection Skid
      a. Flanged connection at UV break tank, the inlet for membrane permeate.

b. Outlet flanged connections for UV-disinfected membrane permeate.

9. Electrical/Communication
   a. Meltric plug or cable termination buss for 480VAC power into the MCC panel.
   b. Provide a window into the UV System Equipment Skid sufficient for all conduits for power and communication purposes. This window is to be identified on panel drawings.

1.12 WARRANTY

A. Provide warranty from System Supplier for the System's materials and workmanship per the following:
   1. 12 months from startup and commissioning of the system and acceptance by ADEQ (permitting authority) to operate.

1.13 MAINTENANCE AND TESTING SERVICES

A. Maintenance and testing services shall be made available to Owner by the System Supplier.
   1. Maintenance and testing services shall include maintenance checks on system equipment, recommendations on system operation, verification that the system is being operated following System Supplier's recommendations and requirements, and replacement of membranes, as necessary.
   2. Maintenance and testing services shall be offered to the Owner at System Supplier's billable rates, or as provided as a line item in this Bid.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied.

B. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.
   2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

C. Subject to compliance with the Contract Documents, the following system suppliers are acceptable:
   1. Cloacina (Basis of Design)
   2. Or Equal.

D. Submit request for product substitution in accordance with Specification Section 01 33 23.

2.2 DESIGN CRITERIA

A. Loading criteria characterizing the requirements of the treatment system are provided below:
   1. Flows:
      a. Minimum Daily Flow (MDF): 9,000 GPD.
      b. Average Annual Flow (AAF): 60,000 GPD.
      c. Maximum Month Flow (MMF): 86,000 GPD.
      d. Pre-Equalization Peak Hour Flow (PHF): 208,000 GPD.
      e. Post-Equalization Peak Hour Flow (PHF): 172,000 GPD.
   2. Influent Design Concentrations:
      a. Biochemical Oxygen Demand (BOD): 465 mg/L
      b. Total Suspended Solids (TSS): 465 mg/L
      c. Total Kjeldahl Nitrogen (TKN): 85 mg/L
      d. Ammonia- Nitrogen (NH3-N): 69 mg/L
      e. Phosphorus (TP): 8 mg/L

f. Alkalinity (CaCO3): 200 mg/L

3. Effluent Treatment Requirements:
   a. pH: 6.5 to 9.2 S.U.
   b. Biochemical Oxygen Demand (BOD): 10 mg/L
   c. Total Suspended Solids (TSS): 10 mg/L
   d. Total Nitrogen (TN): 10 mg/L
   e. Ammonia Nitrogen (NH3-N): 1 mg/L
   f. Total Phosphorus (TP): No Permit Limit
   g. E. Coli: 126 CFU / 100 mL

2.3 EQUALIZATION TANK AND PUMPING SYSTEM

A. Pre-equalization flow criteria characterizing the requirements of the Equalization Tank are provided below:
   1. Design Flows: See 2.2 A.1 above.

B. Design Equalization System to fit within the site space allocated on the contract Construction Drawings.
   1. Maximum System Footprint:
      a. Length: 49 FT
      b. Width: 9 FT

C. System Configuration and Unit Processes:
   1. Process flow from the influent lift station will be pumped to the Package Equalization Tank designed for temporary storage of screened sewage.
   2. Convey equalized flow to the MBR Treatment Units via transfer pumps.

D. System Components
   1. Coarse screening
      a. Provide coarse screening unit to separate solids from influent to the system that would otherwise impact downstream processes.
      b. Provide bypass of course screen to allow for course screen to be operated or bypassed with minimal operator manipulation.
      c. Provide a 6 mm perforated plate.
      d. Provide an integrated auger/compactor to provide washing and compaction of the solids.
   2. Aeration Equipment
      a. Provide Equalization tank with an array of floor mounted disk-style air diffusers for conveyance of air specifically for maintaining solids in suspension.
   3. Transfer Pumps
      a. Provide Transfer Pumps to convey screened sewage to the MBR treatment units.
   4. Provide access stairs and catwalk for operator access to the top of the tankage and for access to instrumentation and equipment installed inside the tanks.
   5. Provide Equipment Skid with centralized equipment, piping, conduit, and instrumentation.
      a. Design Equipment Skid to also contain the system control panel.
      b. Provide operator access to all components.
   6. Provide Equalization System instrumentation as follows:
      a. Furnish all instrumentation from a single manufacturer.
      b. Provide magnetic flow meters on all inlets to the Equalization Tank.
      c. Level transmitter installed within the tank.
   7. All components of the system must come from the factory fully assembled as one unit, without any additional components that need to be installed outside of the system's footprint.

E. System Equipment Design Criteria:
   1. Coarse Screening:
      a. Number: 1
      b. Type: Rotary Brush

c. Perforation Size: 6 mm
d. Capacity: Per manufacturer

2. Aeration Diffusers:
   a. Type: Coarse tube
   b. Mount diffusers to a weighted stainless plate capable of holding two disks.
   c. Manifold disks together and attach to air supply laterals by means of a single stainless steel ¾" Hose Barb.
   d. Acceptable Manufacturers:
      1) EDI
3. Aeration Blowers:
   a. Type: Regenerative
   b. Size: Per System Supplier for acceptable flow based on process calculations to meet the project design criteria, and thermal performance across its application's pressure range which may vary due to variable flow rates, water surface levels and air line configurations.
   c. Number: 1
   d. Provide all blowers with thermal, over-pressure and electrical overload protection as determined by their manufacturer to be appropriate to the application.
   e. Design aeration blowers to be controlled from the MBR control panel and include local Hand/Off/Auto (HOA) switches.
   f. Acceptable Manufacturers:
      1) FPZ, or approved equal
4. Transfer Pump:
   a. Type: End suction centrifugal
   b. Capacity: Per System Supplier
   c. Number: 2 minimum
   d. Design transfer pumps to be controlled by Equalization Tank control panel with local Hand/Off/Auto (HOA) switches.
   e. Acceptable Manufacturers:
      1) Goulds, or approved equal

F. Electrical
   1. Incoming Power: 480 V, 3 Phase 30 Amp service.
   2. Equalization Tank Control Panel:
      a. See section 2.7.B.b for panel components.
      b. Additional Panel Components:
         1) Allen Bradley programmable logic controller (PLC)
         2) VFDs
   3. The Equalization Tank System must be integrated with the MBR System controls.

2.4 MBR TREATMENT SYSTEM

A. Post-equalization flow criteria characterizing the requirements of the MBR are provided below:
   1. Design Flows: See 2.2 A.1 above.

B. Each MBR System must fit within the site space allocated on the contract Construction Drawings.
   1. Maximum System Footprint (each unit):
      a. Length: 51 FT
      b. Width: 9 FT

C. System Configuration and Unit Processes:
   1. The sequence of process flow (assuming MLE process) in the Package MBR System Process Train:
      a. Anoxic Chamber
      b. Aeration Chamber
      c. Membrane Chamber(s).

d. Mixed liquor: conveyed as “forward activated sludge” (FAS) from the last Aeration Chamber to Membrane Chamber(s) via FAS pump(s).
e. Return mixed liquor minus permeate from the Membrane Chamber(s) to the first Anoxic Chamber by gravity via RAS lines as recycled activated sludge (RAS).

2. Convey permeate discharged from each unit for reuse or disposal (i.e. “effluent”) to a separate skid-mounted Disinfection System.
   a. Design each MBR skid to accommodate the addition of gravity flow control equipment as appropriate for conveyance of effluent to the UV Disinfection System.
3. System Supplier shall not utilize the redundant membrane chamber in the total process volume for process calculations and modeling.
4. System will provide heating elements and recirculation programming to allow cartridges to be stored in place during winter shut down of the system. Temperature probes will provide output to HMI for operators to verify cartridge basin temperatures. Provide probes to measure and read-out at HMI the disinfection residual of the cartridge basins.

D. Biological Process:
1. The biological process shall be Modified Ludzack-Ettinger (MLE) for efficacious removal of contaminant biological oxygen demand (BOD) and removal of contaminants organic nitrogen (TKN) and ammonia (i.e. “nitrification”) by biological oxidation in oxygen-enriched Aeration process zones.
2. Design MLE process also for removal of contaminant nitrates (i.e. “denitrification”) and removal of contaminant BOD by biological reduction-oxidation processes in oxygen-deprived Anoxic process zones.
3. The activated sludge and contaminants together in mixture are termed “mixed liquor.”
4. Provide means to circulate process flow from Aeration zones to Anoxic zones for conveyance of nitrates generated in Aeration zones to Anoxic Zones, and to concurrently recycle at equal flow rate from Anoxic zones to Aeration zones for conveyance of influent and residual BOD, TKN and ammonia from Anoxic zones to Aeration zones.
5. Recirculation through the process zones shall convey suspended, live biomass “activated sludge.”
6. Design system to eliminate a certain mass of activated sludge daily on a quasi-continuous basis from the process to offset the growth of new biomass so that a mixed liquor suspended solids set point can be maintained.
   a. Provide means to convey waste activated sludge (WAS) from the System to existing drying beds on site.
7. Biological process design criteria:
   a. Solids Retention Time (SRT): 7 – 29 days.
   b. Design Liquid Temperature: 15 Degrees Celsius.
   c. Design Minimum Liquid Temperature: 10 Degrees Celsius.
   d. Mixed Liquor Suspended Solids (MLSS) in process aeration basin: 3,000 – 9,600 mg/L.
   e. Maximum Mixed Liquor Suspended Solids (MLSS) at membrane interface: 12,000 mg/L.

