TECHNICAL SPECIFICATIONS

HASKELL R. SREET WASTEWATER TREATMENT PLANT FATS, OILS, AND GREASE RECEIVING STATION IMPROVEMENTS

BID NUMBER 93-22

VOLUME 3 OF 3

CONTRACT DOCUMENTS

FEBRUARY, 2022

Kristina D. Mena, Chair
Ivonne Santiago, P.E., Vice Chair
Bryan R. Morris, Secretary-Treasurer
Charlie Intebi, Member
Lisa Saenz, Member
Stefanie Block Uribarri, Member
Mayor Oscar Leeser, Ex-Officio Member

John E. Balliew, P.E., President/CEO
Marcela Navarrete C.P.A., Vice President
Paul Rivas, Interim Vice President
Irazema Rojas P.E., Interim Chief Technical Officer
Felipe Lopez, P.E., Chief Operations Officer
Martin Noriega, P.E., Chief Operations Officer
Gilbert Trejo, P.E., Interim Chief Operations Officer

CIP No. S090011
Eng. / Proj. ID 2372

[THIS PAGE INTENTIONALLY LEFT BLANK]

TABLE OF CONTENTS

TECHNICAL SPECIFICATIONS

STATE OF TEXAS
JOEL MORA
108768
LICENSED
PROFESSIONAL ENGINEER
2/4/22

SECTION		NO. OF PAGES
DIVISION 01 – GENERAL REQUIREMENTS		
01 11 13	SUMMARY OF WORK	4
01 14 16	COORDINATION WITH OWNER'S OPERATIONS	6
01 14 19	USE OF SITE	2
01 22 13	MEASUREMENT AND PAYMENT AND SUBSTITUTION REQUEST FORMS	5
01 25 00	SUBSTITUTION PROCEDURES	7
01 26 00	CONTRACT MODIFICATION PROCEDURES, REQUEST FORMS AND CHANGE PROPOSAL FORM	11
01 29 73	SCHEDULE OF VALUES	3
01 29 76	PROGRESS PAYMENT PROCEDURES	3
01 31 13	PROJECT COORDINATION	1
01 31 19.13	PRE-CONSTRUCTION CONFERENCE	4
01 31 19.23	PROGRESS MEETINGS	3
01 31 26	ELECTRONIC COMMUNICATIONS PROTOCOL	5
01 32 16	PROGRESS SCHEDULE	3
01 32 33	PHOTOGRAPHIC DOCUMENTATION	5
01 33 00	SUBMITTAL PROCEDURES	10
01 35 23	SAFETY REQUIREMENTS	5

SECTION **NO. OF PAGES**

DIVISION 01 – GENERAL REQUIREMENTS (CONTINUED)

01 35 29 CONTRACTOR'S HEALTH AND SAFETY PLAN.....5

01 41 26 STORMWATER POLLUTION PROTECTION PLAN AND PERMIT, STORMWATER INSPECTION REPORT, STORMWATER PERMIT CERTIFICATION, AND STORMWATER POLLUTION PREVENTION PLAN (SWPPP) REVISION FORMS 14

01 42 00 REFERENCES 9

01 45 29.13 TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR.....3

01 45 53 CLEANING TESTING & DISINFECTING HYDRAULIC STRUCTURES.....12

01 51 05 TEMPORARY UTILITIES.....6

01 52 13 CONTRACTOR'S FIELD OFFICE AND SHEDS 3

01 52 16 FIRST AID FACILITIES 2

01 52 19 SANITARY FACILITIES.....3

01 55 13 ACCESS ROADS AND PARKING AREAS 4

01 57 05 TEMPORARY CONTROLS.....11

01 61 00 COMMON PRODUCT REQUIREMENTS.....2

01 62 00 PRODUCT OPTIONS.....2

01 64 00 OWNER FURNISHED PRODUCTS.....2

01 65 00 PRODUCT DELIVERY REQUIREMENTS 4

01 66 00 PRODUCT STORAGE AND HANDLING REQUIREMENTS 4

01 71 33 PROTECTION OF THE WORK AND PROPERTY 5

01 73 19 INSTALLATION 4

01 73 24 CONNECTIONS TO EXISTING FACILITIES 1

SECTION **NO. OF PAGES**

DIVISION 01 – GENERAL REQUIREMENTS (CONTINUED)

01 73 29 CUTTING AND PATCHING 5

01 74 05 CLEANING 3

01 75 11 CHECKOUT AND STARTUP PROCEDURES AND SUPPLIERS INSTALLATION CERTIFICATIONS 5

01 77 23 POST-FINAL INSPECTION 1

01 78 23 OPERATIONS AND MAINTENANCE DATA.....7

01 78 36 WARRANTIES 3

01 78 39 PROJECT RECORD DOCUMENTS.....4

01 78 43 SPARE PARTS AND EXTRA MATERIALS.....3

01 79 23 INSTRUCTIONS OF OPERATIONS AND MAINTENANCE PERSONNEL7

01 91 00 COMMISSIONING.....10

DIVISION 02 – EXISTING CONDITIONS

02 41 00 DEMOLITION 6

DIVISION 03 – CONCRETE

03 00 05 CONCRETE 16

DIVISION 05 – METALS

05 05 33 ANCHOR SYSTEMS.....17

05 50 13 MISCELLANEOUS METAL FABRICATIONS 6

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 92 00 JOINT SEALANTS 10

STATE OF TEXAS
HOUSAM HOBI
120827
LICENSED
PROFESSIONAL ENGINEER
02/04/2022

SECTION **NO. OF PAGES**

DIVISION 09 – FINISHES

09 91 00 PAINTING 13

DIVISION 10 – SPECIALTIES

10 14 00 SIGNAGE 14

DIVISION 26 – ELECTRICAL

26 05 05 GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS 5

26 05 19 LOW-VOLTAGE ELECTRICAL POWER CONDUITS & CABLES 5

26 05 23 INSTRUMENTATION CABLE 3

26 05 26 GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS 3

26 05 29 HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS 4

26 05 33.13 RIGID CONDUITS 9

26 05 33.16 FLEXIBLE CONDUITS 2

26 05 33.33 PULL, JUNCTION AND TERMINAL BOXES 3

26 05 43.13 UNDERGROUND DUCTBANKS FOR ELECTRICAL SYSTEMS 4

26 05 53 IDENTIFICATION FOR ELECTRICAL SYSTEMS 8

26 08 00 ELECTRICAL ACCEPTANCE TESTING 3

26 24 19 MOTOR CONTROL CENTER MODIFICATIONS 6

26 28 16.33 DISCONNECT SWITCHES 2

26 29 23 LOW-VOLTAGE VARIABLE FREQUENCY DRIVES 10

26 29 33 CONTROL STATIONS 3

26 50 00 LIGHTING 3

26 51 00 HEAT TRACING 6

STATE OF TEXAS
BRIAN E. YOUNG
118600
LICENSED
PROFESSIONAL ENGINEER
2/4/22

SECTION **NO. OF PAGES**

DIVISION 31 – EARTHWORK

31 20 00 EARTH MOVING AND OSHA REGULATIONS 17

DIVISION 33 – UTILITIES

33 05 05 BURIED PIPING INSTALLATION AND BURIED PIPING SCHEDULE FORM 16

DIVISION 40 – PROCESS INTEGRATION

40 05 05 EXPOSED PIPING INSTALLATION AND EXPOSED PIPING TABLE ...12

40 05 06 COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING 7

40 05 07 PIPE HANGERS AND SUPPORTS 8

40 05 08 WALL PIPES, FLOOR PIPES AND PIPE SLEEVES 4

40 05 17 COPPER PROCESS PIPE 4

40 05 19 DUCTILE IRON PROCESS PIPE 9

40 05 23.23 STAINLESS STEEL PROCESS PIPE FOR LIQUID SERVICE.....6

40 05 31 THERMOPLASTIC PROCESS PIPE 7

40 05 53 PROCESS VALVES 12

40 05 93 COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT.....10

40 42 00 INSULATION OF PROCESS PIPING 5

40 61 13 PROCESS CONTROL SYSTEMS GENERAL PROVISIONS 10

40 61 23 PLANT MONITORING AND CONTROL SYSTEM START-UP AND FIELD TESTING.....4

40 61 26 PROCESS CONTROL SYSTEM TRAINING 2

40 61 93 PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST AND LOCATION CHART 7

STATE OF TEXAS
ZANE E. WILSTERMAN
111912
LICENSED
PROFESSIONAL ENGINEER
2–4–22

SECTION **NO. OF PAGES**

40 61 96 PROCESS CONTROL DESCRIPTIONS 15

40 64 00 PROGRAMMABLE LOGIC CONTROLLERS 3

40 67 17 PROCESS CONTROL PANELS AND ENCLOSURES 9

40 70 05 PRIMARY SENSORS AND FIELD INSTRUMENTS 10

40 78 00 PANEL MOUNTED INSTRUMENTS AND DEVICES 7

40 96 20 FIELD INSTRUMENTS AND CHART 1

DIVISION 41 – MATERIAL PROCESSING AND HANDLING EQUIPMENT

41 22 13 STATIONARY DAVIT CRANE 4

DIVISION 43 – PROCESS GAS AND LIQUID HANDLING, PURIFICATION AND STORAGE EQUIPMENT

43 21 36.23 ROTARY LOBE PUMPS 8

DIVISION 46 – WATER AND WASTEWATER EQUIPMENT

46 24 23 INLINE GRINDER AND ROCK TRAP 10

+ + END OF TABLE OF CONTENTS + +

SECTION 01 11 13

SUMMARY OF WORK

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. This Section includes the following Articles:

Article	Title
1.1	Section Includes
1.2	Location and Description of Work
1.3	Other Construction Contracts
1.4	Work by Others
1.5	Work by OWNER
1.6	Sequence and Progress of Work
1.7	CONTRACTOR's Use of Site
1.8	Easements and Rights-of-Way
1.9	Notices to Owners and Authorities of Properties Adjacent to the Work

1.2 LOCATION AND DESCRIPTION OF WORK

A. The Work is located at the Haskell Wastewater Treatment Plant at 4100 Delta Dr. in El Paso, TX. Work will be performed near the mixed sludge building and DAFT tank as shown in Volume 1 of the contract documents.

B. Work to be performed under this Contract includes, but is not limited to, improvements to the existing FOG Station owned by El Paso Water (OWNER). The Work includes, but is not limited to, the following:
   1. Removal of existing concrete slab and CMU wall,
   2. Trenching and relocation of underground pipelines.
   2. New equipment to be installed includes an offloading nozzle, stainless steel piping, heat tracing system, metering pumps, offloading pumps, rock trap with grinder, carbon filter (with flame arrester), breathing valve, davit crane, control panel, valves, and instruments shown in the drawings. New installations include electrical, I&C, water and drainage connections. Site construction will include new foundation and curb. Work will include modifications to existing 18,000-gallon tank, and an interconnection to the mixed sludge well and pumping station.
   3. Reinstatement of service, functional testing and site acceptance testing of all equipment and process.

C. Contracting Method: The Project shall be constructed under one prime Contract.

D. Hazardous Environmental Conditions:
   1. To the best of Owner's knowledge, information, and belief, the Site has been a wastewater treatment plant since 1923. Prior to that the site was used as a garbage landfill.

1.3 OTHER CONSTRUCTION CONTRACTS

A. Other construction contracts have been or will be awarded by OWNER that are in close proximity to or border on the Work of this Contract. Work under these other contracts is briefly described as follows:
   1. Secondary Clarifier Inlet Gate Replacement
      a. Principal Work Location: Secondary Clarifiers
      b. Scope: Bypassing Inlet channel and replacing inlet gates
      c. Contract times expected to start: Early February
      d. Approximate Final Completion: Late April

   2. Grit Basin Rehabilitation Project
      a. Principal Work Location: Grit Removal Building
      b. Scope: Rehabbing Junction Box and Inlet Channel
      c. Contract times expected to start: Early March
      d. Approximate Final Completion: Early April

1.4 WORK BY OTHERS

A. Non-Professional Services Contracted by OWNER: OWNER will retain services of the following entities to perform the services indicated relative to the Project. CONTRACTOR shall coordinate and schedule the Work with, and cooperate with, the entities performing the following services for OWNER.
   1. Testing and Code-Required Special Inspections:
      a. OWNER has, or will, retain the services of a qualified testing laboratory to perform testing and code-required special inspections for the Work, in accordance with Section 01 45 29.13, Code-Required Special Inspections and Procedures, and selected other provisions of the Contract Documents related to field testing.
   2. SCADA Configuration and Integration Services:
      a. OWNER has, or will, retain the services of a qualified systems integration firm to perform SCADA configuration services and other information technology services relative to the Work, in accordance with Section 46 61 13.

1.5 WORK BY OWNER (NOT USED)

1.6 SEQUENCE AND PROGRESS OF WORK

A. Requirements for sequencing and coordinating with OWNER's operations, including maintenance of facility operations during construction, and requirements for tie-ins and shutdowns, are in Section 01 14 16, Coordination with Owner's Operations.

1.7 CONTRACTOR'S USE OF SITE

A. CONTRACTOR's use of the Site shall be confined to the areas shown on volume 2 of the contract documents.

B. Move stored materials and equipment that interfere with operations of OWNER, other contractors, and others performing work for OWNER.

C. Limits on CONTRACTOR's use of the Site are:
   1. As indicated in Section 01 14 19, Use of Site.
   2. Do not use the Site for operations other than those required for the Project.

1.8 EASEMENTS AND RIGHTS-OF-WAY

A. General:
   1. Easements and rights-of-way required for the permanent improvements included in the Work will be provided by OWNER in accordance with the General Conditions and Supplementary Conditions.
   2. Confine construction operations within OWNER's property, public rights-of-way, easements obtained by OWNER, and limits shown, and property for which CONTRACTOR has made arrangements directly with property owner(s).
   3. Use care in placing construction tools, equipment, excavated materials, and materials and equipment to be incorporated into the Work to avoid damaging property and interfering with traffic.
   4. Do not enter private property outside the construction limits without permission from the owner of the property.

1.9 NOTICES TO OWNERS AND AUTHORITIES OF PROPERTIES ADJACENT TO THE WORK

A. Notify owners of adjacent property and utility owners when prosecution of the Work may affect their property, facilities, or use of property.

B. When it is necessary to temporarily obstruct access to property, or when utility service connection will be interrupted, provide notices sufficiently in advance to enable affected persons to provide for their needs. Such notifications shall comply with Laws and Regulations and, whether delivered orally or in writing, shall include appropriate information concerning the interruption and instructions on how to limit inconvenience caused thereby.

SECTION 01 14 16

COORDINATION WITH OWNER'S OPERATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for coordinating with OWNER's operations during the Project, and includes requirements for tie-ins and shutdowns necessary to complete the Work without impact on OWNER's operations except as allowed in this Section.
   2. CONTRACTOR shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to coordinate with OWNER's operations during the Work in accordance with this Section.

B. Coordination:
   1. Review construction procedures under other Specifications sections and coordinate Work that will be performed with or before the Work specified in this Section.

C. Related Sections:
   1. Section 01 11 13, Summary of Work.
   2. Section 01 73 29, Cutting and Patching.
   3. Section 01 73 24, Connections to Existing Facilities.

D. Except for shutdowns specified in this Section, perform the Work such that OWNER's facilities remain in continuous satisfactory operation during the Project. Schedule and conduct the Work such that the Work does not: impede OWNER's production or processes, create potential hazards to operating equipment and personnel, reduce the quality of the facility's products or effluent, cause odors or other nuisances, or affect the public health, safety, and convenience.

E. Work not specifically covered in this Section or in referenced Sections may, in general, be completed, within the approved Contract Times, at any time during regular working hours in accordance with the Contract Documents, subject to the requirements in this Section.

F. As a substitute to the procedures specified in this Section, CONTRACTOR may propose providing additional temporary facilities that can eliminate or mitigate a constraint without additional cost to OWNER, provided such additional temporary facilities: do not present hazards to the public, personnel, structures, and equipment; that such additional temporary facilities do not adversely affect OWNER's ability to comply with Laws and Regulations, permits, and operating requirements; that such temporary facilities do not generate or foster the generation of odors and other nuisances; and that requirements of the Contract Documents are fulfilled.

G. Coordinate shutdowns with OWNER and ENGINEER. Shutdowns shall be carefully scheduled and should not impact OWNER's operations and processes.

H. Operation of Existing Systems and Equipment during the Work:
   1. Do not shut off or disconnect existing operating systems or equipment, unless accepted by ENGINEER in writing.
   2. Operation of existing systems and equipment will be by OWNER unless otherwise specified or indicated.
   3. Where necessary for the Work, CONTRACTOR shall seal or bulkhead OWNER-operated gates and valves to prevent leakage that may affect the Work, OWNER's operations, or both.
   4. Provide temporary watertight plugs, bulkheads, hot tap or line stop as required. After completing the Work, remove seals, plugs, bulkhead, hot tap and line stop to satisfaction of ENGINEER.

I. Bypassing:
   1. CONTRACTOR may use a temporary bypassing option for water or wastewater at CONTRACTOR's expense if this is a preferred method during tie-ins.
   2. No additional payment from the OWNER will be made to the CONTRACTOR for performing a bypassing option by the CONTRACTOR.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Substitute Sequence Submittal: If CONTRACTOR deviates from specified sequence or procedures, furnish submittal for approval explaining in detail the proposed sequence or procedures and associated effects, including evidence that OWNER's operations will not be adversely affected, to an extent greater than originally contemplated in the Contract Documents, by proposed substitution. List benefits of proposed substitution, including benefits to Progress Schedule.

B. Informational Submittals: Submit the following:
   1. Shutdown Planning Submittal:
      a. CONTRACTOR shall submit an inventory of labor, materials, and equipment required to perform the shutdown and tie-in tasks, an estimate of time required to accomplish the complete shutdown including time for OWNER to take down and start up existing equipment, systems, or conduits, and written description of steps required to complete the Work associated with the shutdown.
      b. Furnish submittal to ENGINEER 5 days prior to proposed shutdown start date. Do not start shutdown until obtaining ENGINEER's acceptance of shutdown planning submittal.
   2. Shutdown Notification: After ENGINEER's acceptance of shutdown planning submittal and prior to starting the shutdown, submit written notification to OWNER and ENGINEER of date and time each shutdown is to start. Submit notification not less than 48 hours in advance of each shutdown.

1.3 GENERAL CONSTRAINTS

A. New materials, equipment, and systems may be used by OWNER after the specified field quality controls and testing are successfully completed and the materials or equipment are Substantially Complete in accordance with the Contract Documents.

B. The following constraints apply to coordination with OWNER's operations:
   1. Operational Access: OWNER's personnel shall have access to equipment and areas of the facility that remain in operation.
   2. Temporary Partitions and Enclosures: Provide temporary partitions and enclosures necessary to maintain dust-free, heated, and ventilated spaces in areas of the project area that are adjacent to the work and that must be kept operational.
   3. Schedule and perform equipment and system start-ups for Monday through Thursday. Equipment and systems shall not be placed into operation on Friday, Saturday, and Sunday without prior approval of OWNER, unless specifically indicated otherwise in the Contract Documents.
   4. Dead End Valves or Conduits: Provide blind flanges, watertight bulkheads, or valve at temporary and permanent terminuses of conduits, including piping and ducting. Blind flanges and bulkheads shall be suitable for the service and braced and blocked, as required, or otherwise restrained as directed by ENGINEER. Temporary valves shall be suitable for their associated service. Where valve is provided at permanent terminus of conduit, including piping or ducting, also provide on downstream side of valve a blind flange with drain/flushing connection.
   5. CONTRACTOR shall maintain clean and dry work area by pumping and properly disposing of fluid and other material that accumulates in work areas; specifically, as a high groundwater elevation will be found at the South tie-in location.
   6. Draining and Cleaning of Conduits:
      a. Unless otherwise shown or indicated, CONTRACTOR shall dewater/water stop the water supply mains prior to initiating the shutdown. Flush, wash down, and clean the work areas.
      b. CONTRACTOR shall remove liquids and solids and dispose of them at appropriate location. Unless otherwise specified or indicated, contents of conduits (including piping) undergoing modifications shall be transferred to conduits with capacity sufficient to accept such discharges, using hoses, temporary piping, temporary pumps, or other means provided by CONTRACTOR. Discharge of fluids across floors is not allowed.
      c. If drainage point is not available on the conduit (including piping) to be drained, provide a wet tap using tapping saddle and valve or other method approved by ENGINEER. Uncontrolled spillage of contents of conduits (including piping) is not allowed.
      d. Spillage shall be brought to ENGINEER's attention immediately, both verbally and in writing, and reported in accordance with TCEQ Laws and Regulations. CONTRACTOR shall wash down spillage, disinfect as required by ONWER, use available floor drains or sumps or other appropriate location and flush the system to prevent clogging and odors. If spillage is not suitable for discharge

to the drainage system, as determined by ENGINEER, CONTRACTOR shall remove spillage by other method, such as vactor truck, sorbents, or other method acceptable to ENGINEER.

1.4 SEQUENCE OF WORK

A. See Section 01 11 13, Summary of Work for the indicated sequence of which the Work is to be performed.

1.5 TIE-INS

A. Refer to Contract Drawings for the location of tie-ins. For tie-ins not indicated in the Contract Drawings, obtain requirements for tie-ins from ENGINEER by requesting an interpretation or clarification.
B. CONTRACTOR shall submit a tapping saddle submittal for piping configuration of the proposed work to tie into the sludge mixing well inlet line. If the tapping saddle submittal differs from the Contract Drawings sheet C-04, it will be to CONTRACTOR's benefit and will not result in an increase of the cost of the project
C. CONTRACTOR shall submit a reroute tie-in submittal for piping configuration of the proposed work to tie into the sludge mixing well outlet lines. If the outlet lines reroute tie-in differs from the Contract Drawings sheet C-05, it will be to CONTRACTOR's benefit and will not result in an increase of the cost of the project

1.6 SHUTDOWNS

A. General:
   1. Terminology: A "shutdown" is when a portion of the normal operation of OWNER's facility, whether equipment, systems, conduit (including piping and ducting), must be temporarily suspended or taken out of service to perform the Work.
   2. Work that may interrupt normal operations shall be accomplished at times convenient to OWNER unless otherwise indicated in the Contract Documents.
   3. Furnish at the Site, in close proximity to the shutdown and tie-in work areas, tools, materials, equipment, spare parts, both temporary and permanent, necessary to successfully perform the shutdown. Complete to the extent possible, prefabrication of piping and other assemblies prior to commencing the associated shutdown. Demonstrate to ENGINEER's satisfaction that CONTRACTOR has complied with such requirements before commencing the shutdown.
   4. If CONTRACTOR's operations cause an unscheduled interruption of OWNER's operations, immediately re-establish satisfactory operation for OWNER.
   5. Unscheduled shutdowns or interruptions of continued safe and satisfactory operation of OWNER's facilities that result in fines or penalties by authorities having jurisdiction shall be paid solely by CONTRACTOR if, in ENGINEER's opinion, CONTRACTOR did not comply with requirements of the Contract Documents, or was negligent in the Work, or did not exercise proper precautions in performing the Work and complying with applicable permits, Laws, and Regulations.

6. Where necessary, obtain ENGINEER's interpretation or clarification before proceeding.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 GENERAL

A. In addition to requirements of this Section, comply with Section 01 73 29, Cutting and Patching, and other Contract Documents applicable to Work associated with shutdowns, tie-ins, temporary pumping (where applicable), and similar work.

3.2 DETAILED SHUTDOWN REQUIREMENTS

A. Shutdown A:
   1. General:
      a. Affected Facilities Operating Prior to Shutdown: Haskell WWTP.
      b. Equipment Out of Service During Shutdown: not limited to WAS line, sludge inlet and outlet lines, wastewater lines, water lines, and Sludge Mixing Well.
      c. Procedure:
         1. Submit Shutdown Submittal for ENGINEER to review; Submittal shall include duration, start time and date and completion time and date for all required shutdown(s) that are implemented in conjunction or independently for each line and interrelated activities during the shutdown: not limited to WAS line, sludge line inlet, sludge mixing well draining procedures, sludge line outlets, water supply stoppage procedures, dewatering and sludge by-passing procedures, necessary tools and materials to be utilized that are readily available at the time of the shutdown. ENGINEER shall review Submittal within 7 working days. A shutdown Submittal must be approved by ENGINEER prior to proceeding with actual shutdown.
         2. Contact OWNER and ENGINEER 72 hours before shutdown occurring via a preparatory meeting. The Preparatory meeting is orchestrated and documented by the CONTACTOR to ensure shutdown is fully communicated with/approved by OWNER and ENGINEER.
         3. Flows from water supply lines, wastewater lines, or sludge shall be shutdown to permit completion of the proposed work and proposed improved system and new tie ins as shown on the contract drawings. Tie-in lines shall be drain sufficiently in order to complete the work as shown in the contract drawings
         4. All required labor, equipment, materials, instrumentation and special tools shall be at project site and in working conditions the day prior to shutdown.
         5. Once items A.1.c.(1 through 4) are in place, CONTRACTOR shall cut into utility line following items A.1.e, A.1.f, and A.1.g.
         6. All new pipelines require hydrostatic testing completed. Refer to Section 40 05 05 for exposed piping schedule.

d. NOTE: Any proposed deviations from steps A.1.c.(1 through 6) will be to the CONTRACTOR's benefit and will not result in an increase of the cost of the project. Any proposed deviation shall be submitted for ENGINEER's acceptance at the same time for the Shutdown Submittal, ENGINEER shall review Submittal within 7 working days.
e. Dates: Shutdown shall be limited to 8 hours from shutdown start time.
f. Time: Shutdown shall initiate during normal workday shift plant hours (from 7:00 AM to 4:00 PM).
g. Shutdown shall occur with an authorization from OWNER and ENGINEER five (5) days in advance.

2. Prior to Shutdown:
   a. Obtain ENGINEER's acceptance of proposed shutdown planning submittal and shutdown notification submittal.
   b. Bring necessary piping, couplings, valves, equipment, and appurtenances to the work areas.
   c. Assist OWNER in preparing to take equipment and conduits (including piping and ducting) temporarily out of service.

4. During Shutdown:
   a. Dewater the water supply lines as required to complete the tie-ins.
   b. Bypass any sewer as required to complete the tie-ins
   c. Bypass any sludge as required to complete the tie-ins.

5. Following Shutdown:
   a. Verify functionality of proposed improved pipelines.
   b. Verify functionality of tie-ins.
   b. Verify operation of new equipment, instrumentation, and systems, and verify that joints in conduits (including piping and ducting) are watertight as applicable.
   c. Repair joints that are not watertight, as applicable.
   d. Remove temporary appurtenances.
   e. Obtain acceptance of all tie-ins in writing from ENGINEER.

+ + END OF SECTION + +

SECTION 01 14 19

USE OF SITE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for use of the Site during the Project, and includes requirements for use of existing facilities, as applicable.
   2. CONTRACTOR shall provide all labor, materials, equipment, tools, and incidentals shown, specified, and required to comply with restrictions on CONTRACTOR's use of the Site and other areas.
   3. Comply with requirements of the General Conditions, as may be modified by the Supplementary Conditions, regarding the CONTRACTOR's use of the Site and other areas.

1.2 USE OF PREMISES

A. Limit use of premises at the Site to work areas shown or indicated on the Drawings (volume 2 of contract documents) and as specified in this Section. Do not disturb portions of the Site beyond areas of the Work.
   1. Limits:
      a. Confine construction operations to the following areas:
         1) CONTRACTOR to confirm confinement of areas of construction operations with ENGINEER.
      b. Confine storage of materials and equipment, and locations of temporary facilities to the following areas:
         1) CONTRACTOR to confirm confinement of storage of materials, equipment and temporary facilities with ENGINEER.
      c. Do not enter the following areas:
         1) Owner Offices unless OWNER approved.
         2) Plant unit processes other than Mixed sludge building.
         4) Areas outside of the work areas indicated in Paragraph 1.2.A.1 of this Section and outside of work areas indicated on the Drawings, including outside the Project areas indicated on the "key plan" in the Drawings.
   2. Access to Site, Access Roads, and Parking Areas: Refer to Section 01 55 13, Access Roads and Parking Areas.

B. Use of Existing Buildings and Structures: Obtain OWNER's written permission for each proposed use of existing buildings and structures.
   1. Use of Existing Utilities, Sanitary Facilities, and First-aid Facilities: Refer to Section 01 51 05, Temporary Utilities.
   2. Use of Existing Hoisting Equipment and Access to Work Areas for Loading:

a. CONTRACTOR shall obtain OWNER's written permission for use of any existing equipment or for access to work areas for loading.