E. System Components:
1. Fine screening
   a. The MBR process shall be preceded by a fine screen unit with perforation size no greater than 2 millimeters; provide rollable collection device with securable lid and one year of collection bags sized for container.
2. The Package MBR System’s Process Train shall consist of one or more series of Anoxic Chamber(s), Aeration Chamber(s), and Membrane Chamber(s):
   a. Anoxic Chamber(s) shall comprise the anoxic zones.
      1) Wastewater is pumped from the equalization process after the mechanical screening process into the anoxic process, where removal and breakdown of organics (BOD) and the denitrification process initiate.
      2) The anoxic process is mixed with submersible mixers to prevent settling, but dissolved oxygen is kept low to aid in initial treatment.

3) The anoxic process is also where mixed liquor is returned from the membrane chambers (RAS), allowing for recycling of biology throughout the MBR System.
4) Anoxic zone shall contain an Oxidation-Reduction Potential (ORP) probe which shall serve to monitor anoxic conditions.

b. Aeration Chamber(s) comprise aeration zones.
1) Each aeration chamber shall contain an array of disk-style air diffusers for conveyance of air and molecular oxygen specifically to the mixed liquor at rates sufficient for processing of contaminants in the mixed liquor as its process flow is conveyed through the aeration zone.
2) Each aeration chamber shall serve to effect BOD removal and nitrification processes.
3) Provide aeration zone with pH probe to serve as monitoring for manual control of alkalinity (caustic) feed pump(s) discharge to the MBR System.

c. Membrane Clarification
1) Clear effluent for reuse or disposal shall be separated from mixed liquor by ultrafiltration membranes modules submerged in mixed liquor process flow.
2) Individual membranes shall be assembled in a housing called a membrane module.
3) Membrane modules shall be configured to uniformly distribute the mixed liquor over exposed membrane surfaces with minimal solids accumulation while passing water through membrane pores.
4) Membrane modules shall be manifolded into “cassettes” where permeate shall be collected into a permeate pipe, or “line”.
5) Motive energy to effect the separation of permeate from suspended solids near the membrane surface shall be supplied by a permeate pump that shall draw a relative low pressure “vacuum” inside membranes annular spaces and convey the collected permeate through the permeate line to a “Clearwell” reservoir.
6) Membrane cassettes shall operate within individual “membrane chambers”, separate from the aeration tank.
7) The mixed liquor of each Process Train shall be clarified by at least one Membrane Train.
a) Hydraulically, a Membrane Train is comprised of one Membrane chamber and its flow path from its FAS Pump through its membrane(s).
b) At its membrane(s), the Membrane Train’s flow path splits between permeate and RAS flow.
8) A redundant membrane train shall be supplied with all the same components as its counterpart(s).
9) Ancillary equipment to a Membrane Train shall include membrane (sparging/air scour) blower(s); membrane line priming and air purging pump(s); permeate pump(s); a permeate flow meter, a trans-membrane pressure transducer; and a chemical injection system for membranes clean in place (CIP) procedures.
a) Every Membrane Train ancillary equipment unit shall be assigned to just one Membrane Train. Each Membrane Train shall operate as a discrete functional unit for redundancy purposes.
10) Membrane trains shall be each capable of performing up to Peak Daily Flow independently.
11) Membranes shall each be placed into isolated membrane chambers, which are able to be isolated for the purposes of recovery cleans/inspections.
a) Separate dip tanks or placing the membranes into common reactor volumes is not allowed.
b) Membrane cassettes commonly manifolded (whether in the same tanks or not) together utilizing common permeate, CIP, Air Scour equipment will not be allowed.

d. Forward Activated Sludge (FAS) Process:
1) Wastewater is pumped from the aeration zone into the membrane chambers utilizing FAS pumps.

2) FAS initiates the return activated sludge process.

e. Return Activated Sludge (RAS) Process:
   1) Wastewater not permeated by the membranes overflows the membrane chambers via overflow lines and return RAS to the Anoxic process via gravity.
   2) Design RAS line to accommodate a flow rate which is equal to the maximum RAS flow rate for the MBR System per System Supplier's process calculation.

f. Wasting Process:
   1) Waste Activated Sludge (WAS) is pumped from the Membrane Chamber(s) to a Sludge Storage Chamber for further processing.

g. Access Stairs and Catwalk:
   1) Provides the operator access to the top of the tankage and for access to instrumentation and equipment installed inside the tanks.

h. Equipment Skid:
   1) Provides operator access to centralized equipment, piping, conduit, and instrumentation.
   2) Contains the Control Panel.

i. Instrumentation:
   1) Provide all instrumentation from a single manufacturer, no exceptions.
   2) Provide influent magnetic flow meters on all inlet locations to the MBR System.
   3) Provide level transducer for clear well.

j. Chemical Pumping Systems:
   1) Stored in storage trailers on site and routed to the MBR System. Refer to Section 2.6 for further details.

F. System Equipment Design Criteria:
   1. Fine Screening:
      a. Number: 1 per unit
      b. Type: Rotary Brush
      c. Perforation Size: 2 mm
      d. Capacity: Per manufacturer
      e. Motor Power: 0.5 HP
   2. Submersible Mixers:
      a. Type: Submersible
      b. Mount: Mounted to a slide rail for access and maintenance of mixer unit.
      c. Size: Sized by the System Supplier and configured in quantities per Anoxic chamber sufficient to maintain suspension and circulation of mixed liquor suspended solids.
      d. Acceptable Manufacturers:
         1) Xylem Flygt
   3. Process Aeration Diffusers:
      a. Type: Threaded disk style for continuous submergence in wastewater mixed liquor activated sludge service.
      b. Perforation size: 1.2 mm.
      c. Mount: Mounted to a weighted stainless plate capable of mounting two disks. Disks shall be manifolded together and attach to air supply laterals by means of a single stainless steel ¾" Hose Barb.
      d. Diffuser Membrane Material: EPDM.
      e. Diffuser Manifolds Material: 304 stainless steel
      f. Acceptable Manufacturers:
         1) EDI for disc style diffusers, no exceptions allowed
   4. Aeration Blowers:
      a. Type: Regenerative type, capable of variable flow
      b. Capacity: Sized by the System Supplier for acceptable flow based on process calculations to meet the project design criteria, and thermal performance across its application's pressure range which may vary due to variable flow rates, water surface levels and air line configurations.

c. Fit with thermal, over-pressure and electrolytic protection as determined by their manufacturer to be appropriate to the application.
d. Controlled from the MBR control panel and include local Hand/Off/Auto (HOA) switches.
e. Acceptable Manufacturers:
1) FPZ, or approved equal

5. FAS Pumps:
a. Type: Submersible style pump equipped with a 460V/3 phase/60 Hz explosion proof motor with FLS leak detector.
b. Mount: Mounted on base elbow with SS slide rail system
c. Impeller Material: Hard-Iron.
d. Provide with variable frequency drive, sized by the System Supplier according to process calculations to meet project design criteria.
e. Number: Two (Per MBR Treatment Unit)
f. Controlled by MBR control panel with local Hand/Off/Auto (HOA) switches per pump.
g. Acceptable Manufacturers:
1) HOMA, or approved equal

6. Membranes:
a. Type: Hollow fiber, with reinforced construction and configured for a normal filtration flow direction from outside the fiber through to the inside (lumen) of the fiber.
b. Confirm the conditions listed below and certify that the membranes provided will meet or exceed these specifications under all conditions.
c. If deviations are required, the Manufacturer will identify these deviations to ensure certification:
1) Absolute pore size of no greater than 0.1 micron and a nominal pore size of no greater than 0.04 microns. Cake filtration may not be used to achieve nominal pore size.
2) Physically strong enough to withstand the operating conditions associated with operation in an aerated tank of mixed liquor at concentrations up to 12,000 mg/L.
3) Ability to withstand back pulse flow (from inside to outside).
4) Back pulse flux rate to be up to 20 gfd.
5) Tolerate no less than 2,000,000 ppm hours of lifetime exposure to chlorine
6) Tolerate a pH of up to 10.5 for up to 10 hours at a time
7) Tolerant of cleans at a pH of 2 for up to 10 hours at a time
d. Submerged Membrane Units (SMU) and Membrane Modules
1) SMU and supporting pipe designed for a cross-flow configuration by which the system will remove a portion of the water as the recycle flow circulates through the Membrane Zone.
2) Materials used to hold the membranes in place shall be chemically resistant materials to allow permeate to be withdrawn.
3) Prefabricated, preassembled and factory certified before shipment to the site.
4) Each SMU shall be provided as complete, with all necessary components, accessories and appurtenances required to make a complete and operable system.
5) SMU shall be furnished in a secure housing with non-reactive materials such as 304L SS, 316 SS, PVC, and/or fiberglass. Appurtenances and fasters (including nuts, bolts, screws, cables, washers) shall be stainless steel.
6) Furnished with integral diffusers designed to promote efficient air scouring of membrane elements.
7) Equipped with one or more SMU subunits.
8) Constructed such that the membranes are held vertically and sealed firmly to the subunit.
9) Membrane cassette/subunit may be removed from the membrane tanks manually or via lifting device.
e. Fabrication
1) Membrane Modules

a) Fabricated using corrosion resistant materials for continuous immersion in activated sludge mixed liquor with membranes and aerators arranged to have rising action of air bubbles continuously distribute and scour all exposed membrane surfaces.
b) Provide stainless steel for any metallic parts immersed in the mixed liquor.
c) Components securely fixed in the membrane basin under turbulent flow conditions.
d) Fabricated to standard dimensions and tolerances for complete interchangeability of replacement units from the same membrane manufacturer.

2) Air piping
a) Arranged to minimize field connections required and prevent fouling with mixed liquor backflow while evenly distributing air to all exposed membrane surfaces.

3) Filtrate piping
a) Arranged to minimize field connections required and shall facilitate routing cleaning and maintenance to prevent mixed liquor bypass around the membranes.

4) Cassettes
a) Arranged with minimum clearance of 3 inches to the tank walls.

f. Membrane Clean In Place (CIP) System:
1) Cleaning of the membrane units includes pumps and controls for maintenance and recovery cleanings.
2) In-situ chemical cleaning directly in the membrane process tanks required to avoid moving cassettes into a separate membrane dip tank.
3) Completely automatic and simple to use and initiate.
4) Design for the ability to increase or decrease the frequency of chemical cleans to fit the operating conditions.
5) CIP Pumps – See Section 2.6.
6) Contractor to provide the chemical storage facilities, including secondary containment, required to store and deliver CIP chemicals to the System.

g. Acceptable Manufacturers:
1) Veolia (ZeeWeed)
2) DuPont (Memcor)
3) Or approved equal

7. Membrane Blowers:
a. Type: Regenerative type, capable of variable flow, and
b. Capacity: Sized by the System Supplier for acceptable flow based on process calculations to meet the project design criteria and thermal performance across its application's pressure range which may vary due to variable flow rates, water surface levels and air line configurations.
c. Fit with thermal, over-pressure, and electrolytic protection as determined by their manufacturer to be appropriate to the application.
d. Mount: Mounted within the MBR unit
e. Number: Two (Per MBR Treatment Unit)
f. Controlled by the MBR control panel with local Hand/Off/Auto (HOA) switches.
g. Acceptable Manufacturers:
1) FPZ, or approved equal

8. Permeate Pumps:
a. Type: Rotary lobe style and designed for forward and backward flow movement.
b. Capacity: Sized by System Supplier to meet maximum flow allowable per populated membrane chamber, as shown in process calculations associated with project design criteria.
c. Provided with variable frequency drive, sized by the System Supplier according to process calculations to meet project design criteria.

d. Number: Two (per MBR Treatment Unit)
e. Controlled by MBR control panel with local Hand/Off/Auto (HOA) switches.
f. Provide independent flow meter on the permeate line.
g. Acceptable Manufacturers:
    1) Boerger
    2) Vogelsang

9. Priming/Air Purging Pump
    a. Provided for purging air from the membrane permeate line following a backwash cycle, prior to System reversing to forward flow operation.
    b. Type: Diaphragm style sized for 120VAC/1ph/60Hz operation.
    c. Acceptable Manufacturers:
        1) Xylem VersiJet
10. Waste Activated Sludge (WAS) Pump:
    a. Type: Progressive cavity style pump capable of pumping liquid with up to 5% percent solids.
    b. Number: One (per MBR Treatment Unit)
    c. Capacity: Sized by System Supplier
    d. Provide independent flow meter on WAS line
    e. Acceptable Manufacturers:
        1) Seepex
11. Process Tanks

G. Electrical
1. Incoming Power: 480 V, 3 Phase 130 Amp service.
2. MBR Treatment System Control Panel Design:
    a. See section 2.7.B.b below for panel components.
    b. Additional Panel Components:
        1) Allen Bradley programmable logic controller (PLC)
        2) VFDs

H. Instrumentation
1. pH Analyzers
    a. Materials:
        1) Sensor: Polyethersulfone (PES), KYNAR, polyvinylidene fluoride (PVDF), liquid crystal polymer, or epoxy (less than 140 F).
        2) O-rings: VITON.
    b. Sensor:
        1) Immersion type.
        2) Range: 4 to 12 pH.
        3) Accuracy: less than 0.02 pH.
        4) Repeatability: Less than 0.05.
        5) Sensitivity: 0.01 pH.
        6) Flow Rate: 10 ft per second, maximum.
    c. Transmitter:
        1) Compatible with sensor.
        2) Output: 4-20 mA.
        3) Accuracy: less than 1% of FS.
        4) Enclosure: IP66/IP67, tightness and corrosion resistance in accordance with NEMA Type 4X.
        5) Power 120 VAC.
2. ORP Analyzers:
    a. Materials:
        1) Body, cover: Polyethersulfone (PES), KYNAR, polyvinylidene fluoride (PVDF), liquid crystal polymer, or epoxy (less than 140 F).
        2) O-rings: VITON.

b. Integral pre-amplifier to convert high impedance ORP measurement into stable, noise-free signal (if not furnished with integral transmitter).
c. Automatic temperature compensation.
d. Shielded cable.
e. Sensitivity: ±0.5 mV.
f. Range: -1500 mV to +1500 mV.
g. Stability: 2 mV per 24 hours.
h. Transmitter:
1) 120 VAC.
2) Output signal: 4 – 20 mA.
3) Temperature compensated.

3. Dissolved Oxygen Analyzers
a. Materials:
1) Sensor wetted parts: Noryl, Teflon, 316 stainless steel, PVC, polypropylene, PBT (thermoplastic polyesters based on polybutylene terephthalate), or PC (polycarbonate).
2) Sensor membrane: Polybutyl methoacrolate or Teflon.
3) If amperometric type sensor:
a) Anode: Silver
b) Cathode: Gold
b. Sensor:
1) Utilize digital sensor capable of being calibrated with a lab analyzer and then connected to a second analyzer in the field without the need to recalibrate.
2) Temperature compensated.
3) Accuracy: ±0.2 PPM or ±0.2% of span at calibrating temperature.
4) Response time: 95% in 60 seconds.
c. Controller:
1) 120 VAC.
2) Output signal: 4 – 20 mA.
3) Enclosure: NEMA 4X.

4. Turbidity Analyzers:
a. Materials:
1) Sensor: ASA S 777K / RAL7000, TPE RESIN Elastocon® STK40, Thermoplastic Elastomer TPS-SEBS.
b. Sensor:
1) Measuring range: 0 to 700 NTU.
2) Accuracy:
a) 0 to 40 NTU: ±2% of reading ±0.01 NTU
b) 40 to 1000 NTU: ±10% of reading.
3) Resolution: 0.001 NTU.
4) Response Time: T90 < 45 seconds at 100 mL/min.
5) Lower limit of Detection: 0.002 NTU.
6) An internal bubble removal system shall be included to vent entrained air from the sample stream.
c. Transmitter:
1) 120 VAC.
2) Output signal: 4 – 20 mA.
3) Enclosure: NEMA 4X and IP55.

2.5 UV DISINFECTION SYSTEM

A. Design criteria characterizing the requirements of the UV System are provided below:
1. Design Flow of UV System: 225 GPM
2. Minimum UVT: 65%
3. UV Dose: 40 mJ/cm^2

B. The System must fit within the site space allocated on the contract construction drawings.

1. Maximum System Footprint:
    a. Length: 30 FT
    b. Width: 13 FT
2. Footprint includes all components of UV system including Break Tank.

C. System Configuration and Unit Processes:
1. The sequence of process flow in the UV Disinfection System Process Train is to be conveyed by gravity from the clearwell within the MBR System to a break tank.
2. Flow from the break tank shall be conveyed to the UV disinfection system consisting of closed-vessel ultraviolet reactors equipped with high-intensity UV lamp assemblies designed to deliver the required UV dose for microbial inactivation.
3. Disinfected effluent will discharge from the UV reactors to the downstream effluent structure.
4. Gravity flow from MBR treatment units to break tank thru UV to discharge outfall is critical performance element in consideration of performance criteria of equivalent manufactures systems.

D. System Components
1. UV Break Tank
    a. Color: black or green opaque Polyethylene tank.
    b. Tank wall: Sized for liquids of 1.5 specific gravity, up to 16 lbs/gallon.
    c. Tank size: Specified by system supplier as required by UV reactor size.
    d. Tank Nozzles: Integrally welded or custom fitted to the polyethylene tank to provide process connects as specified by the system supplier at appropriate elevations relative to the UV skid system.
    e. Contractor to coordinate all connected piping to break tank with Sytem Supplier requirements.
    f. Provide level monitoring by hydrostatic level transmitter and redundant high and low level floats.
2. UV Reactors
    a. Provide closed vessel, medium pressure UV units to meet the necessary flow and dose requirements.
    b. Provided in an N+1 configuration (up to 3 total units) for system redundancy.
    c. Design to include automatic wiper cleaning mechanism, UV intensity sensor, and UV reactor temperature monitoring sensors.
    d. Ballasts capable of modulating lamp output based on the dose equation and flow measurement through the system.
        1) Minimum lamp turndown of 50% required.
3. UV Equipment Skid
    a. Constructed of 304 Stainless Steel.
    b. Formed with integrated slots to allow for wiring between UV Master Control Panel, UV unit control panels, UV units, and associated devices to be routed below the walking surface of the skid.
    c. Provide structurally evaluating lifting design and anchorage requirements.
    d. All skid openings to be sealed off against small animal ingress/egress.
4. UV Cooling System
    a. Provide an end-suction horizontal centrifugal pump to extend run times of the UV to limit the number of lamps strikes per day.
    b. Design to provide enough cooling flow to UV units to allow for periods of no flow of a minimum of 4 hours.
5. Monitoring Sensors
    a. Flow Meter
        1) Flow monitoring of the discharge of the UV skid shall be monitored by an electromagnetic flow meter.
        2) 0 diameter requirements on inlet and outlet of meter.
    b. UV Transmittance

1) Monitored by side-stream device.
2) Include sampling pump to provide flow to the sensor.
3) Include automated cleaning system to maintain accurate reading.