C. Promptly repair damage to premises caused by construction operations. Upon completion of the Work, restore premises to specified condition; if condition is not specified, restore to pre-construction condition.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 22 13

MEASUREMENT AND PAYMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Items listed starting in Article 1.4 of this Section refer to and are the same pay items listed in the Bid Form and constitute all pay items for completing the Work.
   2. No direct or separate payment will be made for providing miscellaneous temporary or accessory works, plant or facility services, CONTRACTOR's or ENGINEER's field offices, layout surveys, Project signs, sanitary requirements, testing, safety provisions and safety devices, submittals and record drawings, water supplies, power and fuel, maintenance of traffic, removal of waste, security, coordination with OWNER's operations, information technology (including hardware, software, and services) required during construction, commissioning where specified, bonds, insurance, or other requirements of the General Conditions, Supplementary Conditions, Division 01 Specifications, and other requirements of the Contract Documents.
   3. Compensation for all services, items, materials, and equipment shall be included in prices stipulated for lump sum and unit price pay items listed in this Section and included in the Contract.

B. Each lump sum and unit price, as bid, shall include an amount considered by CONTRACTOR to be adequate to cover CONTRACTOR's overhead and profit for each separately identified item.

1.2 ENGINEER'S ESTIMATE OF QUANTITIES

A. ENGINEER's estimated quantities for items of Unit Price Work, as included in the Contract, are approximate only and are included solely for purpose of comparing Bids and pricing. OWNER does not expressly or by implication agree that nature of materials encountered below the ground surface or actual quantities of material encountered or required will correspond with the quantities included in the Contract at the time of award and reserves the right to increase or decrease quantities, and to eliminate quantities, as OWNER may deem necessary.

1.3 ADJUSTMENT OF UNIT PRICES FOR INCREASE OR DECREASE OF ESTIMATED QUANTITIES

A. Increases or decreases in the quantity of an item of Unit Price Work will be determined by comparing total payable quantity of Unit Price Work with ENGINEER's estimated quantity indicated in the Contract Documents.

B. Provisions, if any, regarding adjustment of unit prices due to variations in actual quantities from the estimated quantities awarded with the Contract, are in the Supplementary Conditions.
   1. ENGINEER's review for possible unit price cost adjustment, when provision for such adjustment is indicated in the Supplementary Conditions, will be at a time ENGINEER deems reasonable and proper.
   2. Payment for Unit Price Work item that has an as-awarded computed total value of less than the percent (indicated in the Supplementary Conditions) of the sum of the as-awarded total Contract Price will be made at the unit price in the Contract, regardless of an increase or decrease in quantity.

1.4 RELATED PROVISIONS

A. Payments to CONTRACTOR: Refer to General Conditions, Supplementary Conditions and Agreement.

B. Changes in Contract Price: Refer to General Conditions and Supplementary Conditions.

C. Schedule of Values: Refer to General Conditions, Supplementary Conditions, and Section 01 29 73, Schedule of Values.

1.4 CONTRACT NO. 1 – GENERAL CONSTRUCTION

A. Item 1 – Insurance, Bonds, Mobilization and Demobilization and Move-In Related Expenses. Lump sum:
   1. Measurement shall be made in the stated lump sum for the Insurance and Bonds, mobilization and demobilization.
   2. Payment shall include costs for approximately fifty (50) percent of mobilization and approximately fifty (50) percent of demobilization, including coordination, bonds, insurance, construction permits and fees if applicable, Contractor field office, construction water, sanitary and power needs, contract closeout and site cleanup with respect to this project in conformance with these Contract Documents. Total amount for the sum of this item may not exceed five (5) percent of total amount of Bid Proposal Items 2 through 7 of the Bid Form. Payment will be processed per the guidelines of this specification and the General Conditions of the Contract.

B. Item 2 – Demolition of existing concrete pad and CMU wall, curb, asphalt (including basecourse), excavation, underground utility relocations. Complete in place. Lump sum:
   1. Measurement shall be made in the lump sum for demolition of the entirety of the system.
   2. Payment made for Bid Item No.2 shall include all costs for demolition and all work associated with the removal and disposal of the existing CMU wall, concrete slab, curb & gutter, and asphalt, payable in one lump sum.

C. Item 3 – Furnish and install new 4-inch PVC drain system including three (3) floor drains within proposed FOG Station, trench drain, and sewer manhole tie-in. Complete in place. Lump sum:
   1. Measurement shall be made in the lump sum for the construction of the entirety of the drain system.
   2. Payment made for Bid Item No.3 shall include all costs for completion of all work associated with the installation of three (3) 4-inch drains and manhole tie-in, payable in one lump sum.

D. Item 4 – Furnish and install new concrete foundation and pad, tank anchor system including footer, wall, slab, all coatings, four pump support trust blocks, rock trap and inline grinder support trust blocks, asphalt pavement (including basecourse), curb, bollards, and trench drain. Complete in place. Lump sum:
   1. Measurement shall be made in the lump sum for the construction of the entirety of the new concrete foundation and pad system.
   2. Payment made for Bid Item No.4 shall include all costs for completion of all work concrete work for mechanical and process equipment support, including curb & gutter, and asphalt payable in one lump sum.

E. Item 5 – Furnish and install 4-inch stainless steel pipe, fittings, flanges, quick connect, hose bib, flushing points, pipe supports, and tie-in to existing Sludge Mixing Well as shown on drawings. Complete in Place. Lump sum:
   1. Measurement shall be made in the lump sum for the construction of the entirety of the new process pipeline and all appurtenances system.
   2. Payment made for Bid Item No.5 shall include all costs for completion of all work concrete work for all process piping system including all fittings and appurtenances for a fully functional pipeline system free of leaks in one lump sum.

F. Item 6 – Furnish and install stainless steel knife gate valves. Complete in place. Each:
   1. Measurement shall be made as a lump sum for the installation of thirteen (13) steel knife gate valves as part of the new process pipeline for the improved FOG Station.
   2. Payment made for Bid Item No.6 shall include all costs for completion of all work concrete work for all thirteen (13) stainless steel knife gate valves for a fully functional pipeline system free of leaks in one lump sum.

G. Item 7 – Furnish and install stainless steel check valves. Complete in place. Each:
   1. Measurement shall be made as a lump sum for the installation of five (5) stainless steel check valves as part of the new process pipeline for the improved FOG Station.
   2. Payment made for Bid Item No.7 shall include all costs for completion of all work concrete work for all five (5) stainless steel check valves for a fully functional pipeline system free of leaks in one lump sum.

H. Item 8 – Furnish and install breathing valve, carbon canister, 6-inch CPVC piping, relief valve, 6-inch stainless steel flame arrester and support, flanged tee and fittings, tank custom cover, Complete in place. Lump Sum:

1. Measurement shall be made as a lump sum for the installation of all odor control components for the improved FOG Station.
2. Payment made for Bid Item No.8 shall include all costs for completion of all work concrete work for a fully functional odor control system free of leaks in one lump sum.

J. Item 9 – Furnish and install Davit crane, rock trap, and inline grinder and all other mechanical appurtenances for a complete in place. Lump Sum:
1. Measurement shall be made as a lump sum for the installation of all mechanical protection equipment for the improved FOG Station.
2. Payment made for Bid Item No.9 shall include all costs for completion of all work concrete work for a fully functional mechanical protection equipment system free of leaks in one lump sum.

K. Item 10 – Furnish and install mixing/metering pump, Complete in Place. Each:
1. Measurement shall be made as a lump sum for the installation of two (2) mixing pumps and two (2) metering pumps for the improved FOG Station.
2. Payment made for Bid Item No.10 shall be to furnish and install work materials and labor for the installation of two (2) mixing pumps and two (2) metering pumps for a fully functional FOG pumping system as described and shown on the contract documents, complete in place. Payment shall be made at the contract lump sum price shown in the proposal.

L. Item 11 – Furnish and install 3-inch and 4-inch Corious flowmeters, Complete in Place. Each:
1. Measurement shall be made as a lump sum for the installation of one (1) 3-inch Corious flowmeter for the improved FOG Station.
2. Payment made for Bid Item No.10 shall be to furnish and install work materials and labor for the installation of one (1) 3-inch Corious flowmeter for a fully functional FOG pumping system as described and shown on the contract documents, complete in place. Payment shall be made at the contract lump sum price shown in the proposal.

M. Item 12 – Furnish and install all electrical upgrades, conduit, cabling, terminations, and control paneling required for a complete the Installation of the proposed FOG Station. Lump sum:
1. Measurement shall be made lump sum for completion of an electrical system for the improved FOG Station.
2. Payment made for Bid Item No. 12 shall be to furnish and install work materials and labor for the installation of all associated electrical upgrades equipment for a fully functional electrical system as described and shown on the contract documents, complete in place. Payment shall be made at the contract lump sum price shown in the proposal.

N. Item 13 – Furnish and install all instrumentation and control upgrades for a complete in place integration of proposed FOG Station, including tank level, metering pumps, VFDs, flowmeter with existing SCADA system. Lump sum:
1. Measurement shall be made lump sum for completion of a SCADA system for the improved FOG Station.

2. Payment made for Bid Item No. 13 shall be to furnish and install work materials and labor for the installation of all associated equipment, instrumentation and control for a fully functional SCADA system as described and shown on the contract documents, complete in place. Payment shall be made at the contract lump sum price shown in the proposal.

O. Item 14 – Provide startup, testing, and training services by the individual manufacturers factory representatives to verify proper installation of all FOG Station equipment including controls and system operation. Lump sum:
   1. Measurement shall be made lump sum for completion of an operational tested system with training for all components for the improved FOG Station.
   2. Payment made for Bid Item No. 14 shall be to provide startup, training and third-party certification of all associated equipment, instrumentation and control for a fully functional FOG Station, including start-up and testing, software training, as described and shown on the contract documents, complete in place. Payment shall be made at the contract lump sum price shown in the proposal.

P. Item 15 – Pre-and Post-Construction Site – project site video recording. Lump sum:
   1. Measurement shall be made in the lump sum for video recording of the construction site pre-and post-construction.
   2. Payment made for Bid Item No. 15 at the stated lump sum shall include high quality digital video and photographs of the entire site prior to construction activities and following construction activities, and all ancillary requirements necessary to satisfactorily complete the Work. Payment shall be made at the contract lump sum price shown in the proposal.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope: Section includes:
   1. Administrative and procedural requirements for selecting materials and equipment for the Project.
   2. Procedural requirements for substitutions of materials and equipment.
   3. Procedural requirements for substitute construction methods or procedures, when construction methods or procedures are specified.

B. A proposed substitute will not be accepted for review if:
   1. Approval would require changes in design concept or a substantial revision of the Contract Documents.
   2. Approval would delay completion of the Work or the work of other contractors.
   3. Substitution request is indicated or implied on a Shop Drawing or other submittal, or on a request for interpretation or clarification, and is not accompanied by CONTRACTOR's formal and complete request for substitution.

C. If proposed substitute is not approved, CONTRACTOR shall provide the specified materials, equipment, method, or procedure, as applicable.

D. Approval of a substitute does not relieve CONTRACTOR from requirement for submitting Shop Drawings and other submittals in accordance with the Contract Documents.

E. ENGINEER and OWNER have the right to rely upon the completeness and accuracy of the information included in CONTRACTOR's request for approval of a substitute, and CONTRACTOR accepts full responsibility for the completeness and accuracy thereof.

F. When approved substitute is defective or fail to perform in accordance with the Contract Documents, responsibility for remedying the defect or failure resides solely with CONTRACTOR and Supplier.

1.2 SUBSTITUTE MATERIALS AND EQUIPMENT

A. Requests for approval of substitute items of materials or equipment will be considered within a period of 15 days after the Effective Date of the Contract. After the end of specified period, substitution requests will be considered only in case of unavailability of a specified item of material or equipment or other conditions beyond CONTRACTOR's control.

B. Procedure:

1. Submit to ENGINEER two (2) printed copies of each request for substitution and electronic version.
2. Submit requests for substitution in accordance with requirements for furnishing submittals, as indicated in Section 01 33 00, Submittal Procedures.
3. Submit separate request for each proposed substitute.
4. Submit request for substitution using forms attached to this Section. Complete all information requested on each form, and enclose with the forms supplementary information as required. In addition to requirements of the General Conditions and information required on substitution request forms, include with each substitute request the following:
   a. Identification of the materials and equipment (as applicable), including manufacturer's name and address.
   b. Manufacturer's literature with description of the materials and equipment, performance and test data, and reference standards with which materials and equipment comply.
   c. Samples, when appropriate.
   d. Name and address of similar projects on which the materials and equipment were used, date of installation, and names and contact information (including telephone number) for the facility operations and maintenance manager.

1.3 SUBSTITUTE CONSTRUCTION METHODS OR PROCEDURES

A. Where construction methods or procedures are specified, for a period of 15 days after the Effective Date of the Contract, ENGINEER will consider CONTRACTOR's written requests for substitute construction methods or procedures shown or specified in the Contract Documents.

B. The provisions of the General Conditions, as may be modified by the Supplementary Conditions, regarding substitute items of materials and equipment are hereby extended to apply to substitute construction methods or procedures.

C. Procedure:
   1. Submit to ENGINEER two (2) printed copies of each request for substitution.
   2. Submit requests for substitution in accordance with requirements for furnishing submittals, as indicated in Section 01 33 00, Submittal Procedures.
   3. Submit separate request for each proposed substitute.
   4. Submit request for substitution using forms attached to this Section. Complete all information requested on each form, and enclose with the forms supplementary information as required. In addition to requirements of the General Conditions and information required on substitution request forms, include with each substitute request the following:
      a. Detailed description of proposed method or procedure.
      b. Itemized comparison of the proposed substitution with the specified method or procedure.
      c. Drawings illustrating method or procedure.

d. Other data required by ENGINEER to establish that proposed substitution is equivalent to specified method or procedure.

1.4 CONTRACTOR'S REPRESENTATIONS

A. In submitting request for substitution, CONTRACTOR represents that:
   1. CONTRACTOR has read and fully understands the provisions regarding substitutes as indicated in the General Conditions, as may be modified by the Supplementary Conditions.
   2. Substitution request is complete and includes all information required by the Contract Documents.
   3. CONTRACTOR certifications required by the General Conditions, as may be modified by the Supplementary Conditions, are valid and made with CONTRACTOR's full knowledge, information, and belief.
   4. CONTRACTOR will provide the same or better guarantees or warranties for proposed substitute as for the specified materials, equipment, methods, or procedures, as applicable.
   5. CONTRACTOR waives all Claims for additional costs or extension of time related to proposed substitute that subsequently may become apparent.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ATTACHMENTS

A. The documents listed below, and attached following this Section's "End of Section" designation, are part of this Specification Section.
   1. Substitution Request Form (two pages).
   2. Product Substitution Checklist (one page).

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SUBSTITUTION REQUEST

Project: _____ Substitution Request Number: _____

_____ From: _____

To: _____ Date: _____

_____ Engineer Project. No._____

Re: _____ Contract For: _____

Specification Title: _____ Description: _____

Section: _____ Page: _____ Article/Paragraph: _____

Proposed Substitute: _____

Manufacturer: _____ Address: _____ Phone: _____

Trade Name: _____ Model No.: _____

Installer: _____ Address: _____ Phone: _____

History: ☐ New product ☐ 1 to 4 years old ☐ 5 to 10 years old ☐ More than 10 years old

Differences between proposed substitute and specified item: _____

_____

_____

☐ Point-by-point comparative data attached — REQUIRED BY THE CONTRACT DOCUMENTS

Reason for not providing specified item: _____

_____

Similar Installation:

Project: _____ Engineer: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: ☐ No ☐ Yes; explain _____

_____

Savings to Owner for accepting substitute: ($)
(attach detailed, itemized estimate)

_____ _____

Proposed substitute changes Contract Time: ☐ No ☐ Yes [Add] [Deduct] _____days.
(clarify whether change is to Substantial Completion, Milestone, or time for readiness for final payment)

Supporting Data Attached: ☐ Drawings ☐ Product Data ☐ Samples ☐ Tests ☐ Reports ☐ _____

SUBSTITUTION REQUEST
(Continued)

☐ Substitute product, method, or procedure is subject to payment of licensing fee or royalty (check if "yes" and attach information)

☐ Substitute product, method, or procedure is patented or copyrighted (check if "yes" and attach information)

The undersigned certifies:

- Representations in the General Conditions and in Section 01 25 00, Substitution Procedures, regarding substitutions are valid.
- Same or better warranty and guarantee will be furnished for proposed substitution as for specified item.
- Same maintenance service and source of replacement parts, as applicable, is available.
- Proposed substitute will have no adverse effect on other trades and will not affect or delay Progress Schedule.
- Cost data as stated above is complete. Claims for additional costs or time related to accepted substitution which may subsequently become apparent are waived.
- Proposed substitute does not affect dimensions and functional clearances.
- Payment will be made for Engineer's review and changes, if any, to the design and Contract Documents, and construction costs caused by the substitute.
- Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitted by: _____

Signed by: _____

Firm: _____

Address: _____

_____

Telephone: _____

Attachments: ☐

ENGINEER'S REVIEW AND ACCEPTANCE (OR NON-ACCEPTANCE) WILL BE DOCUMENTED IN A FIELD ORDER OR CHANGE ORDER, AS APPROPRIATE. _____

Additional Comments: ☐ Contractor ☐ Subcontractor ☐ Supplier ☐ Manufacturer ☐ Engineer ☐ Other:

Adapted from CSI Form No. 13.0B, 2004 edition

PRODUCT SUBSTITUTION CHECKLIST

Date: _____ Re: _____

Engineer Proj No.: _____ Manufacturer's Project No.: _____

Filing No.: _____ Contract For: _____

Item Equivalence:

☐ Is the submitted item equivalent to the specified item? _____

☐ Does it serve the same function? _____

☐ Does it have the same dimensions? _____

☐ Does it have the same appearance? _____

☐ Will it last as long? _____

☐ Does it comply with the same codes, and standards and performance requirements? _____

☐ Has the item been used locally, and where are the projects? _____

_____

☐ Has a problem occurred with the item, and what was the remedy? _____

_____

Effect on the Project:

☐ Will the substitute affect other aspects of the construction? _____

☐ Are any details affected and are changes required? _____

☐ What is the cost of the changes? _____

☐ Who pays for the required changes? _____

☐ Are Contract Times affected? _____

_____

Effect on the Warranty:

☐ How does the proposed warranty differ from the specified warranty? _____

_____

☐ Does the manufacturer have a track record of standing behind the warranty? _____

_____

Adapted from CSI Form No. 20.3, 1998 edition

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 26 00

CONTRACT MODIFICATION PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope.
   1. This Section expands upon provisions of the General Conditions, as may be modified by the Supplementary Conditions, and includes:
      a. Requests for interpretation.
      b. Written clarifications.
      c. Minor changes in the Work and Field Orders.
      d. Work Change Directives.
      e. Proposal Requests.
      f. Change Proposals.
      g. Change Orders.

B. Submit Contract modification documents to ENGINEER, addressed to the contact person and contact information indicated in Section 01 33 00, Submittal Procedures, and in accordance with Section 01 31 26, Electronic Communication Protocols.

C. Retain at CONTRACTOR's office and at the Site complete copy of each Contract modification document and related documents, and ENGINEER's response.

1.2 REQUESTS FOR INTERPRETATION

A. General.
   1. Transmit written requests for interpretation to ENGINEER. CONTRACTOR and OWNER may prepare and transmit requests for interpretation.
   2. Prepare and transmit request for interpretation to obtain clarifications or interpretations of the Contract Documents. Report conflicts, errors, ambiguities, and discrepancies in the Contract Documents by requesting an interpretation.
   3. Do not transmit request for interpretation when other form of communication is appropriate, such as CONTRACTOR's submittals, requests for approvals of substitutes, notices, ordinary correspondence, or other form of communication. Improperly prepared or inappropriate requests for interpretation will be returned without response or action by ENGINEER.
   4. Do not submit request for interpretation or clarification when:
      a. answer may be obtained by observations at the Site; or
      b. required information is clearly indicated in the Contract Documents; or

c. required information is included in industry standards referenced in the Contract Documents or Supplier's instructions that are consistent with the Contract Documents; or
d. are reasonably inferable from any of foregoing.

5. CONTRACTOR shall have sole financial responsibility for requests for interpretations or clarifications that are submitted late, out of sequence, or that are unnecessary.

B. Procedure.
1. Transmit requests for interpretation in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Include with each request for interpretation a separate letter of transmittal.
2. ENGINEER will provide timely review of requests for interpretation. Allow sufficient time for review and response.
3. ENGINEER will maintain log of requests for interpretation. Upon request, copy of log will be transmitted to requestor.
4. ENGINEER's response to requests for interpretation will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each response to a request for interpretation will include a separate letter of transmittal.
5. ENGINEER's written response to each request for interpretation will be distributed to:
   a. CONTRACTOR.
   b. OWNER.
   c. Resident Project Representative (RPR).
   d. ENGINEER.
6. If ENGINEER requests additional information to make an interpretation, entity requesting the interpretation shall transmit the information requested within ten days, unless ENGINEER allows additional time, via correspondence referring to request for interpretation number.
7. Interpretations that One or Both Parties Believes Entails a Change to the Contract:
   a. If CONTRACTOR or OWNER believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of ENGINEER's interpretation, so advise ENGINEER in writing before proceeding with the Work associated with the request for interpretation.
   b. If, after this initial communication, either OWNER or CONTRACTOR believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.

C. Preparation of Requests for Interpretation:
1. Prepare each request for interpretation on the "Request for Interpretation" form included with this Section, or other form acceptable to ENGINEER.
2. Number each request for interpretation as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number. Example: First request for interpretation on the general contract for project titled, "Contract A15" would be, "RFI No. A15-GC-001".

3. In space provided on form, describe the interpretation requested. Provide additional sheets as necessary. Include text and sketches as required in sufficient detail to describe the need for an interpretation.
4. When applicable, request for interpretation shall include CONTRACTOR's recommended resolution.

1.3 WRITTEN CLARIFICATIONS

A. General:
1. Written clarifications, when required, will be initiated and issued by ENGINEER.
2. Written clarifications do not change the Contract Price or Contract Times, and do not alter the Contract Documents.
3. Written clarifications will be issued as correspondence or using clarification notice form, with additional information as required.

B. Procedure.
1. ENGINEER's written clarifications will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section.
2. Each written clarification will be distributed to:
   a. CONTRACTOR.
   b. OWNER.
   c. Resident Project Representative (RPR).
   d. ENGINEER.
3. Written Clarifications that One or Both Parties Believes Entails a Change to the Contract:
   a. If CONTRACTOR or OWNER believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of ENGINEER's written clarification, so advise ENGINEER in writing before proceeding with the Work associated with the written clarification.
   b. If, after this initial communication, either OWNER or CONTRACTOR believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.
4. If ENGINEER's written clarification is unclear, prepare and transmit a request for interpretation.

1.4 MINOR CHANGES IN THE WORK AND FIELD ORDERS

A. General:
1. Field Orders, when required, will be initiated and issued by ENGINEER.
2. Field Orders authorize minor variations in the Work but do not change the Contract Price or Contract Times.
3. Field Orders will be in the form of Engineers Joint Contract Documents Committee document EJCDC® C-942, "Field Order".
4. ENGINEER will maintain a log of Field Orders issued.

B. Procedure.
   1. Field Orders will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Field Order will include a separate letter of transmittal.
   2. Each Field Order will be distributed to:
      a. CONTRACTOR.
      b. OWNER.
      c. Resident Project Representative (RPR).
      d. ENGINEER.
   3. Field Orders that One or Both Parties Believes Entails a Change to the Contract Price or Contract Times:
      a. If CONTRACTOR or OWNER believes that a change in the Contract Price or Contract Times or other change to the Contract is required as a result of a Field Order, so advise ENGINEER in writing before proceeding with the Work associated with the Field Order.
      b. If, after this initial communication, CONTRACTOR believes that change in Contract Price, Contract Times, both, or other relief with respect to the terms of the Contract is necessary, recourse shall be in accordance with the Contract Documents.
   4. If the Field Order is unclear, submit request for interpretation.

1.5 WORK CHANGE DIRECTIVES

A. General:
   1. Work Change Directives, when required, order additions, deletions, or revisions to the Work.
   2. Work Change Directives do not change the Contract Price or Contract Times but are evidence that the parties to the Contract expect that the change ordered or documented by the Work Change Directive will be incorporated in subsequently issued Change Order following agreement by the parties as to the Work Change Directive's effect, if any, on the Contract Price or Contract Times.
   3. Work Change Directives will be in the form of EJCDC® C-940, "Work Change Directive".

B. Procedure.
   1. Work Change Directives signed by OWNER and ENGINEER will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Work Change Directive will include a separate letter of transmittal. CONTRACTOR shall print three originals of Work Change Directive for CONTRACTOR's signature.
   2. CONTRACTOR shall promptly sign each original Work Change Directive and, within five days of receipt, return all originals to ENGINEER.
   3. Original, signed Work Change Directives will be distributed as follows:
      a. CONTRACTOR: One original.
      b. OWNER: One original.
      c. ENGINEER: One original.

4. One copy of each Work Change Directive will be distributed to:
   a. Resident Project Representative (RPR).
   b. (--2--).
5. Documentation of Costs:
   a. When basis of payment for Work ordered under a Work Change Directive will be paid as Cost of the Work, or when otherwise required by ENGINEER, document for the Work performed under each separate Work Change Directive, for each day, the following:
      1) Number and labor classifications of workers employed and hours worked.
      2) Construction equipment used including manufacturer, model, and year of manufacture, and number of hours such equipment was onsite and used for the Work under the Work Change Directive.
      3) Consumables and similar materials used.
      4) Receipts, bills, or invoices for and descriptions of materials and equipment incorporated into the Work.
      5) Invoices and labor and equipment breakdowns for Subcontractors and Suppliers.
      6) Other information required by OWNER or ENGINEER,
   b. Submit such information in a format acceptable to ENGINEER.
   c. Transmit such documentation to ENGINEER as a Change Proposal.

1.6 PROPOSAL REQUESTS

A. General:
   1. Proposal Requests may be initiated by ENGINEER or OWNER.
   2. Proposal Requests are for requesting the effect on the Contract Price and the Contract Times and other information relative to contemplated changes in the Work. Proposal Requests do not authorize changes or variations in the Work, and do not change the Contract Price or Contract Times or terms of the Contract.
   3. Proposal Requests will be furnished using the “Proposal Request” form included with this Section.

B. Procedure.
   1. Proposal Requests will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Proposal Requests will include a separate letter of transmittal.
   2. Each signed Proposal Request will be transmitted to:

      a. CONTRACTOR.
      b. OWNER.
      c. Resident Project Representative (RPR).
      d. ENGINEER.
   3. Transmit request for interpretation to clarify conflicts, errors, ambiguities, and discrepancies in Proposal Request.

4. Upon receipt of Proposal Request, CONTRACTOR shall prepare and transmit to ENGINEER a Change Proposal, in accordance with the Contract Documents, for the proposed Work described in the Proposal Request.

1.7 CHANGE PROPOSALS

A. General.
   1. Prepare and transmit written Change Proposal to ENGINEER in response to each Proposal Request; or when CONTRACTOR believes a change in the Contract Price or Contract Times or other change to the terms of the Contract is required; or to appeal an initial decision by ENGINEER concerning the requirements of the Contract Documents or relating to the acceptability of the Work under the Contract Documents; contest a set-off against payment due; or seek other relief under the Contract.

B. Procedure.
   1. Prepare and transmit Change Proposals within time limits indicated in the General Conditions, as may be modified by the Supplementary Conditions.
   2. Transmit Change Proposals in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Include with each Change Proposal all required supporting documentation and a separate letter of transmittal.
   3. ENGINEER's Review and Requests for Additional Information:
      a. ENGINEER will review and act on each Change Proposal in accordance with, and within the time limits indicated in, the General Conditions, as may be modified by the Supplementary Conditions.
      b. When, ENGINEER requests additional information to render a decision, submit required information within five days of receipt of ENGINEER's request, unless ENGINEER allows more time. Submit the required information via correspondence that refers to the specific Change Proposal number.
      c. OWNER shall transmit to ENGINEER such comments, if any, that OWNER has on the Change Proposal, within 10 days of OWNER's receipt of the Change Proposal.
      d. ENGINEER will render a written decision on the Change Proposal.
      e. ENGINEER's response to Change Proposals will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section, the General Conditions, and the Supplementary Conditions.

   4. ENGINEER's response to each Change Proposal will be distributed to:
      a. CONTRACTOR.
      b. OWNER.
      c. Resident Project Representative (RPR).
      d. ENGINEER.
   5. If Change Proposal is recommended for approval by ENGINEER and is approved by OWNER, a Change Order will be issued or, when applicable, an appropriate use of contingency allowance will be authorized by OWNER.