6. Automated Valves
   a. Provide electrically actuated butterfly valves for automatic alternation between UV units during normal operation or in the case of UV unit failure.
   b. Provide electrically actuated butterfly valves on the discharge piping of the system to allow for automated discharge to two (2) or three (3) locations, based on treatment conditions or downstream permissions.
7. Static Loop
   a. Piping design shall include a static loop on the discharge of the UV skid to prevent the system from gravity draining below the level of the UV chambers.
   b. Static loop to include combination air-vacuum release valve.
8. Awning
   a. Provide an awning to allow for locating the UV system outdoors.
      1) Design to cover the entirety of the UV skid to protect the UV chambers from direct sunlight and weather conditions.
   b. Anchor to concrete slab, and overhang the skid by 2 ft in all directions.

E. System Equipment Design Criteria:
1. UV Break Tank
   a. Polyethylene tank
      1) Acceptable manufacturers:
         a) Norwesco
         b) Snyder
         c) Poly Processing
         d) Or Approved Equal.
2. UV Reactors
   a. Closed Vessel, Medium Pressure
      1) Acceptable manufacturers:
         a) Xylem ETS Wafer Product Family
         b) No substitutions allowed
3. Cooling Pump
   a. End-Suction Horizontal Centrifugal
   b. Acceptable manufacturers:
      1) AMT Pumps
      2) Goulds
      3) Or Approved Equal

F. Electrical
1. Incoming Power: 480-V, 3-Phase 175 amp service
2. UV System Control Panel Design:
   a. Skid mounted on the UV Equipment Skid.
   b. The UV system must be integrated with the MBR System controls.
   c. See section 2.7.B.b below for panel components.
3. UV Reactor Panel Design:
   a. Fed by the System suppliers main UV control panel.
   b. Skid mounted on the UV Equipment Skid.
   c. See section 2.7.B.b below for panel components.
   d. Additional Panel Components:
      1) Allen Bradley programmable logic controller (PLC),
      2) UV Lamp Ballasts
   e. Design to communicate with the system suppliers main UV control panel via ethernet/IP communication protocol.

2.6 CHEMICAL PUMPING SYTEM

A. The Chemical Pumping System shall be provided by the System Supplier and installed within storage containers on site.

B. System Configuration and Unit Processes:
   1. Chemical drums shall be delivered on site and stored in a conditioned space with secondary spill containment, heat tracing, and carrier pipe as shown on the Contract Drawings.

C. System Components:
   1. Chemical Systems:
      a. Chemical Pumping:
         1) MBR System shall include standard membrane cleaning chemical dosing pumps (sodium hypochlorite and citric acid).
         2) MBR System shall include additional chemical dosing pumps for alkalinity and carbon addition to support the biological treatment process. All chemical feed equipment, including metering pumps, shall be pre-skidded and fully integrated into the MBR system.
         3) Chemical tubing shall be run with secondary containment conduits for future operations and maintenance. Running raw tubing outside of secondary containment to injection location is not allowed.
         4) All Tubing utilized shall be UV resistant and rated for full outdoor exposure.
         5) Chemical pumping systems shall be fully automated (120V timers are not allowed) and controlled via the MCC.
      b. Clean-In-Place Chemicals:
         1) Maintenance Cleans: CIP programming, chemical consumption calculations, and system operation shall provide for a minimum of two (2) sodium hypochlorite and one (1) citric acid Maintenance Clean cycles per week.
         2) Sodium Hypochlorite (NaOCl): Process calculations and chemical consumption for membrane CIP shall assume hypochlorite concentration of 12.5% NaOCl.
         3) Citric Acid: Process calculations and chemical consumption for membrane CIP shall assume citric acid concentration of 50.0%.
      c. Supplemental Process Chemicals:
         1) Carbon (COD): Process calculations and chemical consumption for supplemental carbon shall assume Acetic Acid 56% or MicroC 2000® (by EOSI).
         2) Alkalinity (NaOH): Process calculations and chemical consumption for supplemental alkalinity shall assume alkalinity concentration of 25% NaOH.

D. System Equipment Design Criteria:
   1. Membrane Clean-in-Place:
      a. Chemical Dosing Pump:
         1) Type: Peristaltic style metering pumps.
         2) Sized by System Supplier such that flow of chemicals into the MBR System meets pump manufacturer's recommendations and meets required chemical flow rate defined by System Supplier's process calculations.
         3) Acceptable Manufacturers:
            a) Watson-Marlow
      b. Sodium Hypochlorite Pumps:
         1) Number: Four (two per MBR Treatment Unit)
         2) Location: Hypochlorite Room – Chemical Storage Container 1
      c. Citric Acid Pumps:
         1) Number: Four (two per MBR Treatment Unit)
         2) Location: Citric Room – Chemical Storage Container 2
      d. Chemical Pump Skids
         1) Piping and pump accessories should be contained within skids.
         2) Include secondary containment reservoir, designed to capture potential leakage from pump or chemical tubing.

3) Provide calibration column(s), pressure relief valving, and other appurtenances as shown on Drawings

2. Alkalinity Addition:
   a. Chemical Dosing Pump:
      1) Type: Peristaltic style metering pumps.
      2) Sized by System Supplier such that flow of chemical into the Equalization Tank System meets pump manufacturer's recommendations and meets required chemical flow rate defined by System Supplier's process calculations.
      3) Acceptable Manufacturers:
         a) Watson-Marlow
   b. Caustic Pumps:
      1) Number: Two (one per MBR Treatment Unit)
      2) Location: Caustic Room – Chemical Storage Container 1
   c. Chemical Pump Skids
      1) Piping and pump accessories should be contained within skid.
      2) Include secondary containment reservoir, designed to capture potential leakage from pump or chemical tubing.
      3) Provide calibration column(s), pressure relief valving, and other appurtenances as shown on Drawings
3. Carbon Addition:
   a. Chemical Dosing Pump:
      1) Type: Peristaltic style metering pumps.
      2) Chemical pumps shall be sized by System Supplier such that flow of chemical into the System meets pump manufacturer's recommendations and meets required chemical flow rate defined by System Supplier's process calculations.
      3) Acceptable Manufacturers:
         a) Watson-Marlow
   b. Carbon Pumps:
      1) Number: Two (one per MBR Treatment Unit)
      2) Location: Pumps shall be mounted directly on each MBR Treatment Unit
         a) (One) 55-gallon drum of Carbon shall be located outside and within 5 FT of each chemical pump.

2.7 SYSTEM ACCESSORIES

A. Instrumentation:
   1. See Contract Drawings for location of specific instruments.
   2. 24 VDC
   3. Fully automated to operate the required System process.
      a. Flow Meters:
         1) Acceptable Manufacturers: Endress+Hauser W400 Series
      b. Level Transmitter:
         1) Acceptable Manufacturers: Endress+Hauser Hydrostatic Level Transmitter FMX21
      c. Clearwell Level Transmitter:
         1) Acceptable Manufacturers: Endress+Hauser PMC21
      d. DO Probes:
         1) Acceptable Manufacturers: Endress+Hauser COS61D
      e. pH probes:
         1) Acceptable Manufacturers: Endress+Hauser CPF81E
      f. ORP probes:
         1) Acceptable Manufacturers: Endress+Hauser CPF82E
      g. Submerged Turbidimeters:
         1) Acceptable Manufacturers: Endress+Hauser CUS52D
      h. Permeate Pump Pressure Transducer:
         1) Acceptable Manufacturers: Endress+Hauser PMC51
      i. Sensory Manufacturer

1) Acceptable Manufacturers: Endress & Hauser- No substitutions allowed.

j. Floats
   1) Provide level floats as mechanical back-up to level transmitters within the Equalization Tank System.
   2) Mechanically-activated, internally weighted control switches.
   3) Provide with a minimum of 30 ft cable.
   4) Acceptable Manufacturers: SJE Rhombus MegaMaster

k. UV Transmittance
   1) ABB
   2) Or Approved Equal

B. Electrical
   1. Fed from Main Switchboard (MCB1)
   2. See Division 26 for additional electrical requirements.
   3. Panel Design
      a. Provide each Package with stainless steel NEMA 4X air-conditioned control panel.
      b. Coordinate termination type and configuration with contractor to ensure proper power cable connection to panel.
      c. Package System panel components:
         1) Main Disconnect Switch
         2) Uninterruptible power supply (UPS).
         3) Input/output (I/O) modules.
         4) Programmable Logic Controller (PLC).
         5) Human machine interface (HMI),
         6) Alarm beacon and horn.
         7) Other components as required to make each Packaged System self-contained with its own logic.
      d. System specific components specified in section 2.3, 2.4, 2.5, and 2.6.
   4. Conduit
      a. Galvanized rigid conduit (GRC) and liquid tight flexible metal conduit (LFMC).
         1) Provide flexible conduit only where necessary.
      b. Provide termination junction boxes at tank edges to allow for factory disassembly and field re-assembly.
      c. Wire splices to be done in accordance with the latest revision of NEC code at the time of equipment construction.
      d. Label all wiring and terminations in accordance with panel drawings.
      e. For ancillary skids which have been properly designed, cords may be utilized for interconnects, provided they’re protected within the substructure of the assembly and properly supported with COR approval.
   5. Wiring
      a. Wiring to be sized according to NEC requirements for current, insultation type, and any applicable derates.
      b. Alternating current power wiring to be stranded copper with THHN/THWN insulation.
      c. Direct current power wiring to be stranded copper with THHN/THWN insulation or 300V shielded, twisted pair depending on load.
      d. Digital signal wire shall be 18 AWG stranded copper with THHN/THWN insulation or 300V multiconductor cable.
      e. Analog signal wiring shall be 18 AWG stranded copper 300V shielded, twisted pair cable.
      f. Ethernet cables shall be 600V shielded twisted pair.

C. Davit Crane
   1. Provide moveable davit crane as part of the System to lift pumps and other equipment from the process tankage for maintenance.
   2. Provide base plates at each submerged equipment location for alternating location of moveable davit crane to strategic locations for equipment access.

3. Sized by System Supplier to lift the heaviest piece of equipment, per geometry of System Supplier's System.
4. Acceptable Manufacturers:
    a. Thern Commander 500 Series
    b. Oz Crane

D. Valves
1. Solenoid Valves
    a. Size: 3/8 inch
    b. Orifice Size: 5/8 inch
    c. Maximum pressure rating: 150 psi
    d. Power rating: 120V
    e. ASCO 8210 Series or equal
2. Plug Valves for pipe sizes 6" to 12"
    a. Acceptable manufacturers:
        1) DeZurik
        2) PEC,
        3) Or equal.
3. Butterfly Valves for pipe sizes 4" to 18":
    a. Acceptable manufacturers:
        1) FNW
        2) Bray
        3) Or Equal
4. Check Valves for pipe sizes 4" to 8:
    a. Acceptable manufacturers:
        1) DeZurik
        2) CRF
        3) Or equal.
5. Valve Actuators
    a. Input Power: 120V
    b. Acceptable manufacturers:
        1) Triac
        2) Pratt
        3) Bray
6. Gate Valves for pipe sizes 8" to 18":
    a. Acceptable manufacturers:
        1) DeZurik
        2) KGN
        3) Or equal.
7. Ball Valves for pipe sizes 3" and smaller:
    a. Material: Brass
    b. Acceptable manufacturers:
        1) Smith Cooper,
        2) Or equal.
8. Static Loop Combination Air-Vacuum Release Valve:
    a. Acceptable manufacturers:
        1) ARI
        2) Flowmatic
        3) Or Approved Equal

E. Pipe and Fittings
1. Piping Material
    a. Pipe material shall depend on pipe function.
        1) Liquid Process: Schedule 80 PVC
        2) Membrane Air Process: Schedule 10 304 welded stainless steel
        3) Biological Air Process: Carbon steel ASTM A36 and A53

4) UV Disinfection Piping: Schedule 10 304 welded stainless steel
5) Chemical Piping: Schedule 80 CPVC

2. Pipe Supports
   a. Per System Supplier appropriately spaced to support all piping connections.
   b. Acceptable materials:
      1) Galvanized steel.
      2) Stainless Steel.
      3) FRP
3. Slide Rails
   a. Slide rail systems: Construct with Type 304 stainless steel components.

F. Process Tanks
1. Structurally designed AISC standards and requirements with loads as specified in Section 01 81 10 and listed on Contract Drawing S001.
2. Material: Steel
3. Coatings:
   a. Blast clean welded carbon-steel parts and materials per SSPC SP-10.
   b. Interior tank coating: polyamine epoxy applied to 20-30 mils.
   c. Exterior tank coating: urethane mastic applied to 3-5 mils.
4. Finish:
   a. Equalization Tank & MBR System Tanks
      1) Exterior Custom Paint Finish
         BEHR ULTRA
         BASE: 9853
         BEHR ULTRA EXT MATTE FINISH
         CUSTOM COLOR MATCH

CLRNT	BL	CL	DL	KXL
0Z	16	14	32	6
384th	316	324	72	11

G. Catwalk and Access Stairs and Ladders
1. Steel structural members with aluminum grating.
2. Grating hold downs: Type 304 stainless steel clips, secured by 304 SS hardware.
3. Access stairs: steel stringers with non-slip grating steps.
4. Access ladders: steel side rails and rungs.
   a. Provide non-skid finish on rungs.
5. Handrail:
   a. Steel round or box tubing or tubing.
   b. Welded to the structural members,
   c. Provide bolted connections with Type 304 SS hardware in locations where railings need to be disassembled.

H. System Pipe Labeling
1. All process piping shall be labeled with annotations conforming to P&IDs in “Issued for Construction” Contract Drawings.
2. Equipment tags:
   a. Provide for all equipment and tankage.
   b. Material: Type 304SS or aluminum.
      1) Equipment tags made of stickers will not be permitted.
   c. Equipment identification numbering and naming convention engraved.
   d. Use equipment tag numbers shown on P&IDs in “Issued for Construction” Contract Drawings.
3. Label all wiring and terminations.
4. All panels with corresponding diagrams affixed to interior of panel doors.

I. SCADA and Controls

1. Install alarm horn and beacon in control panels. See Specification 40 78 00 – Panel Mounted Instruments for requirements.
2. HMI Display: Touchscreen user interface for control of process equipment, charting, and alarms.
    a. The HMI touchscreen display software: Rockwell FactoryTalk.
3. Programming
    a. PLC software: Rockwell Studio 5000 Logix Designer software
    b. Program PLCs based on a Unit Process Diagram (UPD) control narrative with an organized list of master program setpoints and master alarm setpoints.
4. Submit from System Supplier a controls narrative, complete with alarms and interlocks as apart of the submittals process.

2.8 WINTERIZATION

A. System shall be designed to maintain membrane units in submerged state for entirety of outdoor conditions present during a full calendar year.
    1. Winterization shall include all systems required for winter membrane protection capability, including but not limited to:
        a. Tankage
        b. Associated pumps and/or blowers
        c. Heating element(s)
        d. Associated instrumentation
        e. Control panel(s)
        f. Associated piping, process interconnections, and valving
    2. Winterization procedure shall not require removal of membrane units from associate tankage
    3. Submerged membrane protection operation shall be a fully-automated process during winter conditions

B. Winterization Equipment
    1. Minimum 1 immersion-type heater in each Membrane Tank.
        a. May be designed to be removable for non-winterization operation.
        b. Removable units must have field disconnect capable of Lock Out Tag Out
    2. Submerged membrane protection operation must be integrated into control panel programming
    3. Instrumentation must, at a minimum provide monitoring for:
        a. Temperature – continuous
        b. Tank water level – continuous
        c. Chlorine residual - intermittent
    4. Control panels and associated controls/OIT shall be designed for year-round use
    5. Design and provide insulation for all liquid tankage exposed to year-round holding of liquid for sufficient submergence and protection of membrane units

2.9 COMMUNICATION

A. Control Panel Communication
    1. All control panels provided in this submittal by System Supplier shall integrate together via common data communication protocol.
    2. Data communication protocol: Ethernet/IP via fiber.
    3. Communication to all associated chemical dosing pumps via data communication as shown on the Drawings.
    4. Provide sufficient spare capacity in each network switch and fiber patch panel for future connection to site-wide SCADA

2.10 SOURCE QUALITY CONTROL

A. Factory Acceptance Testing
    1. Description

a. Includes full assembly of the whole System at the System Supplier's manufacturing facility for testing mechanical, electrical, and programming functionality prior to shipment.
b. Performed by the System Supplier FAT technician.
    1) System Supplier's FAT Technician to oversee the FAT testing in its entirety.
    2) FAT Technician must have overseen a minimum of five (5) FAT tests of fully packaged systems with the current System Supplier.

2. General
    a. Inspection of tank fabrication for compliance with tank drawings, weld specifications, and electrochemical passivation of welds.
    b. Inspection shall confirm equipment is in compliance with final Process & Instrumentation Drawings (P&IDs), in conformance with general arrangement drawings.
    c. Perform testing using clean water in forward flow.
    d. System shall perform hydraulically, providing stable operation using clean water within operational design criteria including hydraulic retention time, suction/positive pressures, and intended flowrates.
    e. Provide FAT Testing protocol and plan to Owner/Owner's Engineer at least 1 week prior to start of FAT.
    f. Utilize ancillary tankage and pump systems as necessary to allow the plant to run hydraulically through Peak Day Flows in loop mode for a minimum of 1 hour.
3. Hydraulic Structure Leak Test
    a. Water bearing structures shall undergo leak testing in the Factory.
    b. The test shall consist of filling the structure with water to the maximum design water level. Except as noted on the drawings, the water level shall not be lower than 2' 0" below the top of tank/chamber wall. All visible leakage shall be repaired.
4. Hydrostatic Test
    a. Coordinate hydrostatic testing of all tanks, piping, valves, and equipment in their final orientation and to their fullest intended dynamic operating range.
    b. Provide all necessary pumping equipment, hoses, and fittings to allow for a timely filling/testing scenario be implemented.
    c. Package Systems tested for one day for water tightness with all tanks, piping, equipment filled to normal operating heights and pressures.
        1) Document results for Owner's review in FAT documentation.
5. System Testing
    a. All rotating equipment is to be energized, tested, adjusted, and recorded for the following:
        1) Rotation checked
        2) Leak tested
        3) Flow Tested: Any pumps/blowers which do not meet the design criteria are to be replaced or the pipe networks are to be modified to induce the intended design setpoints.
        4) Suction/Pressure verification
        5) Vibration tested
        6) Full load amps
        7) Overloads set according to equipment FLA's and service factors
        8) VFD settings
        9) Meg-ohm testing of all motors and cables
6. Control Panel Testing
    a. The following shall be energized, tested, adjusted and recorded:
        1) Power failure test
        2) Tripping of all equipment and verification of alarming
        3) Air conditioner testing for on/off
        4) Testing of all equipment in HAND position of HOA
        5) KWH monitor

6) Over/Under Monitor/cutout device
7) All alarms are to be tested and set-up
8) All HOA switches to be tested both on panel front and HMI
9) Controls systems to be tested in accordance with the controls narrative
10) All call to runs are to be verified
11) UPS battery backup elapsed time till failure is to be tested/recorded
12) System to come back online automatically after power is re-energized
13) All graphing/charting must be operational while running in auto mode
14) See Specification 40 61 21 for requirements.

b. As-Builts for any changes to panel during FAT process shall be updated and provided prior to SAT.