6. If parties do not agree on terms for the change, OWNER or CONTRACTOR may file a Claim against the other, in accordance with the General Conditions, as may be modified by the Supplementary Conditions.

C. Preparation of Change Proposals:
1. Each Change Proposal shall be submitted on the "Change Proposal" form included with this Section, or other form acceptable to ENGINEER.
2. Number each Change Proposal as follows: Numbering system shall be the Contract number and designation followed by a hyphen and three-digit sequential number. Example: First Change Proposal for the general contract for project named "Contract A15" would be, "Change Proposal No. A15-GC-001".
3. In space provided on Change Proposal form:
   a. Describe scope of each proposed change. Include text and sketches on additional sheets as required to provide detail sufficient for ENGINEER's review and response. If a change item is submitted in response to Proposal Request, write in as scope, "In accordance with Proposal Request No." followed by the Proposal Request number. Submit written clarifications, if any, to scope of change.
   b. Submit justification for each proposed change. If change is in response to proposal request, write in as justification, "In accordance with Proposal Request No." followed by the proposal request number.
   c. List the total change in the Contract Price and Contract Times for each separate change item included in the Change Proposal.
4. Unless otherwise directed by ENGINEER, attach to the Change Proposal detailed breakdowns of pricing (Cost of the Work and CONTRACTOR's fee) including:
   a. List of Work tasks to accomplish the change.
   b. For each task, labor cost breakdown including labor classification, total hours per labor classification, and hourly cost rate for each labor classification.
   b. Construction equipment and machinery to be used, including manufacturer, model, and year of manufacture, and number of hours for each.
   c. Detailed breakdown of cost of materials and equipment to be incorporated into the Work, including quantities, unit costs, and total cost, with Supplier's written quotations.
   d. Breakdowns of the Cost of the Work and fee for Subcontractors, including labor, construction equipment and machinery, and materials and equipment incorporated into the Work, other costs, and Subcontractor fees (e.g., overhead and profit).
   e. Breakdown of other costs eligible, in accordance with the General Conditions and the Supplementary Conditions under "Cost of the Work" provisions.
   f. Other information required by ENGINEER.
   g. CONTRACTOR's fees applied to eligible CONTRACTOR costs and eligible Subcontractor costs.

1.8 CHANGE ORDERS

A. General:

1. Change Orders will be recommended by ENGINEER (when required by the General Conditions), and will be signed by OWNER and CONTRACTOR, to authorize additions, deletions, or revisions to the Work, or changes to the Contract Price or Contract Times.
2. Change Orders will be in the form of EJCDC® C-941, "Change Order".

B. Procedure.
1. Change Orders for signature by CONTRACTOR will be transmitted in accordance with Section 01 31 26, Electronic Communication Protocols, and requirements of this Section. Each Change Order will include a separate letter of transmittal. CONTRACTOR shall print three originals of Change Order for CONTRACTOR's signature.
2. CONTRACTOR shall promptly sign each original Change Order and, within five days of receipt, return all originals to ENGINEER.
3. ENGINEER will sign each original Change Order and forward them to OWNER.
4. After approval and signature by OWNER, original Change Orders will be distributed as indicated below.
5. Original, signed Change Orders will be distributed as follows:
   a. CONTRACTOR: One original.
   b. OWNER: One original.
   c. ENGINEER: One original.
6. One copy of each Change Order will be distributed to:
   a. Resident Project Representative (RPR).

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ATTACHMENTS

A. The forms listed below, following this Section's "End of Section" designation, are part of this Specifications Section:
1. Request for Interpretation form (one page).
2. Proposal Request form (one page).
3. Change Proposal form (one page).

+ + END OF SECTION + +

REQUEST FOR INTERPRETATION

Owner: _____
Project Name: _____

Contractor: _____ RFI No. _____
Date Transmitted: _____ Date Received: _____
Date Response Requested: _____ Date Response Transmitted: _____

Subject: _____
Specification Section and Paragraph: _____
_____
Drawing References: _____

INTERPRETATION REQUESTED:

Signature: _____ Date: _____

ENGINEER'S RESPONSE:

Signature: _____ Date: _____

PROPOSAL REQUEST

Owner: _____
Project Name: _____

Proposal Request No.: _____ Date: _____

Contract Name and No.: _____

Contractor: _____

Other Contracts Involved in Proposed Change: _____
_____

TO CONTRACTOR: Please submit a complete Change Proposal for the proposed modifications described below. If the associated Change Proposal is approved, a Change Order or allowance authorization will be issued to authorize adjustment so the scope of the Work. This Proposal Request is not a Change Order, Work Change Directive, Field Order, or an authorization to proceed with the proposed Work described below.

SCOPE OF PROPOSED WORK:

1. *Item*:
2. *Item*:
3. *Item*:

Proposal requested by: _____

Signature of Requestor: _____

CHANGE PROPOSAL

Owner: _____
Project Name: _____

Change Proposal No.: _____ Date: _____

Submitted in Response to Proposal Request No.: _____

Contract Name and No.: _____
Contractor: _____

Subject: _____
_____

The following changes to the Contract are proposed:

SCOPE OF WORK: *(attach and list supporting information as required)*

1. *Item*:
2. *Item*:

JUSTIFICATION:

1. *Item*:
2. *Item*:

CHANGES IN CONTRACT PRICE AND CONTRACT TIMES:

We propose that the Contract Price and Contract Times be changed as follows:

For Contract Price, attach detailed cost breakdowns for Contractor and Subcontractors, Supplier quotations, and other information required.
For the Contract Times, state increase, decrease, or no change to Contract Times for Substantial Completion, readiness for final payment, and Milestones, if any. If increase or decrease, state specific number of days for changes to the Contract Times.

Description	Amount	Contract Times (days)	
		Substantial	Final
1. Item	$0.00	0	0
2. Item	$0.00	0	0
Total This Change Proposal	**$0.00**	**0**	**0**

Changes to Milestones, if any: _____

Contractor represents that supporting data attached to this Change Proposal are accurate and complete. The requested time or price adjustment indicated in this Change Proposal is the entire adjustment to which Contractor believes it is entitled as a result of the proposed change(s) indicated herein.

Change Proposal by: _____

Signature of Proposer: _____

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 29 73

SCHEDULE OF VALUES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall prepare and submit to ENGINEER for acceptance a Schedule of Values that allocates cost to each item of the Work. Schedule of Value list of line items shall correspond to each aspect of the Work, establishing in detail the portion of the Contract Price allocated to each major component of the Work.
   2. Upon request of ENGINEER, support values with data that substantiate their correctness.
   3. Submit preliminary Schedule of Values to ENGINEER for initial review. CONTRACTOR shall incorporate ENGINEER's comments into the Schedule of Values and resubmit to ENGINEER. ENGINEER may require corrections and re-submittals until Schedule of Values is acceptable.
   4. Schedule of Values may be used as a basis for negotiating price of changes, if any, in the Work.
   5. Schedule of Values and the Progress Schedule updates specified in Section 01 32 16, Progress Schedule, will be basis for preparing each Application for Payment.

1.2 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Submit to ENGINEER Schedule of Values in the form and quantity required in Section 01 33 00, Submittal Procedures.
   2. Content of Schedule of Values submittals shall be in accordance with Article 1.3 of this Section.
   3. Timing of Submittals:
      a. Submit preliminary Schedule of Values within ten days after the Notice to Proceed.
      b. Submittal of the Schedule of Values for acceptance by ENGINEER shall be in accordance with the General Conditions. ENGINEER will not accept Applications for Payment without an acceptable Schedule of Values.
      c. When required by ENGINEER, promptly submit updated Schedule of Values to include cost breakdowns for changes in the Contract Price.

1.3 SCHEDULE OF VALUES FORMAT AND CONTENT

A. Organization and Major Elements of Schedule of Values
   1. Prepare Schedule of Values on the "progress estimate" or "continuation sheets", as applicable, of the Application for Payment form indicated in Section 01 29 76, Progress Payment Procedures.

2. Include in Schedule of Values itemized list of Work for each major work area included in the Work, for each payment item specified in Section 01 22 13, Measurement and Payment.
3. Organization in Accordance with Specification Sections:
   a. Within each work area, organize the Schedule of Values by the various Specifications Section numbers and titles included in the Contract Documents.
   b. Label each row in the Schedule of Values with the appropriate Specifications Section number. Include an amount for each row in the Schedule of Values.
   c. List sub-items of major products or systems, as appropriate or when requested by ENGINEER.
4. Include in Schedule of Values unit price payment items with their associated quantity. Provide in the Schedule of Values detailed breakdown of unit prices when required by ENGINEER.

B. Requirements for preliminary Schedule of Values and Schedule of Values are:
1. Subcontracted Work:
   a. Schedule of Values shall show division of Work between CONTRACTOR and Subcontractors.
   b. Line items for Work to be done by Subcontractor shall include the word, "(SUBCONTRACTED)".
2. Apportionment between Materials and Equipment, and Installation:
   a. Schedule of Values shall include breakdown of costs for materials and equipment, installation, and other costs used in preparing the Bid by CONTRACTOR and each Subcontractor.
   b. List purchase and delivery costs for materials and equipment for which CONTRACTOR may apply for payment as stored materials.
3. Sum of individual values shown on the Schedule of Values shall equal the total of associated payment item. Sum of payment item totals in the Schedule of Values shall equal the Contract Price.
4. Overhead and Profit: Include in each line item a directly proportional amount of CONTRACTOR's overhead and profit. Do not include overhead and profit as separate item(s).
5. Include separate line item for each allowance, and for each unit price item.
6. Bonds and Insurance Costs: Include line item for bonds and insurance in payment item 1, in amount not exceeding 2.0 percent of the Contract Price. This amount may be applied for in the first Application for Payment.
7. Include relevant items for the General Conditions, permits (when applicable), construction Progress Schedule, and other items required by ENGINEER. Include such items in Applications for Payment on payment schedule acceptable to ENGINEER.
8. Line items for Site maintenance such as dust control, snow removal, compliance with storm water pollution prevention plans and permits, spill prevention control and countermeasures plans, and for construction photographic documentation; temporary utilities and temporary facilities, field offices, temporary controls, field engineering, and similar Work shall be included in the Schedule of Values and proportioned in Applications for Payment throughout duration of the Work.

9. Mobilization and Demobilization:
   a. Include separate line items under each appropriate payment item for mobilization and demobilization. Document for ENGINEER the activities included in mobilization and demobilization line items.
   b. Mobilization and demobilization will be limited to five (5) percent of the Contract Price, and will be paid in two (2) equal payments, each of 50 percent of total amount.
   c. Demobilization shall be included with the Application for Payment following Substantial Completion, or other schedule acceptable to ENGINEER.
11. Project Record Documents:
   b. Adequate record documents shall be maintained to be eligible for payment, spread evenly over progress payments in which construction at the Site is performed.
   c. Remainder of Project record documents line item will be eligible for payment when complete record documents are submitted in accordance with the Contract Documents. If record documents submitted are unsatisfactory to ENGINEER, amount may be reduced via set-offs in accordance with the Contract Documents.
12. Schedule of Values shall include an itemized list of Work by work area, as applicable, for Work included in Section 01 14 16, Coordination with Owner's Operations.
13. Coordinate Schedule of Values with cost-loading of the Progress Schedule, in accordance with Section 01 32 16, Progress Schedule.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 29 76

PROGRESS PAYMENT PROCEDURES

PART 1 – GENERAL

1.1 PROGRESS PAYMENTS

A. Scope:
   1. CONTRACTOR's requests for payment shall be in accordance with the Agreement, General Conditions and Supplementary Conditions, and the Specifications.
   2. Form: Applications for Payment shall be in the form of Engineers Joint Contract Documents Committee (EJCDC) document EJCDC® C-620, "Contractor's Application for Payment", 2013 edition or later.

B. Procedure:
   1. Review with Resident Project Representative (RPR) quantities and the Work proposed for inclusion in each progress payment. Application for Payment shall cover only the Work and quantities recommended by the RPR.
   2. CONTRACTOR will be required to review with ENGINEER or RPR the status of record documents in connection with ENGINEER's review of each Application for Payment. Failure to maintain record document current will be just cause for ENGINEER to recommend a reduction in payment for record documents in accordance with Section 01 29 73, Schedule of Values, and will entitle OWNER to set-offs in accordance with the Contract Documents.
   3. Submit to ENGINEER electronic, fully functional PDF format, with CONTRACTOR's original, "wet" signature, of each complete Application for Payment and other documents to accompany the Application for Payment.
   4. ENGINEER will act on request for payment in accordance with the General Conditions and Supplementary Conditions.

C. Each request for progress payment shall include:
   1. Completed Application for Payment form, including summary/signature page, progress estimate sheets, and stored materials summary. Progress estimate sheets shall have the same level of detail as the Schedule of Values.
   2. Documentation for Stored Materials and Equipment:
      a. For materials and equipment not incorporated in the Work but suitably stored, submit documentation in accordance with the General Conditions and Supplementary Conditions.
      b. Legibly indicate on invoice or bill of sale the specific materials or equipment included in the payment request and corresponding bid/payment item number for each.
   3. For Payment on the Basis of Cost of the Work.

a. When Work included in an Application for Payment will be compensated on the basis of Cost of the Work, whether when the entire Contract is compensated on the basis of Cost of the Work or when the Application for Payment includes Change Order Work to be compensated on the basis of Cost of the Work, the Application for Payment shall include documentation of the costs, including not less than the following:
   1) Number and labor classifications of workers employed and hours worked.
   2) Construction equipment used including manufacturer, model, and year of manufacture, and number of hours such equipment was onsite and used for the Work compensated on the basis of Cost of the Work.
   3) Consumables and similar materials used.
   4) Receipts, bills, or invoices for and descriptions of materials and equipment incorporated into the Work.
   5) Invoices and labor and equipment breakdowns for Subcontractors and Suppliers.
   6) Invoices for other expenses included in the Application for Payment, such as travel and subsistence expenses, costs for bonds and insurance, and all other costs and expenses for which compensation is sought in the subject Application for Payment on the basis of Cost of the Work.
   7) Other information required by OWNER or ENGINEER,

b. Costs for which progress payment is requested on the basis of Cost of the Work and for which documentation acceptable to ENINEER is not submitted will not be eligible for payment.

5. Listing of Subcontractors and Suppliers:
   a. In accordance with the General Conditions, submit not less than monthly updated listing of all Subcontractors and Suppliers known to CONTRACTOR, whether or not such entities have a contract directly with CONTRACTOR.
   b. Submit complete information using the form attached to this Section.
6. Partial Release or Reduction of Retainage:
   a. For each Application for Payment where CONTRACTOR requests partial release or reduction of retainage in any amount (other than request for final payment), submit with associated progress payment request consent of surety to partial release or reduction of retainage, duly completed by CONTRACTOR and surety.
   b. Acceptable form includes AIA® G707A™, "Consent of Surety to Reduction in or Partial Release of Retainage", 1994 or later edition, or other form acceptable to OWNER.
   c. For payment requests that include reduction in or payment of retainage in an amount greater than that required by the Contract Documents, obtain OWNER's concurrence for partial release or reduction in retainage prior to submitting such Application for Payment.

D. Final Payment:
   1. Requirements for request for final payment are in the General Conditions, as may be modified by the Supplementary Conditions.

1.2 PAYMENT FOR STORED MATERIALS AND EQUIPMENT

A. Observation of Stored Materials and Equipment Prior to Application for Payment:
   1. General:
      a. Prior to materials or equipment suitably stored but not yet incorporated into the Work can be eligible for payment, ENGINEER or Resident Project Representative (RPR) shall visit the storage location and verify the extent, condition, and storage environment of the stored items.
      b. When the same material or equipment item is stored for more than two months, such visits to storage location shall be not less than once every two months.
   2. Cost Responsibility for Observations:
      a. When storage location is less than 20 miles from the Site or less than 20 miles from ENGINEER's office, CONTRACTOR is not responsible for reimbursing OWNER for cost of ENGINEER's time and expenses for observing stored materials and equipment.
      b. When storage location is more than 20 miles from the Site and more than 20 miles from ENGINEER's office, CONTRACTOR shall reimburse OWNER, via a set-off under the Contract Documents, for cost of ENGINEER's time and expenses, including travel time, to visit the storage location and observe the stored materials and equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 ATTACHMENTS

A. The forms listed below, following this Section's "End of Section" designation, are part of this Specification Section:
   1. List of Subcontractors and Suppliers form (two pages).

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

LIST OF SUBCONTRACTORS AND SUPPLIERS

Owner: _____
Project Name: _____

Contractor: _____ Date: _____
Contract Designation: _____

Indicate below complete information for each Subcontractor and Supplier known to Contractor, regardless of whether the firm has a direct contract with Contractor. Include all lower-tier Subcontractors and associated Suppliers. Copy and paste the paragraphs below as required to indicate all Subcontractors and Suppliers.

SUBCONTRACTORS

1. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

2. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:
   - *Approximate Subcontract Start Date*:
   - *Approximate Subcontract End Date*:

3. **Subcontractor Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Work Under Specifications Section Nos.*:
   - *Brief Description of Work*:
   - *Current Subcontract Price*:

- *Approximate Subcontract Start Date*:
- *Approximate Subcontract End Date*:

Total of Subcontract Prices for all subcontracts equals approximately ___ percent of the Contract Price *(Contractor to fill in blank monthly)*

SUPPLIERS

1. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

2. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

3. **Supplier Name**:
   - *Address*:
   - *Contact Person*:
   - *Telephone No.*:
   - *E-mail Address*:
   - *Furnishing Items Under Specifications Section Nos.*:
   - *Brief Description of Items*:
   - *Current Purchase Order Amount*:
   - *Approximate Purchase Order Date*:
   - *Approximate Purchase Order End Date*:

SECTION 01 31 13

PROJECT COORDINATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall coordinate the Work, including testing agencies whether hired by CONTRACTOR, OWNER, or others; Subcontractors, Suppliers, and others with whom coordination is necessary, in accordance with the General Conditions, Supplementary Conditions, and this Section, to perform the Work within the Contract Times and in accordance with the Contract Documents.

B. Coordination:
   1. In accordance with the General Conditions as may be modified by the Supplementary Conditions, CONTRACTOR shall cooperate with and coordinate the Work with other contractors, utility owners, utility service companies, OWNER's and facility manager's employees working at the Site, and other entities working at the Site, in accordance with Section 01 11 13, Summary of Work.
   2. CONTRACTOR will not be responsible or liable for damage unless damage is through negligence of CONTRACTOR, or Subcontractors, Supplier, or other entity employed by CONTRACTOR.
   3. Attend and participate in all project coordination and progress meetings, and report on the progress of the Work and compliance with the Progress Schedule.

C. Layout and Coordination Drawings:
   1. Maintain sufficient competent personnel, drafting and computer-aided drafting/design (CADD) equipment, software, systems, and supplies at the Site for preparing layout drawings, coordination drawings, and record documents.
   2. With the Contract Documents and Shop Drawings, use such coordination drawings as tools for coordinating the Work of various trades.
   3. Where such coordination drawings are to be prepared by mechanical, electrical, plumbing, or heating-ventilating-air conditioning Subcontractors and other Subcontractors, ensure that each Subcontractor maintains required personnel and facilities at the Site.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 31 19.13

PRE-CONSTRUCTION CONFERENCE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. A pre-construction conference will be held for the Project.
   2. CONTRACTOR shall attend the conference prepared to discuss all items on the pre-construction conference agenda.
   3. ENGINEER will distribute an agenda, preside at conference, and prepare and distribute minutes to all conference participants and others as requested.

B. Purpose of Pre-construction Conference:
   1. Purpose of conference is to designate responsible personnel, establish working relationships, discuss preliminary schedules submitted by CONTRACTOR, and review administrative and procedural requirements for the Project.
   2. Matters requiring coordination will be discussed and procedures for handling such matters will be established.
   3. Unless otherwise indicated in the Contract Documents or otherwise agreed to by the entities involved, Site mobilization meeting will be part of the pre-construction conference.

1.2 PREPARATION FOR PRE-CONSTRUCTION CONFERENCE

A. Date, Time, and Location:
   1. Conference will be held after execution of the Contract and before Work starts at the Site.
   2. ENGINEER will establish the date, time, and location of conference and notify the interested and involved entities.

B. Submittals Required Prior to Pre-Construction Conference:
   1. Not less than three days prior to pre-construction conference, submit the following preliminary schedules in accordance with the General Conditions and other requirements of the Contract Documents:
      a. Preliminary Progress Schedule.
      b. Preliminary Schedule of Submittals.
      c. Preliminary Schedule of Values.
      d. Listing of identity and general scope of Work or supply (as applicable) of planned Subcontractors and Suppliers. Indicate extent of each Subcontract proposed and overall percentage of Contract Price to be subcontracted.

C. CONTRACTOR shall furnish information required and contribute appropriate items for discussion at the pre-construction conference.

D. Handouts for Pre-Construction Conference:
   1. CONTRACTOR shall bring to the conference the following, with sufficient number of copies for each attendee:
      a. Preliminary Progress Schedule, as submitted to ENGINEER.
      b. Preliminary Schedule of Submittals, as submitted to ENGINEER.
      c. Preliminary Schedule of Values, as submitted to ENGINEER.
      d. Listing of identity and general scope of Work or supply of planned Subcontractors and Suppliers.
      e. List of emergency contact information, in accordance with Article 1.5 of Section 01 35 23, Safety Requirements.

1.3 REQUIRED ATTENDEES

A. Representative of each entity attending the conference shall be authorized to act on that entity's behalf.

B. Contractor Attendance: Conference shall be attended by CONTRACTOR's:
   1. Project manager.
   2. Site superintendent

C. Other attendees will be representatives of:
   1. OWNER.
   2. ENGINEER.
   3. Resident Project Representative (RPR).
   4. Authorities having jurisdiction over the Work, if available.
   5. Utility owners, as applicable.
   6. Others as requested by OWNER, CONTRACTOR, or ENGINEER.

1.4 AGENDA

A. Preliminary Agenda: Be prepared to discuss in detail the topics indicated below. Revisions, if any, to the agenda below will be furnished to required attendees prior to the pre-construction conference.
   1. Procedural and Administrative:
      a. Personnel and Teams:
         1) Designation of roles and personnel.
         2) Limitations of authority of personnel, including personnel who will sign Contract modifications and make binding decisions.
         3) Subcontractors and Suppliers in attendance.
         4) Authorities having jurisdiction.
      b. Procedures for communications and correspondence, including electronic communication protocols.

c. Copies of the Contract Documents and availability.
d. Subcontractors and Suppliers.
   1) Lists of proposed Subcontractors and Suppliers.
e. The Work and Scheduling:
   1) General scope of the Work.
   2) Contract Times, including Milestones (if any).
   3) Phasing and sequencing.
   4) Preliminary Progress Schedule.
   5) Critical path activities.
f. Safety:
   1) Responsibility for safety.
   2) Contractor's safety representative.
   3) Emergency procedures and accident reporting.
   4) Emergency contact information.
   5) Confined space entry permits.
   6) Hazardous materials communication program.
   7) Impact of Project on public safety.
g. Permits.
h. Review of insurance requirements and insurance claims.
i. Coordination:
   1) Project coordination, and coordination among contractors.
   2) Construction coordinator.
   3) Coordination with Owner's operations.
   4) Progress meetings.
   5) Preliminary Schedule of Submittals.
   6) Procedures for furnishing and processing submittals.
   7) Work not eligible for payment until submittals are approved or accepted (as required).
   8) Construction photographic documentation.
j. Substitutes and "Or-Equals":
   1) Product options.
   2) Procedures for proposing "or-equals".
   3) Procedures for proposing substitutes.
k. Contract Modification Procedures
   1) Requests for interpretation
   2) Written clarifications
   3) Field Orders
   4) Proposal Requests
   5) Change Proposals
   6) Work Change Directives.
   7) Change Orders.
   8) Procedure for Claims and dispute resolution
l. Payment:
   1) Owner's Project financing and funding, as applicable.
   2) Owner's tax-exempt status.

3) Preliminary Schedule of Values
4) Procedures for measuring for payment.
5) Retainage.
6) Progress payment procedures.
7) Prevailing wage rates and payrolls.

m. Testing and inspections, including notification requirements.
n. Disposal of demolition materials.
o. Record documents.
p. Preliminary Discussion of Contract Closeout:
1) Procedures for Substantial Completion.
2) Contract closeout requirements.
3) Correction period.
4) Duration of bonds and insurance.

2. Site Mobilization:
a. Working hours and overtime.
b. Field offices, storage trailers, and staging areas.
c. Temporary facilities.
d. Temporary utilities and limitations on utility consumption (where applicable).
e. Utility company coordination (if not done as a separate meeting).
f. Access to Site, access roads, and parking for construction vehicles.
g. Maintenance and protection of traffic.
h. Use of Site and premises.
i. Protection of property.
j. Security.
k. Temporary controls, such as sediment and erosion controls, noise controls, dust control, storm water controls, and other such measures.
l. Site barriers and temporary fencing.
m. Storage of materials and equipment.
n. Reference points and benchmarks; surveys and layouts.
o. Site maintenance during the Project.
p. Cleaning and removal of trash and debris.
q. Restoration.

3. General discussion and questions.
4. Next meeting.
5. Site visit, if required.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 31 19.23

PROGRESS MEETINGS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Progress meetings will be held throughout the Project. CONTRACTOR shall attend each progress meeting prepared to discuss in detail all items on the agenda.
   2. ENGINEER will preside at progress meetings and will prepare and distribute minutes of progress meetings to all meeting participants and others as requested.

1.2 PREPARATION FOR PROGRESS MEETINGS

A. Date and Time:
   1. Regular Meetings: Every week on a day and time agreeable to OWNER, ENGINEER, and CONTRACTOR.
   2. Other Meetings: As required.

B. Location:
   1. CONTRACTOR's field office at the Site or other location mutually agreed upon by OWNER, CONTRACTOR, and ENGINEER.

D. Handouts:
   1. CONTRACTOR shall bring to each progress meeting not less than 8 copies of each of the following:
      a. List of Work accomplished since the previous progress meeting.
      b. Up-to-date Progress Schedule.
      c. Up-to-date Schedule of Submittals.
      d. Detailed "look-ahead" schedule of Work planned through the next progress meeting, with specific starting and ending dates for each activity, including shutdowns, deliveries of important materials and equipment, Milestones (if any), and important activities affecting the OWNER, Project, and Site.
      e. When applicable, list of upcoming, planned time off (with dates) for personnel with significant roles on the Project, and the designated contact person in their absence.

1.3 REQUIRED ATTENDANCE

A. Representatives present for each entity shall be authorized to act on that entity's behalf.

B. Required Attendees:
   1. CONTRACTOR:

a. Project manager.
b. Site superintendent.
c. Safety representative.
d. When needed for the discussion of a particular agenda item, representatives of Subcontractors and Suppliers shall attend meetings.

2. Construction coordinator (if any).
3. ENGINEER:
   a. Project manager or designated representative
   b. Resident Project Representative (if any).
   c. Others as required by ENGINEER.
4. OWNER's representative(s), as required.
5. Testing and inspection entities, as required.
6. Others, as appropriate.

1.4 AGENDA

A. Preliminary Agenda: Be prepared to discuss in detail the topics listed below. Revised agenda, if any, will be furnished to CONTRACTOR prior to first progress meeting. Progress meeting agenda may be modified by ENGINEER during the Project as required.
   1. Review, comment, and amendment (if required) of minutes of previous progress meeting.
   2. Review of progress since the previous progress meeting.
   3. Planned progress through next progress meeting.
   4. Review of Progress Schedule
      a. Contract Times, including Milestones (if any).
      b. Critical path.
      c. Schedules for fabrication and delivery of materials and equipment.
      d. Corrective measures, if required.
   5. Submittals:
      a. Review status of critical submittals.
      b. Review revisions to Schedule of Submittals.
   6. Contract Modifications
      a. Requests for interpretation.
      b. Written clarifications.
      c. Field Orders.
      d. Proposal Requests.
      e. Change Proposals.
      f. Work Change Directives.
      g. Change Orders.
      h. Claims.
   7. Applications for progress payments.
   8. Problems, conflicts, and observations.
   9. Quality standards, testing, and inspections.
   10. Coordination between parties.
   11. Site management issues, including access, security, maintenance and protection of traffic, maintenance, cleaning, and other Site issues.

12. Safety.
13. Permits.
14. Construction photographic documentation.
15. Record documents status.
16. Punch list status, as applicable.
17. Other business.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 31 26

ELECTRONIC COMMUNICATION PROTOCOLS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section establishes the procedures with which the parties will comply regarding transmission or exchange of electronic data for the Project.
   2. CONTRACTOR shall provide labor, materials, tools, equipment, services, utilities, and incidentals shown, specified, and required for complying with this Section throughout the Project.
   3. This Section does not supersede the General Conditions, as may be modified by the Supplementary Conditions, regarding transmitting of the Contract Documents to CONTRACTOR after the Effective Date of the Contract.
   4. In addition to the requirements of this Section, comply with requirements for exchange of electronic data in the following:
      a. Section 01 32 16, Progress Schedule.
      b. Section 01 32 33, Photographic Documentation.
      c. Section 01 33 00, Submittal Procedures.
      d. Section 01 78 39, Project Record Documents.

B. Coordination:
   1. CONTRACTOR shall require all Subcontractors and Suppliers to comply with the electronic communication protocols established in this Section.

C. Related Sections:
   1. Section 01 32 16, Progress Schedule.
   2. Section 01 32 33, Photographic Documentation.
   3. Section 01 33 00, Submittal Procedures.
   4. Section 01 78 39, Project Record Documents.

1.2 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. “Electronic data” means information, communications, drawings, or designs created or stored for the Project in electronic or digital form.
   2. “Confidential information” means electronic data that the transmitting party has designated as confidential and clearly marked with an indication such as “Confidential”, “Business Proprietary”, or similar designation.
   3. “Written” or “in writing” means any and all communications, including without

limitation a notice, consent, or interpretation, prepared and sent to an address provided in the Contract Documents or otherwise agreed upon by the parties and ENGINEER using a transmission method sent forth in this Section that allows the recipient to print or store the communication. Communications transmitted electronically are presumed received when sent in conformance with this Paragraph 1.2.A.3.

1.3 TRANSMISSION OF ELECTRONIC DATA

A. Transmission of electronic data constitutes a warrant by the transmitting party to the receiving party that the transmitting party is one or more of the following:
   1. The copyright owner of the electronic data.
   2. Has permission from the copyright owner to transmit the electronic data for its use on the Project.
   3. Is authorized to transmit confidential information.

B. Receiving party agrees to keep confidential information confidential and not to disclose it to another person except to (1) its employees, (2) those who need to know the content of the confidential information to perform services or construction solely and exclusively for the Project, or (3) its consultants, contractors, Subcontractors, and Suppliers whose contracts include similar restrictions on the use of electronic data and confidential information.

C. Transmitting party does not convey any right in the electronic data or in the software used to generate or transmit such data. Receiving party may not use electronic data unless permission to do so is provided in the Contract Documents, or in a separate license.

D. Unless otherwise granted in a separate license, receiving party's use, modification, or further transmission of electronic data, as provided the Contract Documents, is specifically limited to the design and construction of the Project in accordance with this Section, and nothing contained in this Section conveys any other right to use the electronic data for any other purpose.

E. To the fullest extent permitted by Laws and Regulations, receiving party shall indemnify and defend the transmitting party from and against all claims arising from or related to receiving party's modification to, or unlicensed use of, electronic data.

F. Means of Transmitting Electronic Data: Unless otherwise indicated in Table 01 31 26-A of this Section or elsewhere in the Contract Documents, transmission of electronic data for the Project will generally be via:
   1. E-mail and files attached to e-mail. Maintain e-mail system capable of transmitting and receiving files not less than 20 megabytes (MB) file size.

1.4 ELECTRONIC DATA PROTOCOLS

A. Comply with the data formats, transmission methods, and permitted uses set forth in Table 01 31 26-A, Electronic Data Protocol Table, below, when transmitting or using electronic

data on the Project. Where a row in the table has no indicated means of transmitting electronic data, use for such documents only printed copies transmitted to the receiving party via appropriate delivery method.

TABLE 01 31 26-A
ELECTRONIC DATA PROTOCOL TABLE (E-MAIL ATTACHMENTS)

Electronic Data	Data Format	Transmitting Party	Transmission Method	Receiving Party	Permitted Uses	Notes
1.4.A.1. Project communications						
General communications & correspondence	EM, PDF	O, E, C	EM, EMA	O, E, C	R	
Meeting notices and agendas	EM, PDF	E	EM, EMA	O, C	R	
Meeting minutes	PDF	E	EM, EMA	O, C	R	
1.4.A.2. Contractor's submittals to Engineer						
Shop Drawings	PDF	C	EMA	E	M (1)	(1)
Product data	PDF	C	EMA	E	M (1)	(1)
Informational and closeout submittals:	PDF	C	EMA	E	M (1)	(1) (6)
Documentation of delivery of maintenance materials submittals	PDF	C	EMA	E	M (1)	
1.4.A.3. Engineer's return of reviewed submittals to Contractor						
Shop Drawings	PDF	E	EMA	O., C	R	
Product data	PDF	E	EMA	O., C	R	
Informational and closeout submittals:	PDF	E	EMA	O., C	R	(6)
Documentation of delivery of maintenance materials submittals	PDF	E	EMA	O. C	R	
1.4.A.4. Contract Modifications Documents						
Requests for interpretation to Engineer	PDF	C., O	EMA	E	M (1)	(1)
Engineer's interpretations (RFI responses)	PDF	E	EMA	C, O	R	
Engineer's clarifications to Contractor	EM, PDF	E	EM, EMA	C, O	R	
Engineer's issuance of Field Orders	PDF	E	EMA	C, O	R	
Proposal Requests	PDF	E, O	EMA	C	R	
Change Proposals – submitted to Engineer	PDF	C	EMA	O, E	S	
Change Proposals – Engineer's response	PDF	E	EMA	C. O		
Work Change Directives (for Contractor signature)	PDF	E	EMA	C	R	(2)
Change Orders (for Contractor signature)	PDF	E	EMA	C	R	(2)
1.4.A.5. Applications for Payment	EM, PDF	C	EMA	E, C	R	(3)
1.4.A.6. Claims and other notices	EM, PDF	C	EMA	E, C	R	(4)
1.4.A.7. Closeout Documents	PDF	C	EMA	C	R	
Record drawings	DWG and PDF	C	EMA	E, O	M (5)	(5)
Other record documents	PDF	C	EMA	E. O	M (5)	(5)
Contract closeout documents	EM, PDF	C	EMA	E, C	R	

B. Key to Electronic Data Protocol Table:

Data Format:

EM .msg, .htm, .txt, .rtf, e-mail text
W .docx, Microsoft® Word 2007 or later
EX .xlsx, Microsoft® Excel 2007 or later
PDF .pdf. Portable Document Format

DWG .dwg. Autodesk AutoCAD 2013 drawing.

Transmitting Party:

O OWNER
C CONTRACTOR
E ENGINEER

Transmission Method:

EM Via e-mail
EMA As an attachment to an e-mail transmission
CD Delivered via compact disc
PW Posted to Project website
FTP FTP transfer to receiving FTP server

Receiving Party:

O OWNER
C CONTRACTOR
E ENGINEER

Permitted Uses:

S Store and view only
R Reproduce and distribute
I Integrate (incorporate additional electronic data without modifying data received)
M Modify as required to fulfill obligations for the Project

Notes:

(1) Modifications by ENGINEER to CONTRACTOR's submittals and requests for interpretations are limited to printing out, marking-up, and adding comment sheets.
(2) May be distributed only to affected Subcontractors and Suppliers. Print out, sign document, and return executed printed copy originals to ENGINEER.
(3) Submit printed Applications for Payment with original ("wet") signatures.
(4) Submit notices, including Claims, in accordance with the notice provisions of the General Conditions, as may be modified by the Supplementary Conditions.
(5) Submit record drawings in native CAD format indicated when CONTRACTOR has executed ENGINEER's standard agreement for release of electronic files. In addition, always submit record drawings as

a PDF file. Comply with requirements of Section 01 78 39, Project Record Documents.

(6) For operation and maintenance data, also submit printed copies as required by Section 01 78 23, Operations and Maintenance Data.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 32 16

PROGRESS SCHEDULE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Prepare and submit Progress Schedules in accordance with the General Conditions (as may be modified by the Supplementary Conditions) and this Section, unless otherwise accepted by ENGINEER.
   2. Maintain and update Progress Schedules. Submit updated Progress Schedules as specified in this Section unless otherwise directed by ENGINEER.
   3. ENGINEER's acceptance of the Progress Schedule, and comments or opinions concerning the activities in the Progress Schedule shall not control CONTRACTOR's independent judgment relative to means, methods, techniques, sequences, and procedures of construction. CONTRACTOR is solely responsible for complying with the Contract Times.

1.2 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Progress Schedules:
      a. Submit preliminary Progress Schedule in accordance with Paragraph 2.03 of the General Conditions. Submit in accordance with Section 01 33 00, Submittal Procedures.
      b. After making revisions in accordance with ENGINEER's comments on the preliminary Progress Schedule, submit the Progress Schedule in accordance with Paragraph 2.05 of the General Conditions. Submit in accordance with Section 01 33 00, Submittal Procedures.
      c. Submit updated Progress Schedule at each progress meeting. If a Progress Schedule remains unchanged from one progress meeting to the next, submit a written statement to that effect. For monthly Progress Schedule submittals, bring to progress meeting the number of printed copies of the updated Progress Schedule specified in Section 01 31 19.23, Progress Meetings, and formally submit in accordance with Section 01 33 00, Submittal Procedures.
      d. Furnish each Progress Schedule submittal with letter of transmittal complying with requirements of Section 01 33 00, Submittal Procedures, and specifically indicating the following:
         1) Listing of activities and dates that have changed since the previous Progress Schedule submittal.
         2) Discussion of problems causing delays, anticipated duration of delays, and proposed countermeasures.

2. Recovery Schedules: Submit in accordance with this Section, and other provisions of the Contract Documents.

1.3 PROGRESS SCHEDULE FORMAT AND CONTENT

A. Format:
   1. Type:
      a. Horizontal bar chart or Gantt chart.
   2. Sheet Size: 11 inches by 17 inches, unless otherwise accepted by ENGINEER.
   3. Time Scale: Indicate first date of each work week.
   4. Organization:
      a. Indicate on the separate Schedule of Submittals dates for submitting and reviewing Shop Drawings, Samples, and other submittals.
      b. Group deliveries of materials and equipment into a separate sub-schedule that is part of the Progress Schedule.
      c. Group construction into a separate sub-schedule (that is part of the Progress Schedule) by activity.
      d. Group critical activities that dictate the rate of progress (the "critical path") into a separate sub-schedule that is part of the Progress Schedule. Clearly indicate the critical path on the Progress Schedule.
      e. Organize each sub-schedule by Specification Section number.
   5. Activity Designations: Indicate title and related Specification Section number.

B. Content: Progress Schedules shall indicate the following:
   1. Delivery dates for materials and equipment to be incorporated into the Work.
   2. Dates for beginning and completing each phase of the Work by activity and by trade.
   3. Dates for start-up and check-out, field-testing.
   4. Dates corresponding to the Contract Times, and planned completion date associated with each Milestone (if any), Substantial Completion, and readiness for final payment.

C. Coordinate the Progress Schedule with the Schedule of Submittals.

1.4 RECOVERY SCHEDULES

A. Recovery Schedules – General:
   1. When updated Progress Schedule indicates that the ability to comply with the Contract Times falls 3 or more days behind schedule, and the delay is within the control of CONTRACTOR, and there is no corresponding Change Order or Work Change Directive to support an extension of the Contract Times, CONTRACTOR shall prepare and submit a Progress Schedule demonstrating CONTRACTOR's plan to accelerate the Work to achieve compliance with the Contract Times ("recovery schedule") for ENGINEER's acceptance.
   2. Submit recovery schedule within 2 days after submittal of updated Progress Schedule where need for recovery schedule is indicated.

B. Implementation of Recovery Schedule:

1. At no additional cost to OWNER, do one or more of the following: furnish additional resources (additional workers, additional construction equipment, increased work hours or additional shifts, and other resources), provide suitable materials, expedite procurement of materials and equipment to be incorporated into the Work, and other measures necessary to complete the Work within the Contract Times.
2. Upon acceptance of recovery schedule by ENGINEER, incorporate recovery schedule into the next Progress Schedule update.

C. Lack of Action:
1. CONTRACTOR's refusal, failure, or neglect to take appropriate recovery action, or to submit a recovery schedule, shall constitute reasonable evidence that CONTRACTOR is not prosecuting the Work or separable part thereof with the diligence that will ensure completion within the Contract Times. Such lack of action shall constitute sufficient basis for OWNER to exercise remedies available to OWNER under the Contract Documents.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 32 33

PHOTOGRAPHIC DOCUMENTATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR to perform services specified, including:
      a. Digital photography.
      b. Digital videography.
   2. Furnish documentation for the following:
      a. Pre-construction video recordings.
      b. Periodic construction photographs or video recordings showing progress as necessary or requested by the ENGINEER.

B. Image Quality:
   1. Photographic documentation shall be of high quality and resolution and must be in color.
   2. Photographic images shall be suitably staged and set up (“framed”), focused, and shall have adequate lighting to illuminate the Work and conditions that are the subject of the photograph.
   3. For still photographs, use camera with minimum 16.0-megapixel resolution.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Photographer:
      a. Photographer shall be regularly engaged in professional photography and experienced in photographing construction sites.
      b. Upon request of ENGINEER, submit documentation of photographer having successfully performed photographic documentation for not less than five previous construction projects within the last five years, each lasting not less than six months.
   2. Videographer:
      a. Videographer shall be a specialist regularly engaged in professional video recording and experienced in recording construction sites.
      b. Upon request of ENGINEER, submit documentation of videographer having successfully performed videographic documentation for not less than five previous construction projects within the last five years, each lasting not less than six months.

B. ENGINEER or Resident Project Representative to be present during photographic periods at site unless approved otherwise by Engineer. Dates for photography at site to be coordinated

with Engineer. Photographic and video subjects, views, and angles will vary with progress of the Work.

C. Photographer and Videographer to make and retain detailed records of all photographs and videos by photographer or videographer under this Contract:
   1. The records to be in sufficient detail to support any attestation that may be required of photographer and/or videographer.
   2. Video recording person to retain such records for a period not less than two years from the final acceptance of entire work under this Contract.

1.3 SUBMITTALS

A. Informational Submittals:
   1. Pre-construction Photographic and Video Documentation: Submit acceptable pre-construction photographic and video documentation (digital files) prior to mobilizing to and disturbing the Site. Submit pre-construction photographic and video documentation not later than the first Application for Payment, unless other schedule for pre-construction photographic and video documentation is accepted by ENGINEER.
   2. Construction Progress Photographic Documentation: Submit acceptable construction progress photographic documentation (digital files) not less-often than monthly. Submit with each Application for Payment, unless otherwise agreed to by ENGINEER.
   3. Qualifications Statements:
      a. When requested by ENGINEER, prior to starting photographic or video documentation, submit photographer and/or videographer qualifications and record of experience. List of construction photography and videography experience shall include the following for each project:
         1) Project name and location
         2) Nature of construction.
         3) Project client with contract information.
         4) Approximate duration of photographic and/or video services.

B. Closeout Submittals:
   1. Final Photographic Documentation: Submit acceptable final photographic and video documentation (digital files) prior to requesting the final inspection by ENGINEER.

C. Form of Digital Submittal – Images on Discs:
   1. Submit digital files on USB thumb drive or digital video discs (DVD).
   2. Submit three copies of each USB or disc with digital files of photographic images.
   3. Include the following information on front of each disc containing photographic documentation:
      a. Date(s) photographs were taken.
      b. Name of OWNER.
      c. Name of the Site.
      d. Project name.

e. Photographer name and address.
f. Name of ENGINEER.
g. Name of CONTRACTOR.

D. Form of Digital Submittal – Video Discs:
1. Submit digital files on USB thumb drive or digital video discs (DVD) in standard DVD-R or DVD+R discs.
2. Submit three copies of each USB or disc with digital files of video.
3. Include the following information on front of each disc containing video documentation:
a. Date(s) video was taken.
b. Name of OWNER.
c. Name of the Site.
d. Project name.
e. Videographer name and address.
f. Name of ENGINEER.
g. Name of CONTRACTOR.
h. Weather conditions at time of recording.

1.4 DOCUMENTATION – GENERAL

A. Photographs:
1. For each photograph taken, furnish high-quality digital image in "JPG" file format compatible with Microsoft Windows 10 or higher operating systems.
2. Image resolution shall be sufficient for clear, high-resolution prints. Minimum resolution shall be 150 dots per inch (dpi). Minimum size of digital images shall be eight-inch by ten-inch size for regular photographs.
3. Imprint date and time in the image.
4. Electronic image filename shall describe the image; do not submit filenames automatically created by digital camera. For example, an acceptable electronic filename would be, "Dewatering Building – Looking West at Centrifuge No. 2.jpg".

C. Videography:
1. Video shall be high-definition (HD), high-quality video of the Site and Project work.
2. Camera shall be mounted on tripod prior to starting recording unless otherwise necessary to show area of construction.
3. All video files for the entire Project shall be submitted in one container file format. Video files shall be in one of the following container file formats:
a. AVI (Microsoft systems).
b. Flash Video (F4V, FLV; Adobe systems).
c. QuickTime File Format (MOV, QT; Apple, Inc.).
d. MP4 ("MPEG-4 Part 14").
4. Video image shall have imprinted date and time that video was taken. Display running time and date.
5. Audio Narration should include the following:

a. At beginning of recording, state the date and time followed by the Project name, Project location, Contractor's name, videographer's name, and weather conditions. Show scenes for record weather conditions from local newspaper or television and the actual temperature reading at Project site.
b. Provide sufficient explanation of scenes shown which may include, but is not limited to, a description of items being viewed, recent events, and planned activities. At each change in location, describe vantage point, location, direction (by compass point), and elevation or story of construction.
c. Confirm date and time at the end of each recording.

6. Provide a typewritten transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.

1.5 PRE-CONSTRUCTION DOCUMENTATION

A. Pre-construction Photographic Documentation:
1. Obtain and submit sufficient pre-construction photographic documentation to record Site conditions prior to construction. Photographs shall document work areas of all prime contracts under the Project.
2. Pre-construction photographs are not part of required number of construction progress photographs specified in Article 1.6 of this Section.
3. Furnish pre-construction video of all work areas included in all prime contracts on the Project, including indoor and outdoor work areas and staging areas.

B. If disagreement arises on the condition of the Site and insufficient pre-construction photographic documentation was submitted prior to the disagreement, CONTRACTOR to restore the grounds or area in question to extent directed by ENGINEER and to satisfaction of ENGINEER.

C. Pre-construction Video Documentation:
1. Prior to beginning construction, record video of Project site and surrounding properties from different vantage points, as directed by Engineer.
2. Flag construction limits before recording pre-construction video.
3. Show existing conditions adjacent to Project site before starting the Work.
4. Show existing structures either on or adjoining Project site to accurately record physical conditions at the start of construction.
5. Show protection efforts by Contractor.

D. If disagreement arises on the condition of the Site and insufficient pre-construction photographic documentation was submitted prior to the disagreement, CONTRACTOR to restore the grounds or area in question to extent directed by ENGINEER and to satisfaction of ENGINEER.

1.6 CONSTRUCTION PROGRESS DOCUMENTATION

A. Progress Photographs:

1. Take photographs not less often than once biweekly.
2. Take not less than five photographs each time photographer is at the Site.
3. Maximum number of progress photographs required will be 30 based on the Contract Times to Substantial Completion of the entire Project and scope of the Project on date the Contract Times commence running. Proportionately modify the extent of photographic documentation if scope of the Project or the Contract Times are modified.
4. Obtain and submit interior and exterior photographic documentation of each structure in the work area as directed by ENGINEER at the time photographic documentation is taken.

1.7 FINAL PHOTOGRAPHIC DOCUMENTATION

A. Final Photographs:
   1. Take photographs at time and day acceptable to ENGINEER. Do not take final photographs prior to Substantial Completion of the entire Project. Work documented in final photographs shall be generally complete, including painting and finishing, furnishings, landscaping, and other visible Work.
   2. Take not less than 10 final photographs, based on scope of the Project at the time that the Contract Times commence running. Proportionately modify the number of final photographs if scope of Project is modified. Final photographs are not part of construction progress photographs required under Paragraph 1.6.A of this Section.
   3. Obtain and submit aerial photographs of the Site following completion of restoration and landscaping, with final photographic documentation submittal. Furnish one oblique photograph taken from each cardinal direction (north, south, east, and west). Obtain permits or permission, as applicable, for required flyovers.

B. Video:
   1. Record final video at same time that final photographs are taken.
   2. Final videography shall cover all areas of the Project.

1.8 USAGE RIGHTS

Obtain and transfer copyright usage rights from photographer to Owner for unlimited reproduction of photographic documentation.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 33 00

SUBMITTAL PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall prepare and furnish submittals in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section.
   2. Provide submittals well in advance of need for the material or equipment, or procedure (as applicable), in the Work and with ample time required for delivery of materials and equipment and to implement procedures following ENGINEER's approval or acceptance of the associated submittal. Work covered by a submittal will not be included in progress payments until approval or acceptance of related submittals has been obtained in accordance with the Contract Documents.
   3. CONTRACTOR is responsible for dimensions to be confirmed and corrected at the Site; quantities; information pertaining solely 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. CONTRACTOR's signature of submittal's stamp and letter of transmittal shall be CONTRACTOR's representation that CONTRACTOR has complied with his obligations under the Contract Documents relative to that submittal. ENGINEER and OWNER shall be entitled to rely on such representations by CONTRACTOR.
   5. Provisions of the General Conditions, as may be modified by the Supplementary Conditions, apply to all CONTRACTOR-furnished submittals required by the Contract Documents, regardless of whether such submittals are other than Shop Drawings or Samples.

B. Samples:
   1. Submittal of Samples shall comply with the General Conditions, as may be modified by the Supplementary Conditions, this Section, and the Specifications Section in which the Sample is specified.
   2. Furnish at the same time those Samples and submittals that are related to the same element of the Work or Specifications Section. ENGINEER will not review submittals without associated Samples, and will not review Samples without associated submittals.
   3. Samples shall clearly illustrate functional characteristics of materials, all related parts and attachments, and full range of color, texture, pattern, and materials.

C. Restrictions on Quantity of Submittals and Compensation of OWNER:
   1. CONTRACTOR shall furnish required submittals with sufficient information and accuracy to obtain required approval or acceptance of submittal by ENGINEER with

not more than the number of resubmittals indicated in the General Conditions (as may be modified by the Supplementary Conditions).

2. Total number of CONTRACTOR's submittals shall not exceed 25 percent above the total number of first-time submittals indicated in the Schedule of Submittals initially accepted by ENGINEER in accordance with the General Conditions. ENGINEER will record ENGINEER's time for reviewing submittals of Shop Drawings, Samples, and other submittals and items requiring approval or acceptance, beyond the quantity of first-time submittals indicated in the Schedule of Submittals initially accepted by ENGINEER, and CONTRACTOR shall reimburse OWNER for ENGINEER's charges for such time.
3. In the event that CONTRACTOR requests a substitution for a previously approved item, Contractor shall reimburse OWNER for ENGINEER's charges for such time unless the need for such substitution is beyond the control of CONTRACTOR.
4. OWNER may impose set-offs against CONTRACTOR for the costs for which CONTRACTOR is to reimburse or compensate OWNER, in accordance with the General Conditions.

1.2 TYPES OF SUBMITTALS

A. Submittal types are classified as follows: 1) Action Submittals, 2) Informational Submittals, 3) Closeout Submittals, and 4) Maintenance Material submittals. Type of each required submittal is designated in the respective Specifications Sections; when type of submittal is not designated in the associated Specification Section, submittal will be classified as follows:
   1. Action Submittals include:
      a. Shop Drawings.
      b. Product data.
      c. Delegated design submittals, which include documents prepared, sealed, and signed by a design professional retained by CONTRACTOR, Subcontractor, or Supplier for materials and equipment to be incorporated into the completed Work. Delegated design submittals do not include submittals related to temporary construction unless specified otherwise in the related Specifications Section. Delegated design submittals include: design drawings, design data including calculations, specifications, certifications, and other submittals prepared by such design professional.
      d. Samples.
      e. Testing plans, procedures, and testing limitations.
   2. Informational Submittals include:
      a. Certificates.
      b. Design data not sealed and signed by a design professional retained by CONTRACTOR, Subcontractor, or Supplier.
      c. Pre-construction test and evaluation reports, such as reports on pilot testing, subsurface investigations, testing for a potential Hazardous Environmental Condition, and similar reports.
      d. Supplier instructions, including installation data, and instructions for handling, starting-up, and troubleshooting.

e. Supplier reports.
f. Sustainable design submittals (other than sustainable design closeout documentation).
g. Special procedure submittals, including plans for shutdowns and tie-ins and other procedural submittals.
h. Qualifications statements.
i. Administrative submittals including:
1) Progress Schedules.
2) Schedules of Submittals.
3) Schedules of Values.
4) Photographic documentation.
5) Coordination drawings, when submittal of such is required.
6) Copies of permits obtained by CONTRACTOR.
7) Field engineering reports, survey data, and similar information.

3. Closeout Submittals include:
a. Maintenance contracts.
b. Operations and maintenance data.
c. Bonds, such as special maintenance bonds and bonds for a specific material, equipment item, or system.
d. Warranty documentation.
e. Record documentation.
f. Sustainable design closeout documentation.
g. Software.
h. Keying.

4. Maintenance Material Submittals include:
a. Spare parts.
b. Extra stock materials.
c. Tools.

5. When type of submittal is not specified and is not included in the list above, request an interpretation from ENGINEER and ENGINEER will determine the type of submittal.

B. Not Included in this Section: Administrative and procedural requirements for following are covered elsewhere in the Contract Documents:
1. Requests for interpretations of the Contract Documents.
2. Change Orders, Work Change Directives, and Field Orders.
3. Applications for Payment
4. Reports, documentation, and permit applications required to be furnished by CONTRACTOR to authorities having jurisdiction.

1.3 REQUIREMENTS FOR SCHEDULE OF SUBMITTALS

A. Informational Submittals: Submit the following:
1. Schedule of Submittals:
a. Timing:
1) Furnish submittal within time frames indicated in the Contract Documents.

2) Submit updated Schedule of Submittals with each submittal of the updated Progress Schedule.

b. Content: In accordance with the General Conditions, as may be modified by the Supplementary Conditions, and this Section. Requirements for content of preliminary Schedule of Submittals and subsequent submittals of the Schedule of Submittals are identical. Identify on Schedule of Submittals all submittals required in the Contract Documents. Updates of Schedule of Submittals shall show scheduled dates and actual dates for completed tasks. Indicate submittals that are on the Project's critical path. Indicate the following for each submittal:
   1) Date by which submittal will be received by ENGINEER.
   2) Whether submittal will be for a substitution or "or-equal". Procedures for requesting approval of substitutes and "or-equals" are specified in the General Conditions, Section 01 25 00, Substitution Procedures, and Section 01 62 00, Product Options (for "or-equals").
   3) Date by which ENGINEER's response is required. Not less than 10 work days shall be allowed for ENGINEER's review, starting upon ENGINEER's actual receipt of each submittal. Allow increased time for large or complex submittals.
   4) For submittals for materials or equipment, date by which material or equipment must be at the Site to avoid delaying the Work and to avoid delaying the work of other contractors, if any.

c. Prepare Schedule of Submittals using same software, and in same format, specified for Progress Schedules in Section 01 32 16, Progress Schedule.

d. Coordinate Schedule of Submittals with the Progress Schedule.

e. Schedule of Submittals that is not compatible with the Progress Schedule, or that does not indicate submittals on the Project's critical path, or that that places extraordinary demands on ENGINEER for time and resources, is unacceptable. Do not include submittals not required by the Contract Documents.

f. In preparing Schedule of Submittals:
   1) Considering the nature and complexity of each submittal, allow sufficient time for review and revision.
   2) Reasonable time shall be allowed for: ENGINEER's review and processing of submittals, for submittals to be revised and resubmitted, and for returning submittals to CONTRACTOR.
   3) Identify and accordingly schedule submittals that are expected to have long anticipated review times.

1.4 PROCEDURE FOR SUBMITTALS

A. Submittal Identification System: Use the following submittal identification system, consisting of submittal number and review cycle number.
   1. Submittal Number: Shall be separate and unique number correlating to each individual submittal required. Assign submittal numbers as follows:
      a. First part of submittal number shall be the applicable Specifications Section number, followed by a hyphen.

b. Second part of submittal number shall be a three-digit number (sequentially numbered from 001 through 999) assigned to each separate and unique submittal furnished under the associated Specifications Section.
c. Typical submittal number for the third submittal furnished for Section 40 05 19, Ductile Iron Process Pipe, would be "40 05 19-003".