7. HMI Testing
   a. The following shall be fully operational and tested during FAT:
      1) All HMI pages tabulated and accessible from main HMI page
      2) Charting
      3) Statistics
      4) Reporting
      5) Alarming
      6) Equipment Faceplates
      7) See Specification 40 68 63 for requirements.
8. Electrical Verification
   a. Verify equipment for compliance with approved “Issued for Design” Process and Instrumentation Drawings (P&IDs)
   b. Check that wiring and terminations conform to panel drawings
   c. Check all terminal lugs are factory torqued.
   d. Check that all equipment is tested at field voltage and record the following:
      1) FLA’s (all legs) with service factor ratio taken into consideration.
      2) Meg-ohm testing
      3) 4-20 mA scaling
      4) 4-20 mA verification on all analog inputs (PLC)
      5) Lower Measuring Limit
      6) Upper Measuring Limit
      7) Spanning offsets
      8) Instrument Serial number
      9) All equipment must be factory rotation tested.
9. Mechanical Upfit
   a. Check that all piping, equipment, and ancillaries are in conformance with approved “Issued for Design” Process & Instrumentation Drawings (P&IDs)
   b. Check for compliance with fabrication drawings
   c. Check that all equipment is installed with unions, flanges, or TC fittings to allow for ease of future maintenance.
10. Blowers/Diffusers
    a. Process and membrane blowers are to be factory tested at max and minimum operating depths, the results recorded and compared against the blower curve(s).
    b. Blower inlet/outlet pressures are to be recorded for baseline purposes.
11. Instrumentation and Sensory Equipment
    a. Configure each sensor to system specific level and pressure ranges.
    b. Sensory equipment shall be energized, tested, adjusted and recorded in accordance with:
       1) Proper scaling
       2) Configured for low/high span of sensory equipment
       3) Cross referencing of sensory equipment with mechanical measuring devices and against pump/blower curved.
       4) All sensory equipment with air probe wash systems shall have probe wash system tuned to manufacturer recommended pressures.

12. Chemical Delivery System
    a. Check that all chemical pumps are factory tested with tubes/diaphragms installed, to the extent feasible.
    b. Contractor is responsible for all chemicals and durables for the first operating season, from startup, commissioning, operations through winter shutdown; six (6) month duration.
    c. Contractor will provide an Arizona Grade 3 Wastewater Treatment Operator for the first operating season of the TWWTP to include startup through winterization of the system; housing will be provided onsite within five (5) minutes of the plant at no cost to contractor. Tour of duty is five (5) days a week, 40 hours per week, to include one weekend day as part of the five (5) days a week. Operator will be on call for emergencies to be compensated per emergency situation with Contracting Officer approval.
13. Mixers
    a. Factory install mixers and test to verify ability to homogenize tank contents.
14. Membranes
    a. Not tested in FAT.
    b. Tested on-site during SAT.
    c. Fully submerged continuously in water with a minimum of 2 – 5 ppm sodium hypochlorite (chlorine) following initial submergence to protect material composition and shall not be shipped once wetted.
15. Miscellaneous
    a. All valves are to be checked for operation and sealing while closed.
    b. All hardware materials and torque to be inspected in accordance with the manufacturer specifications.
    c. Manufacture will provide a two year supply spare parts package to be stored on-site in shipping container.
16. Submittals
    a. Provide Factory Acceptance Testing protocol and QC/QA sheets for all Factory Acceptance Tests performed.
    b. System Supplier's Project Manager shall provide weekly updates to Owner/Owner's Engineer/Contractor on FAT progress.
    c. Photo documentation of the entire system shall be provided to the Owner/Owner's Engineer/Contractor for reference.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

A. Locate the 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.

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 PRECOMMISIONING

A. Provide a pre-commissioning checklist to Owner for the purpose of advising the Owner/Owner's Engineer/Contractor as to the items which need to be completed on-site prior to mobilization of a start-up/commissioning technician.
    1. Coordination call with Owner/Owner's Engineer/Contractor post execution of the pre-commissioning checklist.
    2. Owner to provide System Supplier with a list of who should be invited to the Operator Training Sessions.
    3. Provide Seeding and Startup Recommendation Plan prior to SAT Technician arriving on site.

3.3 STARTUP TESTING

A. Description
   1. Provide a factory authorized technician employed by the System Supplier to conduct startup testing procedures.
   2. The MBR System shall be filled by Contractor to full operational depth (7-ft) with clean water prior to System Technician performing system startup; utilizing warf-hydrant installed, reference yard piping civil drawings.
   3. Startup of the System performed by System Technician
      a. Provide a detailed punch list of any outstanding items the Owner/Contractor needs to complete to ensure that the system is properly assembled, powered, and functional.
      b. Any punch list items denoted by the Technician will be discussed and need to be resolved by the Owner/Contractor prior to seeding.
   4. Technician shall be onsite for a minimum of 10 days to conduct SAT activities.
   5. Owner/Contractor to provide electrical, plumbing and mechanical assistance to the technician during this same time, as needed.

B. Startup Submittals
   1. The following submittals are to be provided prior to commissioning.
   2. All submittals shall be approved by the Owner/Owner's Engineer before Commissioning.
      a. A pre-commissioning checklist identifying the punch list/scope items necessary for the Contractor to perform prior to Commissioning must be provided to the Owner/Owner's Engineer no later than 30 days before commissioning.

C. Startup Testing Procedures
   1. On-Site Hydrostatic Testing:
      a. After the Mechanical Inspection, System Supplier shall coordinate hydrostatic testing with the General Contractor.
      b. General Contractor to supply all necessary pumping equipment, hoses, fittings to allow for a timely filling/testing scenario to be implemented.
      c. MBR System shall be tested for a minimum two (2) days for water tightness.
      d. Results shall be documented in the SAT Testing Plan.
   2. Clean Water Loop Testing:
      a. Following the Hydrostatic Test and before seeding, the System Supplier shall be responsible for performing testing using clean water in forward flow.
      b. The system shall perform hydraulically, providing stable operation using clean water within operational design criteria including hydraulic retention time and flux.
      c. Contractor/Owner to provide an unlimited supply of clean water as necessary for the duration of forward-flow testing.
      d. Clean Water Testing shall commence for a minimum of 7 days prior to Commissioning.

3.4 SYSTEM SEEDING

A. This section provides specifications for seeding the Package Systems.
   1. "Seeding" the System is defined as the day wastewater is introduced to the system.
   2. Seeding the plant is accomplished with activated sludge from another facility to help expedite biological growth and improve system performance sooner than if the system were commissioning using naturally-occurring biological growth.
      a. Seeding can also be accomplished with supplemental biology created in a laboratory. The supplemental biology can be delivered to the raw influent wastewater in dried or liquid form.
   3. Seeding a new MBR facility can take multiple days, and growth of a fully developed biological colony can take several months, depending on the seed quality and quantity.
   4. Costs associated with seeding the MBR System with activated sludge or biological starter shall be borne by the Contractor.
   5. It is required that any seed sludge or raw wastewater be introduced into the MBR system through fine screens with perforations no greater than 2mm.

6. At no time shall unscreened wastewater or seed sludge material be pumped directly into the MBR bypassing the fine screens.
7. Provide Seeding Recommendation Report outlining recommended volume of seed material and recommended MBR operational procedures based on expected influent wastewater parameters (flow/loading) and seeding volume/concentration available on the day of seeding.
8. The System Supplier shall have a Technician on-site during seeding.
9. The System Supplier shall be available remotely post-commissioning for on-call operational support.

B. Submittals
1. Commissioning checklists, denoting work that has been completed and work still needing to be finished, shall be provided by the System Supplier to Owner/Owner's Representative at the end of commissioning.

3.5 SYSTEM OPERATIONS TRAINING

A. The System Supplier shall supply a competent field service technician to train plant operators and technical staff on the operations and maintenance of the System. The training shall take place before and/or during Seeding.

B. Owner's wastewater treatment plant operator shall be prepared to shadow System Supplier's SAT Technician during SAT/Commissioning for learning/training opportunities.