2. Review Cycle Number: Shall be a letter designation indicating the initial submittal or re-submittal associated with each submittal number:
   a. "A" = Initial (first) submittal.
   b. "B" = Second submittal (e.g., first re-submittal).
   c. "C" = Third submittal (e.g., second re-submittal).
3. Examples:

Example Description	Submittal Identification	
	Submittal No.	**Review Cycle**
Initial (first) review cycle of the third submittal provided under Section 40 05 19, Ductile Iron Process Pipe	40 05 19-003-	A
Second review cycle (first re-submittal) of third submittal provided under Section 40 05 19, Ductile Iron Process Pipe	40 05 19-003-	B

B. Letter of Transmittal for Submittals:
1. Furnish separate letter of transmittal with each submittal. Each submittal shall be for one Specifications Section.
2. At beginning of each letter of transmittal, include a reference heading indicating: CONTRACTOR's name, OWNER's name, Project name, Contract designation, transmittal number, and submittal number.
3. For submittals with proposed deviations from requirements of the Contract Documents, letter of transmittal shall specifically describe each proposed variation.

C. Contractor's Review and Stamp:
1. Contractor's Review: Before transmitting submittals to ENGINEER, review submittals to:
   a. ensure proper coordination of the Work;
   b. determine that each submittal is in accordance with CONTRACTOR's desires;
   c. verify that submittal contains sufficient information for ENGINEER to determine compliance with the Contract Documents.
2. Incomplete or inadequate submittals will be returned without review.
3. Contractor's Stamp and Signature:
   a. Each submittal furnished shall bear CONTRACTOR's stamp of approval and signature, as evidence that submittal has been reviewed by CONTRACTOR and verified as complete and in accordance with the Contract Documents.
   b. Submittals without CONTRACTOR's stamp and signature will be returned without review. Signatures that appear to be computer-generated will be regarded as unsigned and the associated submittal will be returned without review.
   c. CONTRACTOR's stamp shall contain the following:

"Project Name: _____

Contractor's Name: _____

Contract Designation: _____

Date: _____

---------- *Reference* ----------

Submittal Title: _____

Specifications:

Section: _____

Page No.: _____

Paragraph No.: _____

Drawing No.: _____ of _____

Location of Work: _____

Submittal No. and Review Cycle: _____

Coordinated by Contractor with Submittal Nos.: _____

_____

I hereby certify that the Contractor has satisfied Contractor's obligations under the Contract Documents relative to Contractor's review and approval of this submittal.

Approved for Contractor by: _____"

D. Submittal Marking and Organization:
   1. Mark each page of submittal and each individual component submitted with submittal number and applicable Specifications paragraph. Mark each page of each submittal with the submittal page number.
   2. Arrange submittal information in same order as requirements are written in the associated Specifications Section.
   3. Each Shop Drawing sheet shall have title block with complete identifying information satisfactory to ENGINEER.
   4. Package together submittals for the same Specifications Section. Do not furnish required information piecemeal.

E. Format of Submittal and Recipients:
   1. Action Submittals and Informational Submittals: Furnish in accordance with Table 01 33 00-A, except that submittals of Samples shall be as specified elsewhere in this Section.

TABLE 01 33 00-A: SUBMITTAL CONTACTS AND REQUIRED FORMAT

	Address for Deliveries	Contact Person	E-mail Address	Format*	No. of Printed

					Copies
a.	Engineer: ARADIS U.S., Inc., 400 East Main Street El Paso, TX, 79901	Joel Mora	Joel.Mora@arcadis.com	E	Zero
b.	Resident Project Representative: At the Site.	TBD	TBD	E & P	One
* **Format**: E = Electronic files; P = Printed copies. TBD = To Be Determined					

2. Samples:
   a. Securely label or tag Samples with submittal identification number. Label or tag shall include clear space at least four inches by four inches in size for affixing ENGINEER's review stamp. Label or tag shall not cover, conceal, or alter appearance or features of Sample. Label or tag shall not be separated from the Sample.
   b. Submit quantity of Samples required in Specifications. If quantity of Samples is not indicated in the associated Specifications Section, furnish not less than three identical Samples of each item required for ENGINEER's approval. Samples will not be returned to CONTRACTOR. If CONTRACTOR requires Sample(s) for CONTRACTOR's use, so advise ENGINEER in writing and furnish additional Sample(s). CONTRACTOR is responsible for furnishing, shipping, and transporting additional Samples.
   c Deliver one Sample to ENGINEER's field office at the Site. Deliver balance of Samples to ENGINEER at address indicated in Table 01 33 00-A, unless otherwise directed by ENGINEER.
3. Closeout Submittals:
   a. Furnish the following Closeout Submittals in accordance with Table 01 33 00-A: maintenance contracts; bonds for specific materials, equipment, or systems; warranty documentation; and sustainable design closeout documentation. On documents such as maintenance contracts and bonds, include on each document furnished original ("wet") signature of entity issuing said document. When original "wet" signatures are required, furnish such submittals in printed form and electronic form to ENGINEER, and to other entities furnish as indicated in Table 01 33 00-A.
   b. Record Documentation: Submit in accordance with Section 01 78 39, Project Record Documents.
   c. Software: Submit number of copies required in Specifications Section where the software is specified. If number of copies is not specified, provide two copies on compact disc in addition to software loaded on OWNER's computer(s) or microprocessor(s).

F. Electronic Submittals:
1. Format: Electronic files shall be in "portable document format" (.PDF). Files shall be electronically searchable.
2. Organization and Content:
   a. Each electronic submittal shall be one file; do not divide individual submittals into multiple files each.

b. When submittal is large or contains multiple parts, furnish PDF file with bookmark for each section of submittal.
c. Content shall be identical to printed submittal. First page of electronic submittal shall be CONTRACTOR's letter of transmittal.

3. Quality and Legibility: Electronic submittal files shall be made from the original and shall be clear and legible. Do not submit scans of faxed copies. Electronic file shall be full size of original, printed documents. Properly orient all pages for reading on a computer screen.
4. Provide sufficient Internet service and e-mail capability for CONTRACTOR's use in transferring electronic submittals, receiving responses to electronic submittals, and associated electronic correspondence. Check not less than once per day for distribution of electronic submittals, electronic responses to submittal, and electronic correspondence related to submittals.

G. Distribution:
1. Distribution of ENGINEER's Response via Electronic Files: Upon completion of ENGINEER's review, electronic submittal response will be distributed by ENGINEER to
a. CONTRACTOR.
b. Other prime contractors.
c. OWNER.
d. Resident Project Representative (RPR).
e. ENGINEER's file.

H. Resubmittals: Refer to the General Conditions for requirements regarding resubmitting required submittals.

1.5 ENGINEER'S REVIEW

A. Timing: ENGINEER's review will conform with timing indicated in the Schedule of Submittals accepted by ENGINEER.

B. Submittals not required by the Contract Documents will not be reviewed by ENGINEER and will not be recorded in ENGINEER's submittal log. All printed copies of such submittals will be returned to CONTRACTOR. Electronic copies of such submittals, if any, will not be retained by ENGINEER.

C. Action Submittals, Results of ENGINEER's Review: Each submittal will be given one of the following dispositions by ENGINEER:
1. Approved: Upon return of submittal marked "Approved", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents.
2. Approved as Corrected: Upon return of submittal marked "Approved as Corrected", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control

submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents, and in accordance with the corrections indicated in the ENGINEER's submittal response.

3. Approved as Corrected – Resubmit: Upon return of submittal marked "Approved as Corrected – Resubmit", order, ship, or fabricate materials and equipment included in the submittal (pending ENGINEER's approval or acceptance, as applicable, of source quality control submittals) or otherwise proceed with the Work in accordance with the submittal and the Contract Documents, and in accordance with corrections indicated in ENGINEER's submittal response. Furnish to ENGINEER record re-submittal with all corrections made. Receipt of corrected re-submittal is required before materials or equipment covered in the submittal will be eligible for payment.
4. Revise and Resubmit: Upon return of submittal marked "Revise and Resubmit", make the corrections indicated and re-submit to ENGINEER for approval.
5. Not Approved: This disposition indicates material or equipment that cannot be approved. "Not Approved" disposition may also be applied to submittals that are incomplete. Upon return of submittal marked "Not Approved", repeat initial submittal procedure utilizing approvable material or equipment, with a complete submittal clearly indicating all information required.

D. Informational Submittals, Results of ENGINEER's Review:
1. Each submittal will be given one of the following dispositions:
   a. Accepted: Information included in submittal complies with the applicable requirements of the Contract Documents, and is acceptable. No further action by CONTRACTOR is required relative to this submittal, and the Work covered by the submittal may proceed, and materials and equipment with submittals with this disposition may be shipped or operated, as applicable.
   b. Not Accepted: Submittal does not indicate compliance with applicable requirements of the Contract Documents and is not acceptable. Revise submittal and re-submit to indicate acceptability and compliance with the Contract Documents.

E. Closeout Submittals, Results of ENGINEER's Review: Dispositions and meanings are the same as specified for Informational Submittals. When acceptable, Closeout Submittals will not receive a written response from ENGINEER. Disposition as "accepted" will be recorded in ENGINEER's submittal log. When Closeout Submittal is not acceptable, ENGINEER will provide written response to CONTRACTOR.

F. Maintenance Material Submittals, Results of ENGINEER's Review: Dispositions and meanings are the same as specified for Informational Submittals. When acceptable, Maintenance Material Submittals will not receive a written response from ENGINEER. Disposition as "accepted" will be recorded in ENGINEER's submittal log. When Maintenance Material Submittal is not acceptable, ENGINEER will provide written response to CONTRACTOR, and CONTRACTOR is responsible for costs associated with transporting and handling of maintenance materials until compliance with the Contract Documents is achieved.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 35 23

SAFETY REQUIREMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section augments the requirements elsewhere in the Contract Documents regarding CONTRACTOR's responsibilities for safety and protection and includes requirements for CONTRACTOR's safety representative and other safety requirements applicable to the Project.
   2. CONTRACTOR shall provide labor, materials, tools, equipment, training, certifications, protective measures, and incidentals shown, specified, and required to comply with CONTRACTOR's obligations under the Contract for safety and protection of personnel and property.

B. Related Sections: Provisions of this Section are coordinated with, but are not limited to, the following:
   1. Section 01 41 28, Confined Space Entry Permit.
   2. Section 01 71 33, Protection of Work and Property.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. CONTRACTOR's Safety Representative:
      a. ENGINEER's acceptance of CONTRACTOR's safety representative's qualifications does not in any way mitigate or relieve CONTRACTOR of CONTRACTOR's safety obligations under the Contract Documents.
      b. CONTRACTOR's safety representative shall possess not less than five (5) years of experience serving as the safety representative on projects similar to or larger in size than this Contract, and for type(s) of construction similar in nature to the Work.
      c. CONTRACTOR's safety representative shall be experienced in the types of Work to be performed under the Contract and shall be experienced with safety precautions, procedures, and equipment appropriate for the safe performance of the Work.
      d. Prior to the Effective Date of the Contract, shall have successfully completed a 30-hour OSHA Construction Safety and Health training course, and a 40-hour OSHA Hazardous Materials training course, and training for confined space entry.

e. CONTRACTOR's safety representative shall be completely experienced with and knowledgeable of all applicable health and safety Laws and Regulations and with good safety practices, and shall ensure compliance with such Laws and Regulations and practices at the Site.
f. Minimum responsibilities of CONTRACTOR's safety representative are indicated in this Section.

1.3 SUBMITTALS

A. Informational Submittals: Submit the following:
1. Emergency contact information, in accordance with Article 1.5 of this Section.
2. Citations:
a. Copies of safety citations from authorities having jurisdiction and insurance companies, submitted within 24 hours of CONTRACTOR's receipt of such citations.
3. Qualifications Statements:
a. CONTRACTOR's Safety Representative: Submit name and qualifications of CONTRACTOR's safety representative, including summary of experience, and training received and valid certifications and accreditations applicable to the Project.

1.4 SAFETY REPRESENTATIVE RESPONSIBILITIES

A. General:
1. CONTRACTOR's safety representative shall have appropriate space at the Site to maintain and keep available safety records, up-to-date copies of pertinent safety Laws and Regulations, Material Data Sheets, CONTRACTOR's site-specific health and safety plan, copies of OWNER's health and safety requirements with which CONTRACTOR shall comply, and the Site safety plan including information concerning foreseeable emergency conditions, and emergency contact information as required in Article 1.5 of this Section.

B. CONTRACTOR's safety representative's responsibilities include:
1. Duties and responsibilities in accordance with the General Conditions.
2. CONTRACTOR's safety representative shall coordinate with CONTRACTOR's "competent person" required under Laws and Regulations.
3. CONTRACTOR's safety representative shall attend progress meetings in accordance with Section 01 31 19.23, Progress Meetings.
4. Schedule and conduct safety meetings and safety training programs as required by Laws and Regulations, CONTRACTOR's Site-specific health and safety plan (SSHASP), and good safety practices. Include in the SSHASP a specific schedule (dates) of such meetings and an outline of materials to be covered. Advise ENGINEER prior to the time and place of such meetings. Invite OWNER's personnel to meetings. Instruct CONTRACTOR's employees (and Subcontractors, Suppliers with personnel at the Site, and others for whom CONTRACTOR is responsible) on

recognition of hazards, observance of precautions, of the contents of the SSHASP and other safety programs with which CONTRACTOR shall comply, and use of personal protective equipment (PPE) and safety equipment.

5. Determine that operators of specific construction equipment (and permanent equipment used for construction operations) are qualified by training and experience before such personnel are allowed to operate such equipment.
6. Develop and implement emergency response procedures, including names, locations, and contact telephone numbers for emergency services and medical assistance as indicated in requirements for the emergency contact list in Article 1.5 of this Section.
7. Post appropriate notices regarding health and safety Laws and Regulations at locations at the Site and CONTRACTOR's office that afford maximum exposure to personnel.
8. Post appropriate instructions and warning signs in regard to all hazardous areas and hazardous conditions that cannot be eliminated. Identification of such areas shall be based on experience, site surveillance, and severity of the associated hazard. Signage shall not be used in place of appropriate workplace controls.
9. Ascertain via personal inspection that safety Laws and Regulations and safety program requirements are enforced. Make inspections at not less than once per work shift to ensure that machines, tools, and equipment are in a safe operating condition; and that all work areas are free of hazards to the extent practicable. Implement necessary and timely corrective actions to eliminate unsafe acts and unsafe conditions, and submit to ARCADIS daily copy of findings resulting from inspection, using inspection checklist forms established in CONTRACTROR's SSHASP.
10. Submit to ENGINEER copies of safety citations from authorities having jurisdiction and insurance companies within 24 hours of CONTRACTOR's receipt of such citations.
11. Provide appropriate orientation to employees, visitors, Subcontractors, and Supplier personnel at the Site.
12. Perform all related tasks necessary to achieve the highest degree of safety that the nature of the Work allows.

1.5 EMERGENCY CONTACT INFORMATION

A. CONTRACTOR shall submit list of emergency contact information for 24-hour use throughout the Project. Emergency contact information shall be updated and kept current throughout the Project. If personnel or contact information change, furnish updated emergency contact information list at the next progress meeting.

B. CONTRACTOR's list of emergency contact information shall include:
   1. CONTRACTOR's project manager's office, field office, cellular, and home telephone numbers.
   2. CONTRACTOR's Site superintendent's office, field office, cellular, and home telephone numbers.
   3. CONTRACTOR's foreman's field office, cellular (if available), and home telephone numbers.

4. CONTRACTOR's safety representative's office, cellular, and home telephone numbers.
5. Major Subcontractors' and Suppliers' office, cellular, and home telephone numbers of project manager and foreman (when applicable).

C. Additional Emergency Contact Information:
1. OWNER's office, cellular, and home telephone numbers.
2. OWNER's office, cellular, and home telephone numbers.
3. OWNER's central 24-hour emergency telephone number.
4. ENGINEER's project manager's office, cellular, and home telephone numbers.
5. ENGINEER's project engineer's office, cellular, and home telephone numbers.
6. Resident Project Representative's office, field office, cellular, and home telephone numbers.
7. Utility companies' 24-hour contact telephone number(s), including gas, water, sewer, oil, telephone, cable television/telecommunications, and other companies or concerns having utilities in the vicinity of the Work.
8. Highway and street owners' 24-hour telephone number(s).
9. Emergency telephone numbers, including: "Emergency: Dial 911", and seven-digit telephone numbers for the hospital, ambulance, police, and fire department nearest to the Site. Furnish names of each of these institutions.
10. Other involved entities as applicable.
11. Include with list of emergency contact information an 8.5-inch by 11-inch map showing route from the Site to the nearest hospital.

1.6 SAFETY EQUIPMENT

A. General:
1. CONTRACTOR shall provide proper safety and rescue equipment, adequately maintained and readily available, for any foreseeable contingency.
2. Such equipment shall include items such as safety ropes and harnesses, fall-prevention devices, stretchers, water safety devices, oxygen breathing apparatus, resuscitators, gas detectors, oxygen deficiency indicators, combustible gas detectors, fire extinguishers and first-aid equipment in accordance with the Division 01 Specifications, and similar equipment.
3. Keep safety equipment in protected areas. Check safety equipment at scheduled intervals.
4. Temporary First-Aid Facilities: Provide and maintain in accordance with Section 01 51 05, Temporary Utilities.

B. Safety Equipment Log:
1. Maintain a log indicating the person who checked the equipment, when equipment was checked, and that equipment was acceptable.
2. Update equipment log not less-often than monthly.
3. Include in safety representative's onsite records copies of equipment calibration

records.

C. Provide replacement safety equipment when primary safety equipment is unavailable due to use or when undergoing maintenance.

D. Personal Protective Equipment (PPE):
   1. All persons entering the work areas shall wear appropriate PPE required for the particular area.
   2. Remove from the Site any person failing to comply with this or any other safety requirement.
   3. Continuously provide all necessary PPE for ENGINEER's employees, Resident Project Representative, and consultants. ENGINEER will furnish for ENGINEER's employees and consultants protective helmets (hard hats), safety eyewear, reflective vests, and hearing protection. CONTRACTOR shall furnish other equipment required.

1.7 EVACUATION DRILL

A. Included in CONTRACTOR's SSHASP shall be evacuation drills, conducted not less-often than once every six months, scheduled and conducted by CONTRACTOR under supervision of CONTRACTOR's safety representative.

B. Perform evacuation drill during regular working hours, scheduled to minimize disruption of the Work.

C. Upon evacuation, CONTRACTOR and all personnel for whom CONTRACTOR is responsible, immediately advise ENGINEER's onsite personnel and OWNER's facility manager that all personnel have been evacuated.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 35 29

CONTRACTOR'S HEALTH AND SAFETY PLAN

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall prepare and maintain a written, Site-specific, health and safety plan (SSHASP), and conduct all construction activities in safe manner that avoids:
      a. injuries to employees, Subcontractors, and other persons with an interest at or near the Site;
      b. employee exposures to health hazards above occupational limits established by Laws or Regulations, American Conference of Governmental Industrial Hygienists (ACGIH), and Nuclear Regulatory Commission (NRC), as applicable;
      c. exposure of the public and OWNER's employees to air contaminants above levels established for public exposure by the USEPA, NRC, and by other authorities having jurisdiction at the Site;
      d. significant increases in concentrations of contaminants in soil, water, or sediment near the Site; or
      e. violations of OSHA Regulations, or other Laws or Regulations.

B. Related Sections:
   1. Section 01 11 13, Summary of Work.
   2. Section 01 35 23, Safety Requirements.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Preparer of SSHASP:
      a. Engage a Certified Industrial Hygienist (CIH), accredited by the American Board of Industrial Hygiene, or Certified Safety Professional certified by the Board of Certified Safety Professionals, to prepare or supervise preparation of SSHASP.
      b. SSHASP preparer shall be thoroughly familiar with: (i) Laws and Regulations and industry standards of safety and protection relating to health and safety pertaining to the Work; (ii) the requirements of the Contract Documents relative to health, safety, and protection; (iii) health and safety hazards associated with the Work and appropriate protections therefor; and (iv) CONTRACTOR's and OWNER's safety programs.
      c. SSHASP preparer shall have previously prepared site-specific health and safety plans for not less than five construction projects similar in nature, scope, and complexity to the Work.

d. Submit preparer's qualifications with SSHASP.

B. Regulatory Requirements: Laws and Regulations applying to the Work under this Section include, but are not limited to:
1. 29 CFR 1904 (OSHA), Recording and Reporting Occupational Injuries and Illnesses.
2. 29 CFR 1910 (OSHA), Occupational Safety and Health Standards.
3. 29 CFR 1926 (OSHA), Safety and Health Regulations for Construction.
4. 49 CFR 171.8, Transportation, Definitions and Abbreviations.
5. 40 CFR 261.3, 264, and 265, Resource Conservation and Recovery Act (RCRA).

1.3 SUBMITTALS

A. Informational Submittals: Submit the following:
1. CONTRACTOR's SSHASP, in accordance with this Section. Submit within times indicated in Article 1.4 of this Section.
2. Job safety analyses (JSA) submittals for each action required for the Work that is not covered in CONTRACTOR's SSHASP.
3. Reports:
   a. Health and safety reports.
   b. Accident reports.
4. Qualifications Statements:
   a. Qualifications for SSHASP preparer, including copy of valid, applicable certifications.

1.4 SSHASP AND JSA SUBMITTALS

A. Timing of Submittals:
1. Submit SSHASP the sooner of: seven days prior to pre-construction conference, or 30 days prior to CONTRACTOR's scheduled mobilization at the Site.
2. Do not perform Work at the Site until written SSHASP has been accepted by ENGINEER.
3. When an element of the Work or work activity is not covered by the SSHASP, prepare and submit a JSA and obtain ENGINEER's acceptance of JSA before performing the work activity or activities covered by such JSA.
4. Delays in the Work Associated with Submittal or Review of SSHASP and JSAs:
   a. Notwithstanding other provisions of the Contract Documents, changes in the Contract Price or Contract Times will not be authorized due to delay by CONTRACTOR in developing, submitting, revising, or obtaining acceptance of the SSHASP.

B. Limitations of Engineer's Review of SSHASP and JSAs:
1. ENGINEER's review and acceptance of SSHASP and JSAs (if any) will be only to determine if the topics covered in SSHASP comply with the Contract Documents and specific requirements of safety documents referenced therein (such as OWNER's safety programs, if any).

2. ENGINEER's review and acceptance will not extend to safety measures, means, methods, techniques, procedures of construction, or whether representations made in the SSHASP and JSAs (if any) comply with Laws and Regulations, or standards of good practice.
3. CONTRACTOR's responsibility for safety and protection at the Site shall be as indicated in the Contract Documents. Nothing associated with ENGINEER's review or acceptance of SSHASP or JSAs will create or imply any obligation by ENGINEER to oversee or become, in any way, responsible for CONTRACTOR's safety obligations under the Contract Documents.

1.5 CONTRACTOR'S HEALTH AND SAFETY PROGRAM

A. General:
1. Known prior use(s) of the Site are indicated in Section 01 11 13, Summary of Work.
2. The Site is classified as hazardous waste site. Presence of Constituents of Concern (if any), where known to OWNER and ENGINEER, are indicated in the reports and drawings (if any) of such Hazardous Environmental Conditions listed in the Supplementary Conditions.
3. Each employer working at the Site shall develop and implement a written SSHASP for their employees and other individuals for whom such employer is responsible.
4. When applicable (including when the Site includes one or more Hazardous Environmental Conditions), SSHASP shall comply with 29 CFR 1904, 29 CFR 1910, 29 CFR 1926, and other Laws and Regulations.
5. Include in the SSHASP requirements for complying with OWNER's Site-specific hazard/emergency response plans, if any. During the Project, comply with OWNER's hazard/emergency response plans.

B. Location:
1. Retain at the Site a copy of complete SSHASP, JSAs (if any), and related information. Comply with Section 01 35 23, Safety Requirements.
2. Retain copy of SSHASP, JSAs (if any), and related information at CONTRACTOR's project office.
3. Throughout the Project, update as necessary all copies of SSHASP, JSAs, and related information.
4. Copies of SSHASP, JSAs, and other related information shall be made available to CONTRACTOR's employees, Subcontractors, Suppliers, OWNER, and ENGINEER immediately upon request.

C. SSHASP Content: SSHASP shall address and include the following:
1. Address safety and health hazards of each phase of operations at the Site and shall include requirements and procedures for employee protection.
2. CONTRACTOR's organizational structure and other information required by Paragraph 1.5.D of this Section.
3. Comprehensive work plan.

4. Job safety and health risk or hazard analysis for each task and operation found in the work plan.
5. Employee training assignments including copies of OSHA 40-hour, 24-hour supervised field activities, eight-hour supervisors, and eight-hour refresher training certificates for each CONTRACTOR and Subcontractor employee assigned to the Project.
6. Personal protective equipment (PPE) to be used by employees for each task and activity performed. Include respirator fit test certificates for CONTRACTOR and Subcontractor employees assigned to the Project.
7. Medical Surveillance Requirements: Medical clearance certificates for all CONTRACTOR and Subcontractor employees assigned to the Project.
8. Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment.
9. Site control measures, including procedures for:
   a. preventing trespassing;
   b. preventing unqualified or unprotected workers from entering restricted areas;
   c. preventing "tracking" of contaminants out of the Site;
   d. maintaining log of employees at the Site and visitors to the Site;
   e. communicating routes of escape and gathering points.
   f. ensuring safe handling of Constituents of Concern during the Work, including excavating, handling, loading, and transporting activities. Include procedures for ensuring safety when working in or proximity to Hazardous Environmental Conditions,
10. Plan for safe and effective responses to emergencies, including necessary PPE and other equipment.
11. Not used.
12. Spill containment program. Comply with Section 01 35 44, Spill Prevention Control and Countermeasures Plan.
13. Requirements for complying with Section 01 35 43.13, Environmental Procedures for Hazardous Materials.

D. Contractor's Organizational Structure:
   1. Organizational structure portion of the SSHASP shall refer to or incorporate information on specific chain of command and specify the overall responsibilities of supervisors and employees, and shall include the following:
      a. Name and contact information for CONTRACTOR's "competent person(s)" for various work-related activities.
      b. Name and contact information for CONTRACTOR's safety representative.
      c. Designation of general supervisor who has responsibility and authority to direct operations involving handling of Constituents of Concern and work in or near Hazardous Environmental Conditions.
      c. Other personnel required for operations involving Constituents of Concern and Hazardous Environmental Conditions and emergency response, and general functions and responsibilities of each.

d. Lines of authority, responsibility, and communication.

2. Review and update organizational structure as necessary to reflect current status of work activities on the Project and status of personnel.

E. Work Plan:

1. Comprehensive work plan portion of SSHASP shall refer to or incorporate information on the following:
   a. Tasks and objectives of work activities, onsite operations, and logistics and resources necessary to achieve such tasks and objectives.
   b. Anticipated activities and CONTRACTOR's normal operating procedures.
   c. Personnel and equipment requirements for implementing the work plan.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 41 26

STORMWATER POLLUTION PREVENTION PLAN AND PERMIT

PART 1 – GENERAL

1.1 DESCRIPTION

A. CONTRACTOR shall comply with the Project's Texas Pollutant Discharge Elimination System (TPDES) Permit. CONTRACTOR shall be a co-permittee with OWNER and is responsible for providing necessary materials and taking appropriate measures to comply with requirements of the permit and minimize pollutants in storm water runoff from the Site.

B. Documents: The following are part of the Work included under this Section:
   1. The Contractor shall have the responsibility to comply with all the necessary requirements for the Federal Register dated, September 9, 1992, Volume 57, No. 175 –FINAL NPDES GNERAL PERMITS FOR STORM DISCHARGES FROM CONSTRUCTION SITES (or latest revision thereof). The Contractor shall file the Notice of Intent (NOI) as required, a minimum of 2 days prior to commencement of any construction. The required STORM WATER POLLUTION PREVENTION PLAN (SWPPP) shall be developed for the project by the Contractor as required in the above-mentioned document. The SWPPP shall be kept at the work site and updated as work progresses.
   2. The Contractor shall maintain adequate drainage within and through work area. Earth dam drainage will not be permitted in paved areas. Temporary dams of sandbags, asphaltic concrete or other acceptable materials will be permitted when necessary to protect the work and/or the public, provided such use does not create a hazard or nuisance to the public. Such dams shall be removed from the site as soon as their use is no longer necessary.
   3. SWPPP Revisions: Prepared by CONTRACTOR and submitted to ENGINEER. At minimum, CONTRACTOR shall file a SWPPP Revision prior to starting Work at the Site, and as required by authorities having jurisdiction. SWPPP Revision shall include CONTRACTOR's proposed temporary means for storm water control during all phases of the Work and include plans for storm water conveyance and retention, as applicable. Coordinate with excavation plan submittals required in Division 31 of the Specifications. Should CONTRACTOR propose deviations to the SWPPP included in the Contract Documents, or if project-specific modifications of the SWPPP are required to conform to field conditions, CONTRACTOR shall provide additional SWPPP revisions as necessary, in accordance with requirements of authorities having jurisdiction and applicable permits. SWPPP revisions shall use the SWPPP revision form included in this Section, with supporting documents attached as required, or forms provided by authorities having jurisdiction. SWPPP revisions that do not comply with the Contract Documents and are not required by

authorities having jurisdiction will be regarded as substitutions, in accordance with the General Conditions and substitution procedures in the Specifications.

4. Storm Water Certification Statement: To be provided by CONTRACTOR to OWNER on the form included with this Section, or on a form provided by authority having jurisdiction. Do not perform Work at the Site until the Storm Water Certification has been submitted to OWNER.
5. Notice of Intent (NOI): Prepared by CONTRACTOR and submitted to authorities having jurisdiction following OWNER's receipt and acceptance of CONTRACTOR's SWPPP Revision and preliminary Progress Schedule. NOI will be filed with authorities having jurisdiction by CONTRACTOR within ten days of OWNER's acceptance of CONTRACTOR's SWPPP Revision and preliminary Progress Schedule. Do not perform Work at Site until NOI is submitted to authorities having jurisdiction.
6. Co-permittee Agreement: Prepared by CONTRACTOR using forms included with the SWPPP, and submitted to OWNER within five days of the date the Contract Times commence running, for signature by OWNER. OWNER will file co-permittee agreement with authorities having jurisdiction. Do not perform Work at the Site until co-permittee agreement is submitted to authorities having jurisdiction.
7. Storm Water Inspection Report: Prepared by OWNER's Resident Project Representative (RPR) using the form included with this Section, or a form provided by authority having jurisdiction. Storm water inspection reports will be filed in a log book kept at the Site by ENGINEER. Copy of each report will be furnished to CONTRACTOR upon request. Storm water inspection report will be completed for each of the following:
   a. Pre-construction: After placement of storm water management measures, including sediment and erosion controls, and temporary field offices and other temporary facilities, prior to starting other Work at the Site.
   b. During the Work: Every seven days until Notice of Termination is completed. When the Site is stabilized relative to storm water, erosion, and discharge of sediment, inspection frequency during temporary shutdowns and seasonal shutdowns is once per month until Notice of Termination is completed.
   c. Final: Final inspection report will be prepared prior to completion of Notice of Termination.
8. Notice of Termination (NOT): Prepared by CONTRACTOR on the form included with storm water permit and provided to OWNER for review and signature. OWNER will submit the NOT to authority having jurisdiction. Submit the NOT following completion of all Work that may result in pollution in storm water discharges, including landscaping Work. Final Payment will not be made until the NOT is filed with authority having jurisdiction.

D. Prevent discharge of sediment to and erosion from the Site to surface waters, drainage routes, public streets and rights-of-way, and private property, including dewatering operations. Prevent trash and demolition and construction debris from leaving the Site via storm water runoff. Provide berms, dikes, and other acceptable methods of directing storm water around work areas to drainage routes. Prior to starting the Work associated with

such discharge, construction-related discharges to publicly owned conveyance or treatment systems shall be approved by owner of system to which the discharge will be directed.

E. Do not cause or contribute to a violation of water quality standards, Laws, or Regulations. Notify OWNER of revisions to the SWPPP necessary to protect receiving water quality and comply with applicable permits. Provide and implement measures to control pollutants in storm water runoff from the Site to prevent:
   1. Turbidity increases that will cause a substantial visible contrast to natural conditions.
   2. Increase in suspended, colloidal, and settleable solids that would cause sediment deposition or impair receiving water quality and use.
   3. Presence of residue from oil and floating substances, visible oil, and globules of grease.

F. CONTRACTOR shall pay civil penalties and other costs incurred by OWNER, including additional engineering, RPR, and inspection services, associated with non-complying with applicable permits related to storm water discharges associated with construction activity and sediment and erosion controls associated with the Work.

G. Contract Price includes all material, labor, and other permits and incidental costs related to:
   1. Preparing SWPPP Revisions and other documents that are CONTRACTOR's responsibility, in accordance with this Section.
   2. Installing and maintaining structural and non-structural items used in complying with the SWPPP and its revisions.
   3. Clean-up, disposal, and repairs following wet weather events or spills caused by CONTRACTOR.
   4. Implementing and maintaining "best management practices", as defined in applicable permits and Laws or Regulations, to comply with requirements that govern storm water discharges at the Site.
   5. Inspections of storm water, sediment, and erosion controls as specified.

H. Coordinate requirements of this Section with requirements for earthwork, erosion control, and landscaping in the Contract Documents, applicable permit requirements, and Laws and Regulations.

I. Implement SWPPP controls and practices prior to starting other Work at the Site. Each contractor and subcontractor identified in the SWPPP and SWPPP Revisions shall sign a copy of the storm water certification statement.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with Laws and Regulations relative to environmental protection and restoration, including:
   1. Storm water permit applicable to the Work and Site.
   2. State and local erosion and sediment control guidelines and requirements,
   3. State and local storm water regulations and guidance.

1.3 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Submit the following, in accordance with Article 1.1 and Article 1.4 of this Section; for Projects involving Work at multiple Sites, submit each of the following for each Site, as applicable:
      a. SWPPP Revisions.
      b. Co-Permittee Agreement.
      c. Storm Water Certification Statement.
      d. Notice of Termination
   2. Approval to Discharge to Publicly-owned Treatment Works: For storm water discharges associated with construction activity that are discharged to a publicly owned conveyance or treatment system, prior to commencing discharges, submit system owner's written approval for such discharges.
   3. Storm Water Site Plan Updates: Within three days after each storm water inspection, submit updated storm water site plan.

1.4 SWPPP REVISIONS

A. CONTRACTOR shall prepare a SWPPP Revision in accordance with the Project's storm water permit when:
   1. There is a significant change in design, construction, operation, or maintenance of the Project that significantly affects the potential of discharging pollutants to Waters of the United States, and has not otherwise been addressed in the SWPPP.
   2. SWPPP proves to be ineffective relative to:
      a. eliminating or significantly minimizing pollutants from sources identified in the SWPPP required by this permit, or
      b. achieving general objectives of controlling pollutants in storm water discharges from permitted construction activity.
   3. Prepare and submit SWPPP Revision identifying contractors and subcontractor responsible for implementing part of the SWPPP.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 INSPECTIONS AND REPAIRS

A. Perform Site inspections and assessments as required in applicable storm water permit and this Section. Inspections and assessments shall be done by CONTRACTOR's site superintendent or project manager, together with OWNER's RPR.

B. Inspections:
   1. During the Work, Site inspections shall be performed:
      a. After SWPPP controls are provided and prior to starting other Work at the Site.

b. During the Work: Every seven days until Notice of Termination is completed. When the Site is stabilized relative to storm water, erosion, and discharge of sediment, inspection required frequency during temporary shutdowns and seasonal shutdowns is once per month until Notice of Termination is completed
c. Prior to CONTRACTOR submitting the Notice of Termination.

2. During each inspection, verify sediment control practices and record approximate degree of sediment accumulation as percentage of acceptable sediment storage volume; inspect erosion and sediment control practices and record maintenance performed; observe and record deficiencies relative to implementation of the SWPPP. RPR or ENGINEER will complete Storm Water Inspection Reports and CONTRACTOR shall record and submit the following.
   a. Storm Water Site Plan: On a copy of the Site plan included in the Contract Documents or other map of the Site acceptable to ENGINEER, indicate extent of all disturbed areas and drainage pathways. Indicate areas expected to undergo initial disturbance or significant site work within the next fourteen days.
   b. Indicate on storm water site plan areas of Site that have undergone temporary or permanent stabilization.
   c. Indicate on storm water site plan all disturbed areas that have not undergone active site Work during the previous fourteen days.

C. Maintain at the Site a copy of storm water site plans from storm water inspection submit each storm water map to ENGINEER and RPR. RPR will maintain at the Site a log book with a copy of each Storm Water Inspection Reports.

D. Cooperate with representatives of authorities having jurisdiction during periodic visits to Site, and promptly provide information requested by authorities having jurisdiction.

E. Complete repairs to SWPPP controls in accordance with applicable requirements and to satisfaction of ENGINEER within two calendar days of each inspection.

3.2 ATTACHMENTS

A. The documents listed below, following the “End of Section” designation, are part of this Specification Section. Notice of Intent (NOI) form, Co-permittee Agreement form, and Notice of Termination (NOT) form are included with storm water permit.
   1. Stormwater Inspection Report form (two pages).
   2. Stormwater Permit Certification form (one page).
   3. SWPPP Revision Form (one page).

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

STORMWATER INSPECTION REPORT

Owner: **Site:** **Project:** **Contractor:**

Date of Inspection:_____
Day of Week:

S	M	T	W	T	F	S

Sheet No. _____ of _____ Sheets

If pertinent to the Operation	
Weather	
Temperature	

This inspection and maintenance form is to be used when the Work is subject to a Storm Water General Permit for Construction Activity. Inspections must be performed at least once every seven calendar days; for sites that are stabilized and temporarily shut down inspections may be reduced to once per month. Each erosion and sediment control measure installed on the Site is to be inspected and the Contractor must complete all required maintenance within two calendar days from the date of inspection.

Reason for this inspection:

- ☐ Pre-construction Site assessment
- ☐ Seven calendar day inspection
- ☐ Monthly inspection (when Site is stabilized and shut down)
- ☐ Post-construction inspection prior to Notice of Termination

Key for erosion and sediment control measures to be inspected:
[Use the following designations in the table below]

(1) mulch, (2) seed and mulch, (3) check dams, (4) hay bale/straw bales, (5) silt fence, (6) sediment trap, (7) turbidity curtains, (8) pipe slope drains, (9) drainage structure inlet protection, (10) rolled erosion control products, (11) soil stabilizers, (12) construction entrances, (13) pipe inlet/outlet protection, (14) water diversion structures, (15) sedimentation basins, (16) cofferdams, (17) Other _____.

ID	Location	Disturbance		Measure		Remarks (Evaluate integrity of measure, describe evidence of erosion)	Approximate Sediment Accumulation (% of Depth)	Maintenance Required? (Y or N) (If Yes, Describe Below)
		Existing? (Y or N)	Next 14 Days? (Y or N)	Code #	Temp or Perm? (T, P or NA)			
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								
11								
12								
13								
14								
15								
16								
17								
18								
19								
20								

DESCRIPTION OF REQUIRED MAINTENANCE AND ANY EXISTING DEFICIENCIES IN THE SWPPP:
Specify for each location using row ID number.

_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system to ensure that qualified personnel property gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that false statements made herein may be punishable by Law.

Signature: _____ Prepared: _____ Copy to Contractor: _____
_____
Resident Project Representative (Date) (Date)

Qualified Professional Name Arcadis US, Inc.
(w/Firm Name, if Consultant)

[THIS PAGE INTENTIONALLY LEFT BLANK]

STORMWATER PERMIT CERTIFICATION

Contract Number:_____ Project:_____

Owner:_____

Each Contractor and Subcontractor identified in the Storm Water Pollution Prevention Plan (SWPPP) must certify that they understand the permit conditions and their responsibilities. Every Contractor and Subcontractor performing an activity that involves soil disturbance shall sign this certification and submit it to the Engineer prior to performing the Work. This certification shall be signed by an owner, principal, president, secretary, or treasurer of the firm.

> I certify under penalty of law that I understand and agree to comply with the terms and conditions of the SWPPP for the construction Site identified in such SWPPP as a condition of authorization to discharge storm water. I also understand that my firm and its employees and Subcontractors shall comply with the terms and conditions of Owner's general permit for storm water discharges from construction activities and that it is unlawful for any person to cause or contribute to a violation of water quality standards, Laws, or Regulations.

Firm: _____

Address: _____

City:_____ State_____ Zip_____

_____ _____ _____

Name (Print) Signature Date

_____

Title

[THIS PAGE INTENTIONALLY LEFT BLANK]

STORM WATER POLLUTION PREVENTION PLAN (SWPPP) REVISION

Owner:
Site:
Project:
Contractor:

Date of Inspection:_____

Sheet No. _____ **of** _____

This form shall be used when revisions to the current Storm Water Pollution Prevention Plan (SWPPP) are required by the Storm Water General Permit for Construction Activity or the Contract Documents.

Reason for the Revision(s): Revisions were requested by State: ☐ Yes ☐ No

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

Describe the Revision(s) to the SWPPP:_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____
_____

I certify under penalty of Law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gathered and evaluated the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that false statements made herein may be punishable by Law.

Signature: _____ Prepared: _____ Submitted: _____

_____

(Date) (Date)

Copy to: ☐ Engineer ☐ Contractor _____

SECTION 01 42 00

REFERENCES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Section includes the following:
      a. Definitions and terminology in general use in the Contract Documents.
      b. Applicable codes.
      c. Owner's referenced specifications, where applicable.
      d. Abbreviations in general use throughout the Contract Documents.
      e. General requirements regarding reference standards, including a listing of standard-issuing organizations (and their acronyms) used in the Contract Documents.

1.2 DEFINITIONS AND TERMINOLOGY

A. Definitions and terminology applicable to all the Contract Documents are included in the General Conditions, as may be modified by the Supplementary Conditions.

B. Additional terminology used in the Contract Documents includes the following:
   1. "Indicated" refers to graphic representations, notes, or schedules on the Drawings, or to other paragraphs, provisions, tables, or schedules in the Specifications and similar locations in the other Contract Documents. Terminology such as "shown", "noted", "scheduled", and "specified" are used to help the user locate the reference without limitation on the location.
   2. "Installer", "applicator", or "erector" is CONTRACTOR or another person or entity engaged by CONTRACTOR, either as an employee or Subcontractor, to perform a particular construction activity, including installation, erection, application, or similar Work. Installers shall be experienced in the Work that installer is engaged to perform.
      a. The term "experienced", when used in conjunction with the term "installer", means having successfully completed not less than five previous projects similar in size and scope to this Project; being familiar with the special requirements indicated and required; being familiar with Laws and Regulations; and having complied with requirements of authorities having jurisdiction, and complying with requirements of the Supplier of the material or equipment being installed, unless other experience requirements specific to that element of the Work are indicated elsewhere in the Contract Documents.
   3. Trades: Use of terms such as "carpentry" does not imply that certain construction activities must be performed by accredited or unionized

individuals of a corresponding generic name, such as "carpenter", unless otherwise indicated in the Contract Documents or required by Laws or Regulations. Such terminology also does not imply that specified requirements apply exclusively to trade personnel of the corresponding generic name.

1.3 APPLICABLE CODES

A. References in the Contract Documents to local code(s) shall mean the following:
   1. National Electric Code in effect at the location of the Project.
   2. NFPA 101, Life Safety Code.

1.5 ABBREVIATIONS

A. Common abbreviations that may be found in the Contract Documents are indicated below, alphabetically by their written-out meaning:

alternating current	a-c
ampere	A
antemeridian	a.m.
Architectural Barriers Act	ABA
Americans with Disabilities Act	ADA
Americans with Disabilities Act Accessibility Guidelines	ADAAG
ante meridian	a.m.
average	avg
biochemical oxygen demand	BOD
five-day biochemical oxygen demand	BOD_5
brake horsepower	bhp
British thermal unit	Btu
building information model	BIM
carbonaceous biochemical oxygen demand	CBOD
five-day carbonaceous biochemical oxygen demand	$CBOD_5$
chemical oxygen demand	COD
Centigrade (or Celsius)	C
chlorinated polyvinyl chloride	CPVC
chlorofluorocarbons	CFC
Code of Federal Regulations	CFR
computer-aided drafting and design	CADD, or CAD
cubic inch	cu in

cubic foot		cu ft
cubic yard		cu yd, or CY
cubic feet per minute		cfm
cubic feet per second		cfs
decibel		db
degree Centigrade (or Celsius)	(Write)	degrees C, ^{o}C, or deg C
degrees Fahrenheit		degrees F, ^{o}F, or deg F
diameter		dia
direct current		d-c
dollars		$
each		ea
efficiency		eff
Fahrenheit		F
feet		ft
feet per hour		fph, or ft/hr
feet per minute		fpm
feet per second		fps, or ft/min
figure		fig
flange		flg
foot-pound		ft-lb
gallon		gal
gallons per hour		gph, or gal/hr
gallons per minute		gpm
gallons per second		gps
gram		g
grams per liter		g/L
Hertz		Hz
horsepower		hp or HP
hour		hr
human-machine interface		HMI
inch		in.
inches of mercury		in. Hg
inches water gage		in. w.g.
inch-pound		in.-lb
inside diameter		ID
iron pipe size		IPS

thousand pounds	kips
thousand pounds per square inch	ksi
kilovolt-ampere	kva
kilowatt	kw
kilowatt-hour	kwhr or kwh
linear foot	lin ft or LF
liter	L
Leadership in Energy and Environmental Design (USGBC)	LEED
maximum	max
mercury	Hg
milligram	mg
milligrams per liter	mg/l or mg/L
milliliter	ml
millimeter	mm
million gallons per day	mgd or MGD
million gallon	MG
minimum	min
national pipe threads	NPT
net positive suction head	NPSH
net positive suction head available	NPSHA
net positive suction head required	NPSHR
nitrogen oxide (total concentration of mono-nitrogen oxides such as nitric oxide (NO) and nitrogen dioxide (NO_2))	NOx
nominal pipe size	NPS
number	no.
operator interface terminal	OIT
ounce	oz
ounce-force	ozf
outside diameter	OD
parts per hundred	pph
parts per million	ppm
parts per billion	ppb
polyvinyl chloride	PVC
post meridian	p.m.
pound	lb
pounds per square inch	psi
pounds per square inch absolute	psia

pounds per square inch gauge	psig
pounds per square foot	psf
process control system	PCS
programmable logic controller	PLC
revolutions per minute	rpm
second	sec
specific gravity	sp gr, or SG
square	sq
square foot	sq ft, sf, or ft^2
square inch	sq in., or in^2
square yard	sq yd, or SY
standard	std
standard cubic feet per minute	scfm
total dynamic head	TDH
totally-enclosed fan-cooled	TEFC
volt	V
volts alternating current	vac
volts direct current	vdc
volatile organic compounds	VOC

1.6 REFERENCE STANDARDS

A. Refer to Article 3 of the General Conditions, as may be modified by the Supplementary Conditions, relative to reference standards and resolving discrepancies between reference standards and the Contract Documents. Provisions of reference standards are in effect in accordance with the Specifications.

AA	Aluminum Association
AABC	Associated Air Balance Council
AAMA	American Architectural Manufacturers Association
AASHTO	American Association of State Highway and Transportation Officials
ACI	American Concrete Institute
ACS	American Chemical Society
ADSC-IAFD	International Association of Foundation Drilling.
AEIC	Association of Edison Illuminating Companies
AF&PA	American Forest and Paper Association
ABMA	American Bearing Manufacturers Association (formerly Anti-Friction Bearing Manufacturers Association (AFBMA))

AGMA	American Gear Manufacturers Association
AI	Asphalt Institute
AIA	American Institute of Architects
AIChE	American Institute of Chemical Engineers
AISC	American Institute of Steel Construction
AISI	American Iron and Steel Institute
AITC	American Institute of Timber Construction
ALSC	American Lumber Standards Committee
AMA	Acoustical Materials Association
AMCA	Air Movement and Control Association
AMP	National Association of Architectural Metal Manufacturers, Architectural Metal Products Division
ANSI	American National Standards Institute
APA	The Engineered Wood Association
APHA	American Public Health Association
API	American Petroleum Institute
AREA	American Railway Engineering Association
ARI	Air Conditioning and Refrigeration Institute
ASAE	American Society of Agricultural Engineers
ASCE	American Society of Civil Engineers
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASNT	American Society for Non-Destructive Testing
ASQ	American Society for Quality
ASSE	American Society of Safety Engineers
ASTM	American Society for Testing and Materials
AWCI	Association of the Wall and Ceiling Industry
AWI	Architectural Woodwork Institute
AWPA	American Wood Protection Association
AWPI	American Wood Preservers Institute
AWS	American Welding Society
AWWA	American Water Works Association
BAAQMD	Bay Area Air Quality Management District
BHMA	Builders Hardware Manufacturers Association
BIA	Brick Industry Association
CBMA	Certified Ballast Manufacturers Association
CDA	Copper Development Association
CEMA	Conveyor Equipment Manufacturers Association

CGA	Compressed Gas Association
CISCA	Ceilings and Interior Systems Construction Association
CISPI	Cast Iron Soil Pipe Institute
CLFMI	Chain Link Fence Manufacturers Institute
CMAA	Crane Manufacturers Association of America
CRSI	Concrete Reinforcing Steel Institute
CSI	Construction Specifications Institute
DIN	Deutsches Institut fur Normung eV (German Institute for Standardization)
DIPRA	Ductile Iron Pipe Research Association
EJCDC	Engineers Joint Contract Documents Committee
EJMA	Expansion Joint Manufacturers Association, Inc.
ETL	Intertek Testing Services, Inc. (formerly ETL Testing Laboratories, Inc.)
FCC	Federal Communications Commission
FEMA	Federal Emergency Management Agency
FHWA	Federal Highway Administration
FM	Factory Mutual (FM Global)
FRPI	Fiberglass Reinforced Plastics Institute
FS	Federal Specification
GA	Gypsum Association
GANA	Glass Association of North America
HEW	United States Department of Health, Education and Welfare
HI	Hydraulic Institute
HMI	Hoist Manufacturers Institute
HUD	United States Department of Housing and Urban Development
IBC	International Building Code
ICC	International Code Council
ICEA	Insulated Cable Engineers Association
IEEE	Institute of Electrical and Electronics Engineers
IESNA	Illuminating Engineering Society of North America
IFI	Industrial Fasteners Institute
IRI	Industrial Risk Insurers
ISA	Instrumentation, Systems, and Automation Society (formerly Instrument Society of America)
ISO	Insurance Services Office
ISO	International Organization for Standardization
LPI	Lightning Protection Institute
MIA	Marble Institute of America
ML/SFA	Metal Lath/Steel Framing Association

MS	Military Specifications
MSS	Manufacturers' Standardization Society
MMA	Monorail Manufacturers Association
NAAMM	National Association of Architectural Metal Manufacturers
NACE	National Association of Corrosion Engineers
NAPF	National Association of Pipe Fabricators, Inc.
NARUC	National Association of Regulatory Utilities Commissioners
NBHA	National Builders Hardware Association
NBS	United States Department of Commerce, National Bureau of Standards
NCMA	National Concrete Masonry Association
NEC	National Electric Code
NELMA	Northeastern Lumber Manufacturers' Association
NEMA	National Electrical Manufacturers Association
NESC	National Electrical Safety Code
NETA	International Electrical Testing Association
NFPA	National Fire Protection Association
NFRC	National Fenestration Rating Council
NGA	National Glass Association
NHLA	National Hardwood Lumber Association
NHPMA	Northern Hardwood and Pine Manufacturers Association
NIST	United States Department of Commerce, National Institute of Standards and Technology
NLGA	National Lumber Grades Authority
NRCA	National Roofing Contractors Association
NRMCA	National Ready Mixed Concrete Association
NSF	National Sanitation Foundation
NSSGA	National Stone, Sand, and Gravel Association
NTMA	National Terrazzo and Mosaic Association
OSHA	Occupational Safety and Health Administration
PCA	Portland Cement Association
PCI	Precast/Prestressed Concrete Institute
PEI	Porcelain Enamel Institute
PFI	Pipe Fabrication Institute
PPI	Plastics Pipe Institute
PGMC	Primary Glass Manufacturers Council
PS	Product Standards Section, United States Department of Commerce
RCSC	Research Council on Structural Connections (part of AISC)
RMA	Rubber Manufacturers Association

SAE	Society of Automotive Engineers
SCAQMD	Southern California Air Quality Management District
SCPRF	Structural Clay Products Research Foundation
SCTE	Society of Cable Telecommunications Engineers
SDI	Steel Deck Institute
SDI	Steel Door Institute
SIGMA	Sealed Insulating Glass Manufacturing Association
SJI	Steel Joist Institute
SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
SPI	Society of the Plastics Industry
SPIB	Southern Pine Inspection Bureau
SSPC	Society for Protective Coatings
SWI	Steel Window Institute
TCNA	Tile Council of North America
TEMA	Tubular Exchanger Manufacturers Association
TIA/EIA	Telecommunications Industry Association/Electronic Industries Alliance
UL	Underwriters Laboratories, Inc.
USAB	United States Access Board
USDOE	United States Department of Energy
USEPA	United States Environmental Protection Agency
USGBC	United States Green Building Council
USGS	United States Geological Survey
USPHS	United States Public Health Service
WCLIB	West Coast Lumber Inspection Bureau
WCMA	Window Covering Manufacturers Association
WCMA	Wood Component Manufacturers Association
WDMA	Window and Door Manufacturers Association
WEF	Water Environment Federation
WWEMA	Water and Wastewater Equipment Manufacturers Association
WWPA	Western Wood Products Association

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 45 29.13

TESTING LABORATORY SERVICES FURNISHED BY CONTRACTOR

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall employ and pay for services of independent testing laboratory to perform specified services.
   2. Inspection, sampling, and testing shall be as specified in the Specifications including but not limited to:
      a. Section 01 45 33, Code-Required Special Inspections and Procedures.
      b. Section 03 30 00, Cast-in-Place Concrete.
      c. Section 03 60 00, Grouting.
      d. Section 04 05 11, Masonry Mortaring and Grouting.
      e. Section 05 05 33, Anchor Systems.
      f. Section 09 91 00, Painting.
      g. Section 32 12 00, Flexible Paving.
      h. Section 40 05 05, Exposed Piping Installation.
      s. Other tests indicated in the Contract Documents that are not specifically assigned to others.
   3. CONTRACTOR shall pay for:
      a. Tests not specifically indicated in the Contract Documents as being OWNER's responsibility.
      b. Tests made for CONTRACTOR's convenience.
      c. Repeat tests required because of CONTRACTOR's negligence or defective Work, and retesting after failure of test for the same item to comply with the Contract Documents.
   4. Testing laboratory is not authorized to approve or accept any portion of the Work or defective Work; rescind, alter, or augment requirements of Contract Documents; and perform duties of CONTRACTOR.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
   2. ISO/IEC 17025, General Requirements for the Competence of Testing and Calibration Laboratories.
   3. NIST SRM, Standard Reference Materials.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory:
      a. Comply with applicable requirements of ASTM E329.
      b. Testing laboratory shall be licensed to operate in the same jurisdiction as the Site. Where applicable, laboratory shall be certified by the authority having jurisdiction for the types of testing required.
      c. Testing equipment used by laboratory shall be calibrated at intervals of not more than twelve months by devices of accuracy traceable to one of the following: NIST SRM, ISO/IEC 17025, certified by state or local bureau of weights and measures, or values of natural physical constants generally accepted in the engineering and scientific community.

1.4 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Quality Control Submittals and Test Reports: Testing laboratory shall promptly submit to CONTRACTOR results of testing and inspections, including:
      a. Date issued.
      b. Project title, number, and name of the Site.
      c. Testing laboratory name and address.
      d. Name and signature of inspector or person obtaining samples.
      e. Date of inspection or sampling.
      f. Record of temperature and weather conditions.
      g. Date of test.
      h. Identification of material or item tested, and associated Specifications Section.
      i. Location in the Project.
      j. Type of inspection or test.
      k. Results of tests and observations regarding compliance with the Contract Documents.
   2. Qualifications Statements:
      a. Testing Laboratory:
         1) Qualifications statement indicating experience and facilities for tests required under the Contract Documents.
         2) Copy of report of inspection of facilities during most recent NIST inspection tour. Include memorandum of remedies of deficiencies reported during inspection.
         3) Copy of certificate of calibration for each instrument or measuring device proposed for use, by accredited calibration agency.

1.5 TESTING LABORATORY DUTIES

A. Testing laboratory shall:

1. Cooperate with CONTRACTOR and provide qualified personnel promptly on notice.
2. Perform required inspections, sampling, and testing of materials and methods of construction; comply with applicable reference standards and the Contract Documents; and ascertain compliance with requirements of the Contract Documents.
3. Promptly notify ENGINEER and CONTRACTOR of irregularities or deficiencies in the Work that are observed during performance of services.
4. Promptly submit to CONTRACTOR reports of inspections and tests.
5. Perform additional tests and services, as required by CONTRACTOR.