C. MBR Operator Training:
1. Intensive training program focusing on what the operators should know about the MBR system:
   a. Hands-on, in-person training to go over equipment and system processes.
   b. Remote training where the project manager covers how to use the Operations and Maintenance manual, an overview of the P&ID, and a walkthrough of the design summary report.
   c. Remote training on the SCADA system, to delve into the control system and make sure the operators are comfortable using it.
   d. Full access to an online portal with videos, troubleshooting guides, and other helpful information that the operator can access after the initial training sessions.
   e. Additional follow-up calls or meetings with the operator, and the use of a ticketing system for further questions or support inquiries.
   f. Equipment Preventive Maintenance (PM):
      1) Operator Training material and/or Operations and Maintenance documents shall include information on how the Owner should care for the MBR equipment, including:
         a) Forecasting predictive maintenance
         b) Equipment Troubleshooting

D. UV Operator Training:
1. Focus on hands-on type training as much as practicable.
2. Use the supplied hard copy and electronic Operations and Maintenance Manuals and cover startup, shut down, normal and emergency conditions.
3. Training topics:
   a. UV System overall operation
      1) Physical operation
      2) Process operation
   b. Cleaning operation
   c. Process switches, meters, transmitter, and analyzers
   d. PLC equipment
   e. SCADA system

E. System Supplier shall act as an intermediate contact between UV reactor OEM and process equipment representatives whom are required to provide separate training courses during Commissioning.

F. The Contractor shall assist to facilitate the scheduled training classes such that they minimize field service time requirements.

G. The System Supplier shall provide a training plan and training aids 2 weeks before the training sessions.
   1. The plan shall outline the training topics and provide an approximate schedule for the training.
   2. Training Plan will include training topics, hands-on sessions, remote SCADA training, and Q&A opportunities.
   3. Training aids shall also include access to a detailed online portal with troubleshooting guides, videos, and a repository of resources for future reference.
   4. Equipment Operation:
      a. Describe the equipment's operating (process) function.
      b. Describe equipment's fundamental operating principals and dynamics.
      c. Identify the equipment’s mechanical, electrical, and electronic components and features.
      d. Identify all support equipment associated with the operation of subject equipment (e.g., compressed air intake filters, valve actuators, and motors).
      e. Recommend standard operating procedures to address start-up, routine monitoring, and shutdown of the equipment.
   5. Detailed Component Description:
      a. Describe each component's function.
      b. Group related components into subsystems, where applicable. Describe subsystem functions and their interaction with other subsystems.
      c. Describe equipment safeties and control interlocks.
   6. Equipment Preventive Maintenance (PM):
      a. Describe PM inspection procedures required to perform an inspection of the equipment in operation, spot potential trouble symptoms, and anticipate breakdowns.
      b. Forecast predictive maintenance.
      c. Equipment Troubleshooting:
         1) Define the recommended systematic troubleshooting procedures.
         2) Provide component-specific troubleshooting checklists.
         3) Describe applicable equipment testing and diagnostic procedures to facilitate troubleshooting.

END OF SECTION

SECTION 46 21 40

MECHANICALLY CLEANED SCREENS-IN CHANNEL AUGER

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. In-channel auger type mechanically cleaned screens.

B. Furnish and install one in-channel screen package including, but not limited to the spiral assembly, screen basket, transport tube, press zone assembly, discharge section, drive system, pivot stand, controls, manual bar rack, and other ancillaries described herein.

C. The unit shall be mounted above a two channel with the screen basket section resting on the bottom of the channel.
   1. Design screen basket to retain all solids particles larger than the opening size.
   2. Configure spiral assembly to transport the solids from the channel, compact and wash them before discharging to a separate collection vessel.
   3. Install screening unit as shown on the Contract Drawings.

D. Related Sections include but are not necessarily limited to:
   1. Division 01 - General Requirements.
   2. Section 01 67 00 - Product Requirements.
   3. Section 01 78 23 – Operation and Maintenance Data
   4. Section 01 79 00 – Demonstration and Training
   5. Section 03 41 33 – Precast and Prestressed Concrete.
   6. Section 40 05 59 – Fabricated Stainless Steel Slide Gates
   7. Section 40 78 00- Panel Mounted Instruments

1.2 QUALITY ASSURANCE

A. Referenced Standards:
   1. American Iron and Steel Institute (AISI):
      a. Steel Products Manual.
   2. ASTM International (ASTM):
      a. A36, Standard Specification for Carbon Structural Steel.

B. Qualifications:
   1. Supplied by a single manufacturer or supplier.
   2. Manufacturer shall have a minimum of three similar size and configuration units in operation.
   3. Unit shall meet “Buy American” requirements per NPS requirements.

1.3 SUBMITTALS

A. Shop Drawings:
   1. See Section 01 33 23 for requirements for the mechanics and administration of the submittal process.
   2. See requirements in Section 01 67 00.
   3. Descriptive literature regarding the screenings unit equipment to be supplied.
   4. Detailed specifications for the equipment proposed.
   5. Manufacturer's certification, signed by a corporate officer, confirming that the proposed equipment fully complies with these specifications.
   6. General arrangement drawings for the proposed equipment.
   7. Cut sheets for electric motors and ancillary items manufactured by others.
   8. Horsepower calculations for the drive motor.
   9. Complete schematic diagrams and control descriptions for the electrical control panel.

B. Contract Closeout Information:
   1. Operation and Maintenance Data:
      a. See Section 01 78 23 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.4 DELIVERY, STORAGE, AND HANDLING

A. Packaging, Shipping, Handling, and Unloading
   1. Packaged in containers or on skids suitable for normal shipping, handling, and storage.
   2. Protected from rain, snow, impact, and abrasion while in the possession of the carrier.

B. Acceptance at Site
   1. Contractor to review the contents of the shipment at time of delivery and promptly notify the carrier and supplier of any discrepancies.

C. Storage and Protection
   1. Equipment to remain in the packaging provided by the supplier until it is installed.
   2. Equipment to be stored in a dry environment between 40 and 100 degrees F.

D. Waste Management and Disposal
   1. Contractor responsible for discarding all packaging materials in accordance with local regulations.

1.5 WARRANTY

A. Provide a minimum system warranty of one year (12 months) from Contracting Officer issuing substantial completion letter as issued upon successful completion of the performance test.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable Manufacturers: Contracting Officer will consider Contractor's proposal of equivalent products when the specified salient characteristics are satisfied.

B. If the specified salient characteristics are not satisfied, Contracting Officer will return requests without action, except to record noncompliance with these requirements:
   1. Manufacturers listed, and other manufacturers not listed, but capable of meeting this Specification Section, are expected to provide complete information showing full compliance with specifications.
   2. Use of Manufacturers not listed may require additional design changes which shall be provided by the Contractor at no additional cost to the Government.

C. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. JWC Environmental/IPEC Consultants, Ltd., Model ALT-200 (Basis of Design)
   2. Or equal

D. Submit request for product substitution in accordance with Specification Section 01 33 23.

2.2 EQUIPMENT

A. Perforated Screen Trough and Wash Water Manifold:
   1. Perforated Screen Trough:
      a. Perforations: Nominal 6 mm
      b. Baffles mounted on both sides of trough with replaceable ¼-inch Buna-N channel seals.
      c. Base plate sits flat on channel floor to position trough at 35- degree inclination.
      d. Provide flange with 1-inch diameter lifting hole
   2. Wash Water Manifold:
      a. Provide spray nozzles with flat spray rated to provide 1.5 GPM at 40 psi.
      b. Maximum water usage: 4.5 GPM at 40 psi
      c. Mount manifold to screen basket flange

d. ¾-inch hose barb for attachment of water line from water control assembly.
e. Provide single point of connection to water utility supply.
f. NPT size per Drawings.

3. Material: AISI 304L stainless steel

B. Spiral assembly:
1. General:
a. Provide spiral assembly consisting of a spiral, drive shaft, brushes and plug cutter blade.
b. Shaftless, except in the press zone and discharge section.
c. Inclination angle of Spiral Screen: 35-degrees.
2. Spiral:
a. Constructed of concentric flights formed from 304 stainless steel and welded together to form a continuous spiral.
b. Spiral Diameter: 6-11/16 inch
c. Knurled cup set screws used to secure brush into mounting groove.
d. Transport section of spiral to have minimum outside bar thickness of 5/8 inch.
3. Brush:
a. Fit spiral with a water-resistant brush that will clean the screen basket openings and be fastened to the spiral edge in the screening section only.
b. Attach brush to the spiral with stainless steel fasteners.
4. Shaft:
a. Weld drive shaft directly to the spiral.
b. Material: type 304 stainless steel
c. Keyed to mate with the hollow drive of the gear motor.
d. Shaft diameter: 2 inches.
5. Plug Cutter Blade:
a. Mount on the drive shaft at the drive end serrated cutter blade to aid in discharging the solids plug formation.
b. Position cutter blade on the lead edge of the reverse spiral that directs the solids plug away from the drive area.

C. Transport Tube:
1. Casing:
a. Construct transport tube in 8-inch SCH 10 pipe type 304 stainless steel.
b. Provide tube with three (3) wear strips bolted to the inside surface to prevent the spiral from wearing on the surface of the tube.
2. Wear Bars:
a. 1 inch wide with minimum 1/2 inch thick
b. Material: Type 304 stainless steel.
c. Detachable.

D. Press zone assembly:
1. Provide press zone assembly consisting of an open topped housing containing a slotted screen-dewatering cylinder and a spray wash system.
2. Pressure zone housing:
a. Open topped enclosure 11 gauge, type 304 stainless steel.
b. Sides and bottom in 1/2 inch, type 304 stainless steel end plates.
c. Provide end plates with circular seats for axial positioning of the press screen.
d. The top cover will have neoprene gaskets and be attached with 3/8 inch fasteners.
e. Provide with 2-inch FNPT drain port.
3. Pressure zone screen:
a. 5mm diameter holes on 1-inch straight pattern.
b. Keyed into position and replaceable.
4. Spray Water Manifold:
a. Install shower bar within the press housing to flush solids from the screen surfaces.
b. Material: 1/2 inch SCH 40 type 304 stainless steel.

c. Provide spray nozzles with cone spray rated to provide 0.3 GPM at 40 psi.
d. Maximum water usage: 1.8 GPM at 40 psi
e. Provide water supply piping including ½" NC EX Class 1 Div 1 solenoid valve, ball valve, and flex hose.
f. Provide heat tracing on all water supply piping provided with the unit.