1.6 CONTRACTOR'S RESPONSIBILITIES

A. CONTRACTOR shall:
   1. Cooperate with testing laboratory personnel.
   2. Provide to testing laboratory preliminary representative samples of materials and items to be tested, in required quantities.
   3. Promptly submit to ENGINEER results of tests and inspections received from testing laboratory.
   4. Furnish to laboratory the preliminary design mix proposed for concrete and other material mixes to be tested by testing laboratory.
   5. Provide labor and facilities:
      a. For access to the Work to be tested, and where required, to Suppliers' operations.
      b. For obtaining and handling samples at the Site.
      c. For facilitating inspections and tests.
      d. For testing laboratory's exclusive use for storing and curing of test samples.
      e. Forms for preparing concrete test beams and cylinders.
   6. Notify laboratory and ENGINEER sufficiently in advance of operations to allow assignment of personnel and scheduling of tests.
   7. Arrange with laboratory and pay for additional services, sampling, and testing required for CONTRACTOR's convenience.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 45 53

CLEANING, TESTING, AND DISINFECTING HYDRAULIC STRUCTURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide labor, material, tools, equipment, and incidentals as shown, specified, and required to clean, flush, disinfect, and test chlorine equipment and piping.
   2. The Work under this Section also includes providing all labor and materials required to prepare hydraulic structures for testing and disinfecting, conveying water to testing location, performing testing, and all labor and materials required to drain and dispose of water used for testing and disinfecting.

B. Hydraulic Structures Scheduled for Hydrostatic Testing and Disinfection: Clean, test, and disinfect interior surfaces of the following:

Hydraulic Structure Number	**Hydraulic Structure Service and Location**
1. FOG-TNK-001	18,000 gallon RFP Tank
2.	

C. Hydraulic Structures Scheduled for Hydrostatic Testing Only: Clean and test the following:

Hydraulic Structure Number	**Hydraulic Structure Service and Location**
1.	
2.	

D. Hydraulic Structures Scheduled for Air Testing: Clean and test the following:

Hydraulic Structure Number	**Hydraulic Structure Service and Location**
1.	
2.	

E. Water for Testing:
   1. Water for initial testing will be furnished by OWNER.
   2. CONTRACTOR shall provide temporary piping, hoses, valves, backflow preventers, appurtenances, and services required for testing.
   3. CONTRACTOR shall convey the water to testing location.
   4. Water for testing may be withdrawn from:
      a. (--1--).
   5. Maximum rate at which water may be withdrawn is (--2--). CONTRACTOR shall provide on withdrawal piping, downstream of backflow preventer, flow meter and valve to control rate of flow. Flow meter shall be calibrated within the past 12 months. Operation of flow meter shall be confirmed at the Site and witnessed by ENGINEER. Submit to ENGINEER certification of calibration.
   6. Cost of water for re-testing shall be paid by CONTRACTOR to OWNER at (--1--).

F. Provide chemicals required for disinfection and dechlorination.

G. Not Included Under this Section:
   1. The following are specified under other Specifications Sections:
      a. Cleaning, testing and disinfecting of buried piping is under Section 33 05 05, Buried Piping Installation
      b. Cleaning and testing of manholes for utility service is under Section 33 05 13, Manholes and Structures.
      c. Cleaning, testing, and disinfecting of exposed piping is under Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:

   1. ACI 350.1, Tightness Testing of Environmental Engineering Concrete Structures, and Commentary.
   2. ANSI/AWWA B100, Standard for Granular Filter Material.
   3. ANSI/AWWA C652, Disinfection of Water-Storage Facilities.
   4. ANSI/AWWA C653, Disinfection of Water Treatment Plants.
   5. APHA/AWWA/WEF, Standard Methods for the Examination of Water and Wastewater.
   6. NSF/ANSI 60, Drinking Water Treatment Chemicals – Health Effects.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:

1. "Hydraulic structures" are tanks, channels, and other structures through which fluid is conveyed or that hold fluid. Hydraulic structures include structures open to the atmosphere and structures with closed tops, and structures that contain both fluid and gas. Hydraulic structures include wet wells, junction chambers, equalization tanks, storage tanks, treatment process tanks such as grit chambers, clarifiers, aeration tanks, filter beds, contact tanks, and other channels and tanks designated in this Section. Excluded are structures that are to be cleaned or tested under other Specifications Sections.

1.4 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory:
      a. Testing for bacteria and odor shall be by laboratory certified by authorities having jurisdiction.
      b. Refer to Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor, for testing laboratory qualifications requirements.
   2. Backflow Preventer Technician:
      a. Backflow prevention technicians shall possess a valid certification as a backflow preventer technical issued by authority having jurisdiction.

B. Regulatory Requirements:
   1. Backflow preventers shall be tested by certified backflow prevention technician within 12 months of the date backflow preventer is used on the Project.
   2. (--1--).

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's published data on chemicals used for disinfection and dechlorination.
      b. Evidence of NSF/ANSI 60 compliance for chemicals used in disinfection and dechlorination.
   2. Procedure Submittals (including proposed plans for water conveyance, control, and disposal):
      a. Cleaning procedures.
      b. Hydrostatic testing procedures and equipment required, by hydraulic structure to be tested.
      c. Air testing procedures and equipment required, by hydraulic structure to be tested.
      d. Disinfection procedures and equipment required, by hydraulic structure to be tested.

B. Informational Submittals: Submit the following:
   1. Certifications:
      a. Certification of each backflow preventer proposed for use.
      b. Calibration certification for each flow meter proposed for use.
      c. Certification by CONTRACTOR and testing laboratory that tests were performed in compliance with referenced standards.
   2. Special Procedure Submittals:
      a. Time schedule for each test required.
      b. Procedure for disposal of chlorinated water, including proposed dechlorination chemical and methods proposed for use.

      c. Not less than (--1--) days prior to scheduled test, submit written notification of intent to test each hydraulic structure. Do not commence testing without obtaining ENGINEER's acceptance of testing procedures, chemicals to be used, notification, and other required pre-test submittals.
   3. Field Quality Control Submittals:
      a. Results of each test.
      b. Chain of custody documentation for samples obtained for bacteriological and odor testing.
   4. Qualifications Statements:
      a. Testing laboratory qualifications in accordance with Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor, and this Section.
      b. Certified backflow preventer technician, when requested by ENGINEER.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Test Apparatus and Fluid Control Devices:
   1. Provide temporary pumping, hoses, piping, instrumentation, and other materials, equipment, and items necessary to perform cleaning, testing, and disinfecting of hydraulic structures.
   2. Provide and maintain temporary valves, plugs, bulkheads, and other fluid control devices suitable for the intended use and required cleaning, testing, and disinfecting.
   3. Do not use materials or items that will injure or damage the Work.
   4. Temporary backflow preventers shall be reduced pressure zone-type.

B. Chemicals:
   1. Chemicals used for disinfection and dechlorination shall be listed in NSF/ANSI 60.

PART 3 – EXECUTION

3.1 CLEANING

A. Cleaning Requirements:
   1. Prior to testing, remove all scaffolding, planking, tools, rags, dirt, debris, foreign matter, and material not part of the permanent structure.
   2. Thoroughly clean hydraulic structures' walls, floors, and operating equipment by sweeping, high-pressure wash, scrubbing, or other methods that will not injure the Work and existing facilities.
   3. Remove from each hydraulic structure all water, dirt, and foreign material accumulated during cleaning. Provide temporary pumps, piping, and facilities as required to discharge water from the cleaning operation in manner acceptable to ENGINEER and in accordance with Laws and Regulations.
   4. Do not proceed with testing until ENGINEER has accepted in the field results of cleaning.
   5. Comply with Section 01 74 05, Cleaning, and this Section.

3.2 TESTING AND DISINFECTION – GENERAL

A. General Provisions Applicable to Cleaning and Testing of All Hydraulic Structures:
   1. Separately test each hydraulic structure.
   2. Hydraulic structures shall be free of visible leakage. Repair leaks in manner in accordance with the Contract Documents.
   3. Interior Coatings and Finishes: Apply and cure protective coatings for concrete before starting disinfection.
   4. Exterior Coatings and Finishes: Successfully test hydraulic structure, and obtain ENGINEER's acceptance of results of hydrostatic and air testing before applying exterior coating materials, such as dampproofing, and before installing masonry block veneer (if any).
   5. Provide disinfection be as late as possible in the execution of the Work to provide maximum degree of sterility at the time the Work is placed into continuous service.
   6. Bacteriological and Odor Testing – General:

      a. Testing shall be performed by certified testing laboratory retained by CONTRACTOR. Testing laboratory shall be acceptable to ENGINEER.
      a. Testing will be performed by certified testing laboratory retained by OWNER.
      b. Samples shall be obtained and transported by testing laboratory employee.
      c. Reports of bacteriological testing shall indicate whether results comply with the Contract Documents and shall be acceptable to authorities having jurisdiction.

3.3 HYDROSTATIC TESTING OF HYDRAULIC STRUCTURES

A. Analysis of data from hydrostatic testing of hydraulic structures shall be by CONTRACTOR in accordance with ACI 350.1 and this Section. Provide materials, equipment, and labor to obtain test data.

B. Prior to starting hydrostatic testing, perform the following:
   1. All elements of the hydraulic structure that will resist pressure exerted by retained fluid shall be in place and at specified strength. Concrete shall be fully cured.
   2. Do not backfill structure walls before testing. Refer to Paragraph 3.2.A of this Section regarding application of exterior coatings to hydraulic structures.
   3. Valves, gates, blind flanges, and items other than concrete that control the flow of or otherwise retain fluid in the hydraulic structure shall be watertight for the hydrostatic test.
   4. Repair defective concrete.
   5. Advise ENGINEER and OWNER prior to commencing filling hydraulic structure for hydrostatic testing. Minimum time between notice and starting to fill for hydrostatic testing shall be in accordance with Paragraph 1.5.B.2 of this Section.
   6. Do not perform hydrostatic testing during period when ambient temperature is below 33 degrees F.
   7. Hydraulic structures with interior, wetted concrete surfaces shall remain filled with water for an initial adsorption period of not less than 48 hours. Following this initial period, provide make-up water to fill the hydraulic structure to specified water surface test elevation.

C. Required Water Surface Elevation for Hydrostatic Testing:
   1. Using the water source specified in this Section, fill hydraulic structures to specified water surface test elevation indicated in the following table:

Hydraulic Structure Number	**Hydraulic Structure Service and Location**	**Water Surface Elevation for Testing**

   2. Where test elevation is not specified or indicated and fluid level in the structure will normally be controlled by a weir, fill structure to elevation six inches below the weir crest.
   3. Where test elevation is not specified or indicated and structure does not have a flow control weir, test elevation shall be two feet below top of structure.

D. Filling Hydraulic Structures with Water:
   1. Fill the portion of the hydraulic structure to be tested at rate that does not exceed two vertical feet per hour.

2. When potable water is used for testing, during filling provide temporary backflow preventer at the point where water is withdrawn from potable water system.

E. When water has reached specified test elevation and specified wetting period has elapsed, inspect hydraulic structure's exposed surfaces for leakage. Before starting hydrostatic testing, repair apparent leakage or weeping.

F. Test Duration: Hydrostatic test duration shall be determined by ENGINEER in accordance with ACI 350.1, and shall not be less than 24 hours.

G. Allowable Leakage:
1. Leakage during the test period for hydraulic structures with vertical walls is defined as the volume calculated using the difference in water surface elevations at the start and end of the test period adjusted by adding the volume of precipitation and subtracting the volume of evaporation measured during the test period.
2. Leakage during the test period for hydraulic structures with sloping walls is the quantity of water that must be supplied to the hydraulic structure or section thereof to maintain the water level within three inches of specified water surface test elevation during the hydrostatic test, plus the volume of water required to fill the hydraulic structure to specified water surface test elevation at conclusion of hydrostatic test, plus precipitation, minus evaporation.
3. For hydraulic structures with interior, wetted concrete surfaces that are not lined, allowable leakage is 0.075 percent of volume tested for each 24-hour period or portion thereof.
4. For hydraulic structures with interior wetted concrete surfaces lined with waterproof material, allowable leakage is 0.050 percent of volume tested for each 24-hour period or portion thereof.
5. No leakage is allowed for hydraulic structures with interior, wetted surfaces that do not include concrete.

H. Measurement Locations:
1. For hydraulic structures or portions thereof (when entire hydraulic structure is not tested as a whole) that are equal to or less than 1,000 square feet in water surface area, measure water level at not less than two locations approximately 180 degrees apart.
2. For hydraulic structures or portions thereof (when entire hydraulic structure is not tested as a whole) that are greater than 1,000 square feet in water surface area, measure water level at not less than four locations approximately 90 degrees apart.
3. Each measurement location shall be marked and given distinct reference number. Mark reference point on face of wall above test water surface in manner that will prevent movement or deterioration of reference point mark during the test. Remove reference point mark upon completion of testing and acceptance of testing results by ENGINEER.
4. Position the measurement locations to minimize effects of wave action and wind.

I. Evaporation and Precipitation Measurement:
   1. Evaporation and Precipitation Measurement Vessels:
      a. In hydraulic structures open to atmosphere, a clear plastic, calibrated, open-topped container not less than 18-inch diameter and not less than 18 inches deep shall be provided at each measurement location.
      b. Before starting test, partially fill each evaporation-precipitation measurement vessel and float the vessel in the hydraulic structure, held in position near each measurement location.
      c. Calibration increments in container shall be 0.1-inch or less.
   2. Position evaporation-precipitation measurement vessels so that vessels are not shaded by hydraulic structure's walls, away from overhead items such as beams, pipes, and walkways.

J. Obtaining Test Measurements:
   1. Do not start hydrostatic tests when severe weather conditions, such as heavy precipitation, high winds, major changes in average daily temperature, and other severe conditions are predicted for duration of test period.
   2. Record the following measurements at each test location at start of test period and at 12-hour intervals thereafter:
      a. Distance from reference point elevation to actual water surface.
      b. Depth of water in evaporation-precipitation containers.
      c. Temperature of test water at point 18 inches below water surface.
      d. Temperature of water in evaporation-precipitation measurement vessels at mid-depth.
   3. If actual water surface in hydraulic structure is subject to wave action at measurement location, record as data the average water surface elevation of wave oscillations.
   4. Change in the water surface elevation at each measurement location shall be averaged and adjusted as follows:
      a. Total change in hydraulic structure's water surface elevation shall be adjusted by average change in water surface elevation in evaporation-precipitation measurement vessels.
      b. Where averaged water temperature measurements vary by more than three degrees F from start to completion of test period, adjustment in test volume shall be determined by change of density of water resulting from change in the average water temperature.
   5. Determination of Leakage:
      a. Hydraulic Structures with Vertical Walls: Leakage volume shall be the drop in water surface elevation measured during the test, multiplied by water surface area of hydraulic structure tested.
      b. Hydraulic Structures with Surface Area that Varies with Depth of Water:
         1) Provide test container filled with a known quantity of water at start of test. Attach test pump suction to test container.

2) Pump water from test container into hydraulic structure being tested with the test pump to maintain water level in hydraulic structure within three inches of specified test elevation for duration of test period.
3) At conclusion of test, pump water from test container into hydraulic structure to attain specified water surface test elevation.
4) Measure water remaining in test container and record volume used during test. Volume used is considered to be leakage during the hydrostatic test.

c. Initial full volume shall include the volume of sloping tank bottoms, sump pits, and other features that contain water that is connected to the hydraulic structure during the hydrostatic test.

d. Allowable leakage shall be determined by multiplying the initial full volume by the daily leakage allowance and by the leakage test time period in days.

K. Criteria for Acceptance:
1. Hydrostatic test will pass if measured leakage is less than allowable leakage and no leaks or weeping is observed.
2. If test becomes unreliable due to excessive precipitation, freezing, or other external factors, re-start and re-perform the test at no additional cost to OWNER.
3. If hydrostatic test fails, the hydraulic structure may be re-tested immediately without repairs. If subsequent hydrostatic test fails, repair probable areas of leakage and repeat the hydrostatic test.
4. Re-test hydraulic structure until it meets criteria specified for acceptance. Repair probable leakage areas before testing.

L. Reuse and Disposal of Water Used in Hydrostatic Tests:
1. Obtain ENGINEER's acceptance before water used in one hydrostatic test is pumped to a different hydraulic structure for reuse in subsequent test.
2. If chlorine residual in test water exceeds 0.5 mg/L, dechlorinate water used for hydrostatic testing to remove chlorine residual before discharging water to storm water drainage routes. Dechlorinate water using sodium bisulfite or other dechlorination chemical acceptable to ENGINEER.

M. Hydraulic structure shall not be backfilled or have exterior coating applies (such as dampproofing) until ENGINEER accepts hydrostatic test results.

3.4 AIR TESTING

A. Preparation for Testing:
1. Prepare hydraulic structure for testing by sealing and plugging visible cracks and imperfections in walls, floor, and top.
2. Disconnect air hoses during test period and seal openings in hydraulic structure being tested.

B. Testing Hydraulic Structure for Leaks: Not less than 28 days after hydraulic structure's concrete has been placed and associated piping has been connected, perform air test as follows:
   1. Ensure the following:
      a. Pipe and hatches installed through walls and top of hydraulic structure have been installed and plugged.
      b. Holes through the top of hydraulic structure have final fittings in place.
      c. Pressure relief and vacuum breaker valve assemblies are in place and operable.
      d. Permanently anchor piping and appurtenances.
   2. Fill the hydraulic structure with water as specified in Article 3.3 of this Section to top of hydraulic structure and allow to stand for adsorption period specified in Article 3.3 of this Section.
      a. Maintain gas pressure of three inches of water column during wetting period by trapping air in hydraulic structure and adding such air as is required via a temporary compressor.
      b. Periodically examine outside face of hydraulic structure's walls for water leaks and mop the entire exposed surface of hydraulic structure with soapy-water solution to detect gas leaks.
      c. Mark and repair discovered leaks.
      d. At conclusion of 48-hour wetting period, lower the water level in sealed hydraulic structure until vacuum release equipment operates, but not to more than three inches of water column of vacuum without manually unsealing.
   3. Test gasketed connections around safety equipment, hatch covers, and similar items. For submerged gasketed connections, visually inspect for leakage. For gasketed connections above water surface, test full length of joints with soapy-water solution.
   4. After repairing leaks, re-test hydraulic structure by repeating entire test procedure.

C. Criteria for Acceptance:
   1. Air test will pass when no leaks are evidenced by formation of bubbles in the soapy-water solution, and no leakage or weeping is observed.

3.5 TESTING OF APPURTENANT PIPING

A. Test piping connected to hydraulic structures in accordance with the Contract Documents.

3.6 DISINFECTING HYDRAULIC STRUCTURES

A. Method:
   1. Hydraulic structures to be disinfected shall be chlorinated by CONTRACTOR in accordance with one of the methods in ANSI/AWWA C652, unless otherwise specified or indicated in the Contract Documents.

2. Disinfect filters in accordance with Section 5 of ANSI/AWWA C653.

C. Disinfection Procedure:
1. Provide temporary taps, plugs, valves, drains, pumps, tanks, piping, facilities, and connections required to disinfect, dechlorinate, and remove chlorinated water in accordance with the Contract Documents.
2. Disinfect hydraulic structures immediately before each structure is placed into operation, to prevent facility from becoming contaminated after disinfection.
3. Use solution of water and liquid chlorine, calcium hypochlorite, or sodium hypochlorite for disinfecting hydraulic structures. Placement of solid chlorine, such as powder or tablets, inside hydraulic structures as means of disinfection is unacceptable.
4. Introduce chlorine solution into hydraulic structure in manner accepted by ENGINEER.
5. Add potable water to hydraulic structure with the chlorine solution. Introduce water to hydraulic structure through backflow prevention device.
6. Dechlorination:
   a. When Chlorination Water will be Dischared to Potable Water System: Upon completion of disinfection of each hydraulic structure, dechlorinate contents of hydraulic structure until chlorine residual equals the residual in local potable water system.
   b. If residual of local potable water system is not available, dechlorinate to achieve maximum chlorine residual of (--1--) mg/L.
   c. Dechlorination shall be in accordance with ANSI/AWWA C653.
7. Discharge of Chlorinated Water from Hydraulic Structure:
   a. For purposes of this Article, “chlorinated water” means water discharged from the hydraulic structure after disinfection, regardless of whether the water has been dechlorinated.
   b. Discharge of chlorinated water into a sewer will not be allowed without written approval of owner of wastewater conveyance system and wastewater treatment facility.
   c. Do not discharge chlorinated water onto roadways or into ditches, storm sewers, drainage culverts, streams, or wetlands.

D. Bacteriological and Odor Testing:
1. After disinfection is completed and before hydraulic structure is placed in service, test the hydraulic structure for odor and bacteria in accordance with ANSI/AWWA C652 and APHA/AWWA/WEF Standard Methods for Examination of Water and Wastewater.
2. Obtain from each disinfected hydraulic structure samples for bacteriological and odor testing as follows:
   a. Immediately After Completion of Disinfection: Not less than two samples.
   b. Twenty-four Hours after Obtaining First Set of Samples: Not less than two samples.

3. Sampling and testing for bacteriological and odor tests shall comply with Paragraph 3.2.A.6 of this Section. Test results shall indicate satisfactory results for bacteria and odor, in accordance with requirements of authority having jurisdiction, before hydraulic structure will be Substantially Complete.
4. Repeat the disinfection procedure at no additional cost to OWNER until bacteriological and odor test results are acceptable.

+ + END OF SECTION + +

SECTION 01 51 05

TEMPORARY UTILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all temporary utilities and temporary facilities required for the Project, including the following:
      a. Electricity.
      b. Lighting.
      c. Telephone and communications.
      d. Heating, cooling, ventilating, and temporary enclosures.
      e. Water.
      f. Sanitary facilities.
      g. First-aid facilities.
      h. Fire protection.
   2. Make all arrangements with utility owners for temporary utilities and with others as appropriate for temporary facilities. Obtain required permits and approvals for temporary utilities and temporary facilities.
   3. Pay all service costs for utilities and facilities indicated in this Section as CONTRACTOR's responsibility, including cost of electricity, water, fuel, and other utility services and temporary facilities required for the Work. Refer to Section 33 05 05, Buried Piping Installation and any other section within the Contract Documents that specify use of utilities and facilities.
   4. Continuously maintain adequate temporary utilities and temporary facilities for all purposes for the Project, until removal of temporary utilities and temporary facilities. At minimum, provide and maintain temporary utilities and temporary facilities through Substantial Completion and removal of temporary field offices and sheds unless otherwise approved in writing by ENGINEER.
   5. Should OWNER occupy part of the Work prior to Substantial Completion of the entire Work, cost of utilities consumed via temporary utilities serving the portion occupied by OWNER will be shared proportionately by OWNER and CONTRACTOR as mutually agreed to by the parties.
   6. Maintain, including cleaning, temporary utilities and temporary facilities, and continuously provide consumables as required.
   7. Temporary utilities and temporary facilities shall be adequate for personnel using the Site and the needs of the Project.
   8. Provide temporary utilities and temporary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.

1.2 REQUIREMENTS FOR TEMPORARY UTILITIES AND TEMPORARY FACILITIES

A. Electrical:
   1. Provide temporary electrical service required for the Work, including continuous power for temporary field offices and sheds. Provide temporary outlets with circuit breaker protection and ground fault protection.

B. Lighting.
   1. Provide lighting at the Site of not less than five foot-candles for open areas and not less than ten foot-candles for stairs and shops.
   2. Do not work in areas with insufficient lighting. Where lighting is insufficient for the work activities to be performed, provide additional temporary lighting.
   3. Provide temporary lighting sufficient for observation of the Work by ENGINEER and inspection by CONTRACTOR and authorities having jurisdiction. Where required by ENGINEER, provide additional temporary lighting.

C. Heating, Ventilating, and Enclosures.
   1. Provide sufficient temporary heating, cooling, ventilating, and enclosures to ensure safe working conditions and prevent damage to existing facilities and the Work.
   2. Except where otherwise specified, temporary heating shall maintain temperature of the space served between 50 degrees F and maximum design temperature of building or facility and its contents.
   3. Maintain temperature of areas occupied by OWNER's personnel or electronic equipment, including offices, lunch rooms, locker rooms, toilet rooms, and rooms containing computers, microprocessors, and control equipment, between 65 degrees F and 80 degrees F with relative humidity less than 75 percent.
   4. Required temperature range for storage areas and certain elements of the Work, including preparation of materials and surfaces, installation or application, and curing as applicable, shall be in accordance with the Contract Documents for the associated Work and the Supplier's recommended temperature range for storage, application, or installation, as appropriate.
   5. Provide temporary ventilation sufficient to prevent accumulation in construction areas and areas occupied by OWNER of hazardous and nuisance levels or concentrations of dust and particulates, mist, fumes or vapors, odors, and gases, associated with construction.
   6. Provide temporary enclosures and partitions required to maintain required temperature and humidity.

D. Water:
   1. General:
      a. Provide temporary water facilities including piping, valves, meters if not provided by owner of existing waterline, backflow preventers, pressure regulators, and other appurtenances. Provide freeze-protection as required.
      b. Continuously maintain adequate water flow and pressure for all purposes during the Project, until removal of temporary water systems.
   2. Water for Construction Purposes:
      a. Provide water for Site maintenance and cleaning and, water necessary for construction activities, and water for disinfecting and testing of systems.

3. Water for Human Consumption and Sanitation:
   a. Provide potable water in accordance with Laws and Regulations for consumption by personnel at the Site, for field offices, and for sanitary facilities.
   b. When necessary, provide bottled, potable water for use and consumption by personnel at the Site, including CONTRACTOR, ENGINEER, and visitors to the Site.

E. Sanitary Facilities.
1. Provide suitably-enclosed chemical or self-contained toilets for CONTRACTOR's employees, Subcontractors, Suppliers, ENGINEER, and visitors to the Site. Location of temporary toilets shall be acceptable to OWNER and ENGINEER.
2. Refer to Paragraph 1.2.E of this Section for requirements for water intended for human consumption during construction.
3. Provide suitable temporary washing facilities for employees and visitors.
4. Pay all costs for temporary sanitary facilities and associated services, including cost of electricity, water, fuel, and other utility services required for temporary sanitary facilities.
5. Continuously maintain adequate temporary sanitary facilities for all purposes during the Project, until removal of temporary sanitary facilities. At minimum, provide and maintain temporary sanitary facilities through Substantial Completion and removal of temporary field offices and sheds, and at all times thereafter when CONTRACTOR is at the Site performing Work.
6. Maintain and clean the temporary sanitary facilities and continuously provide consumables as required.
7. Provide temporary sanitary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.
8. Completely remove temporary sanitary facilities and materials when no longer required. Repair damage caused by temporary sanitary facilities and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to pre-construction condition.

F. First-aid Facilities.
1. Provide temporary first-aid stations at or immediately adjacent to the Site's work areas, and inside CONTRACTOR's temporary field office. Locations of first-aid stations shall be determined by CONTRACTOR's safety representative.
2. Replenish supplies in first-aid stations as items are used, prior to expiration of items, and as necessary. Monitor and log inventory of supplies in first-aid stations in accordance with requirements for monitoring and logging safety equipment as indicated in Section 01 35 23, Safety Requirements.
3. First-aid stations shall be adequate for the number of personnel at the Site and the types of work and hazards anticipated.
4. Maintain, including cleaning, first-aid facilities.
5. Personnel Trained in First-Aid:
   a. When work is in progress, furnish at the Site not less than one person trained in first-aid.

b. First-aid-trained personnel shall possess valid certificate indicating that they have successfully completed first-aid training course by the American Red Cross or similar entity.

6. Use of Temporary Facilities:
   a. Properly supervise temporary facilities.
   b. Properly dispose of wastes.
7. Pay all costs for first-aid facilities, including installation, maintenance, and removal. Repair damage caused by temporary facilities and their removal and restore Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.

G. Fire Protection.
   1. Provide temporary fire protection, including portable fire extinguishers rated not less than 2A or 5B in accordance with NFPA 10, Portable Fire Extinguishers, for each temporary building and for every 3,000 square feet of floor area under construction.
   2. Provide Class A (ordinary combustibles), Class B (combustible liquids and gases), and Class C (electrical equipment) fire extinguishers as necessary.
   3. Comply with NFPA 241, Standard for Safeguarding Construction, Alternation, and Demolition Operations, and requirements of fire marshals and authorities having jurisdiction at the Site.

1.3 USE OF OWNER'S SYSTEM

A. Use of Permanent Utility Systems Provided Under the Project:
   1. Permanent electrical, lighting, water, heating, ventilating, and fire protection systems and first-aid facilities may be used to provide temporary utilities and temporary facilities if the following are met:
      a. Obtain OWNER's written permission to use permanent systems.
      b. Permanent systems to be used for temporary utilities or temporary facilities shall be substantial complete, including complete functionality of all controls.
      c. CONTRACTOR shall pay all costs while using permanent system, including operation, maintenance, replacement of consumables, and provide replacement parts.
   2. Do not use the following permanent facilities:
      a. Telephone and communication facilities.
      b. Sanitary facilities.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for temporary utilities and temporary facilities may be new or used, but shall be adequate for purposes intended and shall not create unsafe conditions, and shall comply with Laws and Regulations.