5. Insert, Casing, and Spray Water Manifold Material: AISI 304 stainless steel.

E. Discharge section:
1. Casing:
a. Cylindrical construction with flanged ends with 8-bolt pattern.
b. Full diameter bottom opening configured for vertical discharge of material.
c. Inspection cover located over discharge outlet.
d. Material: AISI 304L stainless steel.
e. Provide 8" by 10" inspection/cleanout door in the top section of tube.
f. Provide machined surface to mate to the drive unit flange.
2. Wear Bars:
a. 1 inch wide with minimum ½ inch thickness
b. Material: 17-4 stainless steel with minimum hardness of 33 HRc.

F. Discharge Bagging Assembly
1. Adapter:
a. Mounted to discharge opening of Discharge Casing and mounted to Cassette Bag Holder
b. Material: AISI 304L stainless steel.
2. Cassette Bag Holder:
a. Three (3) piece assembly with flanged discharge cylinder for connection to adapter, continuous bag flare and clamp
b. Material: ABS plastic.
c. AISI 316 stainless steel ring clamp with retaining spring.
3. Continuous Bag:
a. Cassette bag 230 ft. long continuous non-porous three-ply, co-extruded polyethylene with a thickness not to exceed 1.8 mils.
b. Provide spare bags, one year supply.
c. Provide roller trash can sized for discharge cassette bags.

G. Drive system:
1. Provide spiral drive system consisting of a single speed motor, direct coupled to a Eurodrive FA type helical gear reducer.
2. Electric motor: 1.5 hp, 480 volt, 3 phase, 60 Hz, TEFC EX Class 1 Division 1, with Class F insulation, 40°C ambient temperature.
3. Provide gear reducer rated for AGMA, Class II.
4. Mount drive directly onto the spiral drive shaft.

H. Pivot stand:
1. Provide in-channel screen with a support stand with integral pivot.
2. Construct from structural members of type 304 stainless steel with a minimum thickness of 3/16 inch.
3. Contractor to coordinate size with mechanical screen manufacturer.
4. The integral pivot will allow rotation of the unit out of the channel for maintenance purposes.
5. Design unit to pivot along both vertical and horizontal directions.

2.3 ACCESSORIES

A. Stop (slide gate) gates:
1. See specification section 40 05 59.

B. Manual bar screen:
1. Provide manual bar screen in the second channel separate from the mechanical screen unit.

2. Screen Material and Hardware: 304 stainless steel.
3. ½" wide on 2" centers, resulting in a 1½" spacing.
4. Angled section: Maximum angle 60 degrees to horizontal
5. Fabricate to include an angled and horizontal section as shown on Contract Drawings.
    a. Design horizontal section to drain water from the screenings.
    b. Horizontal section to act as "drying deck" for screened solids.
    c. Drying deck to have minimum 4-point cable lift system for removal cleaning maintenance and replacement via overhead crane.
    d. Lifting cables and hardware: 304 stainless steel minimum.
6. Provide manual rake of manual screen manufacturer recommended length to allow access to bottom of the screening vault from site grade adjacent to the vault.
7. Contractor to coordinate manual screen sizing with precast concrete design.
8. Manufacturer:
    a. Or-Tec
    b. Or Equal

C. Control Panel
1. Provide control panel housed in a NEMA 4X enclosure, suitable for field mounting adjacent to the screen facility as shown on the contract drawings.
    a. Stainless panel box with hinged, gasketed door.
    b. Locate outside of classified space per NFPA 820, with regard to proximity to the open screen channel.
2. Include the following components:
    a. One 15 amp, fused main disconnect switch
    b. One 150 Va control transformer, 208 – 115
    c. One IEC motor contactor with overload
    d. Operator switches for E stop, control power, and hand/off/auto switches for drive and spray wash.
    e. Four sequencing timers for operating motors and valves
    f. Dry contacts for system start, stop control, alarms, and run status.
    g. Install alarm horn and beacon in control panel. See Specification 40 78 00 – Panel Mounted Instruments for requirements.
    h. Provide electrical service entrance and equipment ground.
    i. See Division 26 for additional Electrical requirements

D. Field Devices
1. Solenoid Valves
    a. 120-volt, single phase, 60 hertz solenoid valve, housed in a NEMA enclosure.
    b. Rated for Class I/Div I spaces.
2. Level Sensors
    a. Two ultrasonic or radar-type sensors for level upstream and downstream of the screening unit for unit control.
3. Emergency Stop Local Push Button Station:
    a. Provide explosion-proof, emergency stop push button station as part of control panel mounted to the support stand as shown on the contract drawings.

2.4 FABRICATION

A. General:
1. Design mechanism to automatically remove solids from the bar screen and deposit them onto the dumpster as shown on the Drawings.
2. Assure mechanism is capable of manual reverse operation for removal of oversized objects.
3. Factory assembly unit prior to shipment.

B. Cold Weather Protection:
1. Cover discharge section, press zone, and transport tube with sectioned jacketing with a minimum of 1.5 inch of fiberglass insulation.
    a. Construct jacketing from 14-gauge stainless steel

b. Provide joints along the axial centerline to allow occasional dis-assembly and re-assembly.
2. Provide pipe lines (including spray wash water lines) with heat trace and flexible insulation sheathed in a PVC reinforced plastic covering.
   a. Attach heat tracing to pipe with Velcro straps.
3. Wrap self-regulating heat tracing around the equipment.
   a. Heat tracing: Raychem or approved equal.
4. Terminate heat tracing in a factory mounted junction box, ready for field wiring.

C. Surface Finish:
1. Surface Treatment of Stainless Steel Components:
   a. Acid passivate welds with pickling paste by brushing on all welds and overlapping into heat affected zones.
   b. Leave paste on for 1 to 2 hours before water flush and neutralization with soda ash solution.
   c. Blend surface blemishes and weld tacks smooth and glass bead polish complete surface to a uniform finish.
   d. After polishing, rinse surface then passivate using citric acid solution.
      1) Spray solution onto screens and leave for 30 minutes before water flushing the complete surface.
   e. After drying, coat all surfaces with a thin film for superior corrosion resistance.
2. OEM Components

2.5 SOURCE QUALITY CONTROL

A. Factory assembly, testing and inspection
1. Inspect and operate unit at factory prior to shipment.
2. The Contracting Officer may, at their option and own expense, witness the factory test.

2.6 PROVIDE MANUFACTURER'S STANDARD FINISH ON MOTOR, GEAR REDUCER AND ALL UNIT-MOUNTED ELECTRICAL DEVICESMAINTENANCE MATERIALS

A. Spare Parts:
1. Furnish the Owner the following extra parts:
   a. One torque switch and limit switch of each type on screen.
   b. Three wiper blades.
   c. Set of cog wheels.
   d. Roller and bushings for 20 FT of pin rack.

2.7 CONTROLS

A. The screen manufacturer shall provide an integrated control system that provides at a minimum the functionality as described herein and as shown on the Contract Drawings.
1. Provide additional system components, instrumentation, controls, relays/contacts etc. required for this a fully functional and safe system shall be provided as needed at no additional cost to the contract.

B. The screen shall be primarily operated based on float level and timer operation.
1. Provide Hand/Off/Automatic switch.
2. When in the "Hand" position, the screen auger shall run continuously.
3. When in the "Off" position, the screen auger shall not operate.
4. When in the "Auto" position the screen auger shall be started by the high level float and stop after expiration of adjustable timer.

C. Provide manufacturer's standard motor overload protections, torque cutouts and water supply solenoid valve control.

D. Provide standard local panel alarm light, horn and acknowledge button. See Specification 40 78 00 – Panel Mounted Instruments for requirements.

E. Transmit alarms from the manufacturer’s control panel to the pumping station common alarm system as shown on the drawings.
   1. Provide adequate relays and contacts to provide the alarm.

F. Screen High High alarm shall light up when screen channel is overflown and influent spills into the manual bar rack via the manual slide gates.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment per Manufacturer's recommendation.
   1. Make all electrical connections as specified herein and identified on the drawings.

3.2 FIELD QUALITY CONTROL

A. Provide services of equipment manufacturer's field service representative(s) to:
   1. Inspect equipment covered by this Specification Section.
   2. Supervise pre-start adjustments and installation checks.
   3. Conduct initial start-up of equipment and perform operational checks.

B. Instruct Owner's personnel with the guidelines detailed in 01 79 00 Demonstration and Training.

3.3 TRAINING

A. Training sessions to be scheduled to accommodate shift operators and may be held on different days in different weeks.
   1. PowerPoint presentation and hands-on demonstration of maintenance tasks are recommended.
   2. Training agenda, material and maintenance to be demonstrated shall be submitted for review and approval 30 days prior to scheduled training sessions.

B. There shall be 2 training sessions for operation and maintenance staff, with 2 hours of training per session.
   1. Include demonstration operation of local control panels, alarms, startup, normal operations, and maintenance.

C. The onsite training shall be video recorded.

END OF SECTION

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