B. Provide required materials, equipment, and facilities, including piping, cabling, controls, and appurtenances.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install temporary utilities and temporary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.

B. Location of Temporary Utilities and Temporary Facilities:
   1. Locate temporary systems for proper function and service.
   2. Temporary systems shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility owners and others.
   3. Do not install temporary utilities on the ground, with the exception of temporary extension cords, hoses, and similar systems in place for short durations.

C. Modify and extend temporary systems as required by progress of the Work.

3.2 USE

A. Maintain temporary systems to provide safe, continuous service as required.

B. Properly supervise operation of temporary systems:
   1. Enforce compliance with Laws and Regulations.
   2. Enforce safe practices.
   3. Prevent abuse of services.
   4. Prevent nuisances and hazards caused by temporary systems and their use.
   5. Prevent damage to finishes.
   6. Ensure that temporary systems and equipment do not interrupt continuous progress of construction.

C. At end of each work day, check temporary systems and verify that sufficient consumables are available to maintain operation until work is resumed at the Site. Provide additional consumables if the supply on hand is insufficient.

3.3 REMOVAL

A. Completely remove temporary utilities, temporary facilities, equipment, and materials when no longer required. Repair damage caused by temporary systems and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.

B. Where temporary utilities are disconnected from existing utility, provide suitable, watertight or gastight (as applicable) cap or blind flange, as applicable, on service line, in accordance with requirements of utility owner.

C. Where permanent utilities and systems were used for temporary utilities, upon Substantial Completion replace all consumables such as filters and light bulbs and parts used during the Work.

+ + END OF SECTION + +

SECTION 01 52 13

CONTRACTOR'S FIELD OFFICE AND SHEDS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide a temporary field office for CONTRACTOR's use with not less than the minimum facilities specified. CONTRACTOR shall provide an office space with furnishings, equipment, and consumables, for use by ENGINEER.
   2. Provide required temporary storage and work sheds.
   3. Obtain and pay for required permits and utilities. Field offices and sheds shall comply with Laws and Regulations.

B. Coordination:
   1. Coordinate with OWNER, facility manager, other contractors, and others using the Site the location of field offices and sheds, including contracts indicated in Section 01 11 13, Summary of Work.

C. Location:
   1. Locate field offices and sheds in accordance with the Contract Documents and in accordance with the Site mobilization discussions at the preconstruction conference.
   2. Refer to drawings for suggested locations for contractor's field office and sheds.

D. Furnish in CONTRACTOR's field office one complete set of the Contract Documents for ready reference by interested persons. In addition to the reference set, comply with Section 01 78 39, Project Record Documents and related provisions of the General Conditions, as may be modified by the Supplementary Conditions.

PART 2 – PRODUCTS

2.1 FIELD OFFICE AND SHEDS – FURNISHINGS, AND EQUIPMENT

A. Contractor's Field Office and Furnishings:
   1. Construction: As required by CONTRACTOR and sufficient for Project meetings.
   2. Maintain field office space for ENGINEER's sole use.
   3. Utilities and Services: Provide the following:
      a. Telephone service.
      b. Computer wireless networking (Wi-Fi), and related facilities as required for CONTRACTOR's needs and ENGINEER's use. Wi-Fi shall have sufficient capabilities for email communications, around 1,000

megabytes per second (Mbps), for uploading/downloading project documentation to/from project servers on a daily basis.

c. Utilities and related facilities for lighting and maintaining temperature to comfortable working conditions.

i. Provide automatic heating to maintain indoor temperature in field office of not less than 65 degrees F in cold weather. Furnish all fuel and pay all utility costs.

ii. Automatic cooling to maintain indoor temperature in field office of not warmer than 75 degrees F in warm weather

4. Furnishings:
   a. Conference Facilities: CONTRACTOR shall Provide conference area with conference table and chairs sufficient for 12 people. Conference facilities and furnishings shall be provided with suitable utilities, lighting, ventilation, and temperature controls prior to the first progress meeting, unless otherwise approved by ENGINEER.
   b. Other furnishings required by CONTRACTOR.
5. Provide on field office's exterior an identification sign displaying CONTRACTOR's company name. Maximum size of sign shall be four feet by eight feet. Sign shall be suitable for outdoor use for the duration of the Project.
6. Furnish and maintain at CONTRACTOR's field office 12 protective helmets ('hard hats") for use by visitors to the Site.

B. Contractor's Storage and Work Sheds:
   1. Provide storage and work sheds sized, furnished, and equipped to accommodate personnel, materials, and equipment involved in the Work, including temporary utility services and facilities required for environmental controls sufficient for personnel, materials, and equipment.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Installation:
   1. Install CONTRACTOR's temporary field offices, sheds, and related facilities in accordance with Laws and Regulations.
   2. Install materials and equipment, including prefabricated structures, in accordance with manufacturer's instructions.

3.2 MAINTENANCE AND REMOVAL

A. Maintenance:
   1. Clean and maintain field offices and sheds as required.
   2. Provide consumables as required.

B. Removal:
   1. Do not remove temporary field offices and sheds until after Substantial Completion of the entire Work, unless otherwise approved by ENGINEER.

2. Remove field offices and sheds and restore areas to original condition or better prior to final inspection.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 52 16

FIRST AID FACILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for temporary first-aid facilities for personnel use at Site during construction, including first-aid stations, lists of emergency contact information, and first-aid-trained personnel.
   2. CONTRACTOR shall provide first-aid facilities during the Project, including:
      a. Paying all costs for first-aid facilities, including installation, maintenance, and removal.
      b. Maintaining, including cleaning, first-aid facilities. Keep first-aid facilities continuously supplied with consumables.
      c. Facilities shall be adequate for personnel using the Site.
      d. Providing facilities in compliance with Laws and Regulations.

1.2 TEMPORARY FIRST-AID FACILITIES REQUIRED

A. Provide the following temporary first-aid facilities:
   1. First-aid Stations at the Site:
      a. Provide temporary first-aid stations at or immediately adjacent to the Site's major work areas, and inside CONTRACTOR's temporary field office.
      b. Locations of first-aid stations shall be determined by CONTRACTOR's safety representative.
      c. Other contractors shall provide first-aid stations in their own field office.
      d. First-aid stations shall be adequate for the number of personnel at the Site and the types of work and hazards anticipated.
      e. Not less-often than monthly, inspect each temporary first-aid station and inventory items consumed or used and remove items that are at or near their expiration date. Promptly replace and restock consumables and expired items.
   2. Emergency Contact List:
      a. Provide list of emergency telephone numbers at each hardwired telephone at the Site.
      b. List shall be in accordance with the list of emergency contact information required in Section 01 35 23, Safety Requirements.
   3. Personnel Trained in First-Aid:
      a. When work is in progress, furnish at the Site not less than one person trained in first-aid.

b. First-aid-trained personnel shall possess valid certificate indicating that they have successfully completed first-aid training course by the American Red Cross or similar entity.

B. Restrictions:
1. Existing Facilities: In general, OWNER's existing first-aid facilities shall not be used by contractors without written permission of OWNER with conditions for use. Exceptions include life-threatening situations. When used, promptly and completely restock and restore such facilities with identical items.
2. Permanent Facilities Provided Under the Project: In general, contractors shall not use permanent first-aid facilities provided under the Project. Exceptions include life-threatening situations. When used, promptly and completely restock and restore such facilities with identical items.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 USE

A. Use of Temporary Facilities:
1. Properly supervise temporary facilities.
2. Properly dispose of wastes.

3.2 REMOVAL

A. Completely remove temporary facilities and materials when no longer required. Repair damage caused by temporary facilities and their removal and restore Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to preconstruction condition.

+ + END OF SECTION + +

SECTION 01 52 19

SANITARY FACILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for temporary sanitary facilities, including toilet facilities, drinking water for personnel, and personnel washing facilities.
   2. CONTRACTOR shall provide all temporary sanitary facilities required for the Project.

      a. Make all arrangements with temporary sanitary facility providers for temporary sanitary services and obtain required permits and approvals for temporary sanitary facilities and associated services.
      b. Pay all costs for temporary sanitary facilities and associated services, including cost of electricity, water, fuel, and other utility services required for temporary sanitary facilities.
      c. Continuously maintain adequate temporary sanitary facilities for all purposes during the Project, until removal of temporary sanitary facilities. At minimum, provide and maintain temporary sanitary facilities through Substantial Completion and removal of temporary field offices and sheds, and at all times thereafter when CONTRACTOR is at the Site performing Work.
      d. Maintain and clean the temporary sanitary facilities and continuously provide consumables as required.
      e. Temporary sanitary facilities shall be adequate for personnel using the Site and requirements of Project.
      f. Provide temporary sanitary facilities in compliance with Laws and Regulations and, when applicable, requirements of utility owners.

1.2 REQUIREMENTS FOR TEMPORARY SANITARY FACILITIES

A. Sanitary Facilities.
   1. Portable Toilets:
      a. Provide suitably-enclosed, temporary chemical or self-contained toilets for CONTRACTOR's employees and visitors to the Site.
      b. Location of temporary toilets shall be acceptable to OWNER.
   2. Drinking Water:
      a. Provide supply of potable drinking water and related facilities and consumables for all personnel using the Site, including employees of contractors, OWNER, facility manager, ENGINEER, visitors, and others.
      b. Location of potable drinking water supply shall be as required by CONTRACTOR and convenient for access by personnel

c. Provide potable drinking water supply and cups.
d. Replenish drinking water supply as needed. Avoid creating hazards to health and safety caused by shortages of drinking water quantity and inadequate quality.
e. Drinking water quality shall comply with Laws and Regulations.

3. Washing Facilities:
   a. Provide suitable temporary washing facilities for employees, ENGINEER, and visitors to the Site.
   b. Washing facilities shall be adequate for the nature of work underway at the Site.
   c. Properly handle, store, and dispose of sued wash water, in accordance with Laws and Regulations.

1.3 USE OF OWNER'S SYSTEM

A. Existing Sanitary Facilities:
   1. Do not use facilities in existing buildings or structures for temporary sanitary facilities without written permission of OWNER and facility manager and mutually acceptable basis agreed upon by the parties for proportionate sharing of costs between OWNER and CONTRACTOR.
   1. CONTRACTOR personnel may use OWNER's existing, permanent sanitary facilities at the Site without additional charge. CONTRACTOR's use of OWNER's permanent sanitary facilities is limited to those sanitary facilities adjacent to the chorine room.

B. Use of Permanent Sanitary Facilities Provided Under the Project:
   1. CONTRACTOR's personnel shall not use the following permanent facilities:
      a. Haskell WWTP Sanitary facilities.

PART 2 – PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Materials and equipment for temporary sanitary facilities may be new or used, but shall be adequate for purposes intended and shall not create unsafe conditions, and shall comply with Laws and Regulations.

B. Provide required materials, equipment, and facilities, including piping, wiring, and controls.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install temporary sanitary facilities in neat, orderly, manner, and make structurally, mechanically, and electrically sound throughout.

B. Location of Temporary Sanitary Facilities:

1. Locate temporary sanitary facilities for proper function and service.
2. Temporary sanitary facilities shall not interfere with or provide hazards or nuisances to: the Work under this and other contracts, movement of personnel, traffic areas, materials handling, hoisting systems, storage areas, finishes, and work of utility companies.

C. Modify and extend temporary sanitary facilities as required by progress of the Work.

3.2 USE

A. Maintain temporary sanitary facilities to provide safe, continuous service as required.

B. Supervision and Enforcement of Use:
1. Properly supervise operation of temporary sanitary facilities.
2. Enforce compliance with Laws and Regulations.
3. Enforce safe practices.
4. Prevent abuse of services.
5. Prevent nuisances and hazards caused by temporary sanitary facilities and their use.
6. Prevent damage to finishes.
7. Ensure that temporary sanitary facilities do not interrupt continuous progress of the Work.

C. Checks and Consumables:
1. At end of each work day, check temporary sanitary facilities and verify that sufficient consumables are available to maintain operation until work is resumed at the Site.
2. Provide additional consumables if the supply on hand is insufficient.

3.3 REMOVAL

A. Completely remove temporary sanitary facilities and materials when no longer required. Repair damage caused by temporary sanitary facilities and their removal and restore the Site to condition required by the Contract Documents; if restoration of damaged areas is not specified, restore to pre-construction condition.

B. When permanent sanitary facilities were used for temporary sanitary facilities, immediately prior to requesting inspection for Substantial Completion, replace all consumables used during the Work and verify suitability of sanitary facilities for OWNER’s permanent use. Correct deficiencies and damage.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 55 13

ACCESS ROADS AND PARKING AREAS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide temporary construction roads, walks, parking areas, and appurtenances required during the Project for use by CONTRACTOR, other contractors employed on the Project, OWNER's, facility manager's, and emergency vehicles.
   2. Temporary roads and parking areas shall be designed and maintained by CONTRACTOR and shall be fully passable to vehicles in all weather conditions.

B. Use of Existing Access Roads:
   1. CONTRACTOR will be allowed to use OWNER's existing roads upon obtaining OWNER's written permission.
   2. Prevent interference with traffic on existing roads and parking areas. Always keep access roads and entrances serving the Site clear and available to OWNER, facility manager, and their respective employees; emergency vehicles; and other contractors. Do not use access roads or Site entrances for parking or storage of materials or equipment.
   3. CONTRACTOR shall indemnify and hold harmless OWNER and ENGINEER from expenses and losses caused by CONTRACTOR's operations over existing roads, drives, and parking areas.
   4. Schedule deliveries to minimize use of driveways and Site entrances.

1.2 SITE ACCESS

A. Site Access:
   1. CONTRACTOR access to the Site will be as directed by OWNER.
   2. Access to the Site is limited to a maximum weight of tons per axle.
   3. A maximum available vehicular height clearance is not applicable for the Site.

1.3 CONTRACTOR PARKING

A. CONTRACTOR employee vehicles shall park in area(s) as designated by OWNER.

B. Park construction vehicles and equipment in work areas designated for CONTRACTOR staging shown on the Drawings.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Materials for temporary roads and parking areas shall comply with the Contract Documents' and OWNER requirements for permanent roads, drives, and parking areas.

B. Traffic controls shall comply with requirements of authorities having jurisdiction. When such authority is the OWNER or facility manager, and no requirements are indicated, comply with the standard specifications of the state department of transportation in the area of the Project.

PART 3 – EXECUTION

3.1 TEMPORARY ROADS AND PARKING AREAS

A. Temporary Roads and Parking in Areas Different from Permanent Pavement:
   1. CONTRACTOR to utilized temporary roads and parking areas adequate to support and withstand traffic loads during the Project, that have been implemented for the Contract.
   2. Provide reasonably-level, graded, well-drained subgrade of satisfactory soil material, compacted to not less than 95 percent of maximum dry density in the upper six inches.
   3. Where required to support loads and provide separation between subgrade and subbase materials, provide geosynthetic separation fabric as required.
   4. Subbase:
      a. Provide crushed stone subbase material not less than six inches thick, roller-compacted to a level, smooth, dense surface.
      b. Subbase for temporary roads and areas traveled by construction vehicles shall be adequate for loads and traffic served.

B. Temporary Roads and Parking in Same Areas as Permanent Pavement:
   1. Provide temporary roads and parking areas adequate to support and withstand traffic and construction loads during the Project. Locate temporary roads and parking areas in same location as permanent roads and parking areas. Extend temporary roads and parking areas, within construction limits indicated, as required for construction operations.
   2. Coordinate elevations of temporary roads and parking areas with permanent roads and parking areas.
   3. Prepare subgrade, subbase, and base for temporary roads and parking areas in accordance with the Contract Documents requirements for permanent roads, drives, and parking areas.
   4. Where required by subgrade conditions and construction loads and traffic, provide geosynthetic separation fabric as required on compacted subgrade for subbase support and separation of subbase and subgrade materials.

5. Re-condition granular subbase of temporary roads and parking areas, including removing and properly disposing of granular material that has become intermixed with soil, re-grading, proof-rolling, compacting, and testing.

3.2 TRAFFIC CONTROLS

A. Traffic Controls:
   1. Provide temporary traffic controls at intersections of temporary roads with each other and with parking areas, including intersections with other temporary roads, intersections with public roads, and intersections with permanent access roads at the Site.
   2. Provide temporary warning signs on permanent roads and drives, and provide temporary "STOP" signs for traffic on temporary roads where required and at entrances to permanent pavement.
   3. Comply with requirements of authorities having jurisdiction. When such authority is the OWNER or facility manager, and no requirements are indicated, comply with the standard specifications of the state department of transportation in the area of the Project

3.3 MAINTENANCE OF ROADS

A. General:
   1. Maintain temporary roads and parking to continuously provide at the Site access for construction vehicles and trucks, OWNER and facility manager vehicles, deliveries for OWNER and facility manager, emergency vehicles, and parking areas for OWNER's and facility manager's personnel.
   2. Public roads shall be passable at all times unless a road closure is allowed in writing by authority having jurisdiction.
   3. When granular material of temporary roads and parking without hard surfacing become intermixed with soil or when temporary roads otherwise create a nuisance, remove intermixed granular-and-soil material and replace with clean granular material as required.
   4. Provide snow and ice removal for temporary roads and parking areas.

B. Cleaning and Dust Control:
   1. Cleaning: Clean paved surfaces over which construction vehicles travel. Perform cleaning not less often than the frequency indicated in Section 31 11 00 Clearing and Grubbing, or more frequently as directed by ENGINEER, by mechanical sweeping or other means acceptable to ENGINEER.
   2. Clean the following surfaces:
      a. Roads within limits of the Project.
      b. Permanent roads at the Site between the Site entrance and the work areas, and between the Site entrance and construction parking and staging areas.
      c. Public roads that require sweeping and cleaning due to construction operations.
   3. Dust Control:

a. Control dust resulting from construction activities to prevent nuisances at the Site and in nearby areas.
b. Comply with Section 31 23 16, Trenching and Section 01 57 05, Temporary Controls.

C. Protection of Underground Facilities: Comply with the General Conditions, as may be modified by the Supplementary Conditions, Section 01 71 33, Protection of Work, Property, and Traffic, and other requirements of the Contract Documents.

3.4 REMOVALS AND RESTORATION

A. Removals:
1. Remove temporary roads, drives, walks, and parking areas that are not intended for, or acceptable for, integration into permanent pavement. Return areas of temporary roads, drives, walks, and parking to pre-construction condition unless otherwise required by the Contract Documents.
2. Remove temporary gates, fencing, and traffic controls associated with temporary roads and parking areas.
3. Where areas of temporary roads and parking will be permanently landscaped, remove pavement, granular subbase, geosynthetic (where required by ENGINEER), soil, and other materials that do not comply with the Contract Documents regarding fill, subsoil, and landscaping.
4. Remove and properly dispose of materials contaminated with oil, bitumen, and other petrochemical compounds resulting from CONTRACTOR's operations, and other substances that might impair growth of plants and lawns.

B. Restoration:
1. Repair or replace paving, curbs, gutters, and sidewalks affected by temporary roads and parking, and restore to required conditions in accordance with authorities having jurisdiction.
2. Restore to pre-construction conditions existing roads, walks, and parking areas damaged by CONTRACTOR, subject to approval of the owner of affected roads, drives, walks, and parking areas.

+ + END OF SECTION + +

SECTION 01 57 05

TEMPORARY CONTROLS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide and maintain methods, materials, equipment, and temporary construction as required for controlling environmental conditions at the Site and adjacent areas during construction.
   2. Maintain controls until no longer required. Provide temporary controls at all times when CONTRACTOR is working at the Site.
   3. Temporary controls include, but are not limited to, the following:
      a. Erosion and sediment controls.
      b. Noise controls.
      c. Dust controls.
      d. Pest and rodent controls.
      e. Control of water, including storm water runoff.
      f. Pollution controls.

B. Related Sections:
   1. Section 01 41 26, Storm Water Pollution Prevention Plan and Permit
   2. Section 31 23 16, Trenching.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with applicable provisions and recommendations of the following:
   1. Texas Commission on Environmental Quality (TCEQ).

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Plan for construction staging and maintenance of the Site relative to erosion and sediment controls. Indicate on a site plan the approximate areas of planned disturbance of soils and soil cover over time during the Project. For areas not indicated in the Contract Documents as being disturbed and that CONTRACTOR proposes to disturb, Shop Drawing shall include proposed erosion and sediment control measures for the additional area.
   2. Product Data:
      a. Silt fencing materials.

B. Informational Submittals: Submit the following:
   1. Procedural Submittals:
      a. Proposed dust control measures, 5 days after notice to proceed is given by OWNER.

PART 2 – PRODUCTS

2.1 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

A. Materials for temporary erosion and sediment controls shall be as shown or indicated on the Drawings.

2.2 MATERIALS FOR TEMPORARY EROSION AND SEDIMENT CONTROLS

A. General:
   1. Materials utilized for temporary erosion and sediment controls shall be in accordance with the applicable regulatory requirements indicated in Article 1.2 of this Section, unless otherwise shown or indicated in the Contract Documents.

B. Silt Fencing:
   1. Filter Cloth:
      a. Products and Manufacturers: Provide one of the following:
         1) Contech “Silt Fence”.
         2) Hanes Geo Components “Silt Fence”.
         3) Atlantic Construction Fabrics (ACF) Environmental “Silt Fence”.
         4) Or equal.
      b. Height: Two feet, minimum.
      c. Securely fasten filter cloth to wire mesh using ties spaced at maximum intervals of two feet on centers at top and mid-height of wire mesh.
   2. Wire Mesh: Support filter cloth with wire mesh complying with the following:
      a. Woven wire mesh, 14-gauge steel wire, maximum mesh size six-inch by six-inch.
      b. Height: To match filter cloth height.
      c. Fasten wire mesh to fence supports with wire ties or staples.
   3. Fence Support Posts:
      a. Length: Not less than three feet.
      b. Material: Metal or other acceptable material with "U", “T”, or "I" cross section, or hardwood measuring not less than 1.25-inch by 1.25-inch in cross-section.

C. Straw Bale Dike.
   1. Bales shall be firmly-packed, unrotted straw bound firmly with baling wire. Cross-sectional area on the small end of each bale shall be approximately 12 inches by 12 inches or larger.
   2. Posts shall comply with requirements for silt fencing support posts, or may be suitable reinforcing steel rods.

D. Mulch Materials and Soil Stabilization.
   1. Mulch shall be unrotted straw or salt hay.
   2. Soil stabilization emulsions, when used, shall be an inert, eco-friendly chemical manufactured for the specific purpose of erosion control and soil stabilization, applied with mulch or stabilization fibers.
   3. Wood-fiber or paper-fiber, when used, shall be 100 percent natural and biodegradable.
   4. Erosion control mat or netting shall be biodegradable. Acceptable materials include jute, excelsior, straw or coconut fiber, and cotton.

E. Protection of Storm Water Drainage Inlets and Catch Basins:
   1. Inlet Filter Bag:
      a. Product and Manufacturer: Provide one of the following for each drainage inlet or catch basin to be protected:
         1) Atlantic Construction Fabrics (ACF) Environmental, “Silt Sack”.
         2) Mutual Industries, Inc. “Silt Sack”.
         3) Or equal.
      b. Inlet filter bag permeability shall be not less than 40 gallons per square foot of bag area exposed to the flow. Fabric shall be woven polypropylene with double stitching to prevent bursting.
      c. Inlet filter bags shall:
         1) Fit inside the drainage inlet or catch basin and shall be secured by the structure's grate or by other acceptable means.
         2) Have means of removing inlet filter bag and the silt and sediment collected therein without dumping filter bag's contents into the drainage inlet or catch basin.

F. Filter Bag on Dewatering Pump Discharge:
   1. Provide filter bag on discharge of each dewatering pump drawing from an excavation. Filter bag is not required on pumps associated with dewatering wells.
   2. Products and Manufacturers: Provide one of the following:
      a. UltraTech Dewatering Bag, by Interstate Products.
      b. Filter Bag, by US Fabrics.
      c. Dewatering (Filter) Bag, by Indian Valley Industries.
      d. DirtBag, by Atlantic Construction Fabrics (ACF) Environmental
      e. Or equal.
   3. Size filter bags for maximum flow of the pump. Filter bags shall be specifically fabricated for use as a dewatering pump filter bag.
   4. Provide sufficient spare filter bags for continuous dewatering operations.

I. Temporary Stone Construction Entrance:
   1. Stone: Tough, hard, durable stone complying with the following gradation requirements:

Sieve Size	Total Percent Passing
Four-inch (100 mm)	100
3.5-inch (90 mm)	90 to 100

2.5-inch (65 mm)	25 to 60
1.5-inch (37.5 mm)	Zero to 15

.

2. Geotextile Separation Fabric: As recommended by geotextile manufacturer for separating stone from subgrade, for the vehicle weight and traffic frequency required.

PART 3 – EXECUTION

3.1 NOISE CONTROL

A. Noise Control – General:
   1. CONTRACTOR's vehicles and equipment shall minimize noise emissions to greatest degree practicable. When necessary, provide mufflers and silencers on construction equipment, and provide temporary sound barriers onsite when necessary.
   2. Noise levels shall comply with Laws and Regulations, including OSHA requirements and local ordinances.
   3. Noise emissions shall not interfere with the work of OWNER, facility manager, or others.

3.2 DUST CONTROL

A. Dust Control – General:
   1. Due to the possibility of contamination of soil at the site from arsenic, cadmium, and lead, dust control is imperative and shall be minimized to the greatest extent possible. It is prudent that the Contractor refers to OSHA regulations for specific guidelines on how to reduce work-related exposure to potential contaminated soils, specifically the OSHA Lead in Construction Rule (29 CFR 1926.62).
   2. Control dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, demolition, trenching, cleaning, and other actions. To minimize airborne dust, apply water or use other methods subject to acceptance of ENGINEER and approval of authorities having jurisdiction.
   3. CONTRACTOR shall prevent blowing and movement of dust from exposed soil surfaces and access roads to reduce onsite and off-Site damage, nuisances, and health hazards associated with dust emissions.

B. Dust Control Methods:
   1. Dust control may be achieved by irrigation or soil wetting in which the dust-prone area of the Site shall be sprinkled with water until the surface is moist.
   2. Apply dust controls as frequently as required without creating nuisances such as excessive mud and ponding of water at the Site. Do not use water for dust control when water will cause hazardous or objectionable conditions such as ice, mud, ponds, and pollution.
   3. Provide dust control that is non-polluting and does not contribute to tracking-out of dirt and dust onto pavement.

C. Removal of Dust and Dirt from Travelled Surfaces:
   1. Remove dust and dirt from roadways, drives, parking areas, and other travelled surfaces not less than monthly.
   2. Perform dust and dirt removals from travelled surfaces by mechanical sweeping or other method acceptable to ENGINEER.

3.3 PEST AND RODENT CONTROL

A. Pest and Rodent Control – General:
   1. Provide pest and rodent controls as required to prevent infestation of the Site and storage areas.
   2. Employ methods and use materials that do not adversely affect conditions at the Site or on adjoining properties.
   3. In accordance with Laws and Regulations, promptly and properly dispose of pests and rodents trapped or otherwise controlled.

3.4 WATER CONTROL

A. Water Control – General:
   1. Provide methods to control surface water and water from excavations and structures to prevent damage to the Work, the Site, and adjoining properties.
   2. Control fill, grading, and ditching to direct water away from excavations, pits, tunnels and other construction areas and to direct drainage to proper runoff courses to prevent erosion, damage, or nuisance. Avoid directing to adjoining properties runoff from the Site and construction operations.

B. Equipment and Facilities for Water Control:
   1. Provide, operate, and maintain equipment and facilities of adequate size to control surface water.

C. Discharge and Disposal:
   1. Dispose of storm water and ground water in manner to prevent flooding, erosion, and other damage to any and all parts of the Site and adjoining areas, and that complies with Laws and Regulations.

3.5 POLLUTION CONTROL

A. Pollution Control – General:
   1. Provide means, methods, and facilities required to prevent contamination of soil, water, and atmosphere caused by discharge of noxious substances from or caused by construction operations.
   2. Equipment used during construction shall comply with Laws and Regulations.

B. Spills and Contamination:
   1. Provide equipment and personnel to perform emergency measures required to contain spills and to remove contaminated soils and liquids.

2. Excavate contaminated material and properly dispose of off-Site, and replace with suitable compacted fill and topsoil.

C. Protection of Surface Waters and Ground Water:
1. Provide and maintain special measures to prevent harmful substances from entering surface waters and ground water. Prevent disposal of wastes, effluents, chemicals, and other such substances in or adjacent to surface waters and open drainage routes, in sanitary sewers, or in storm sewers, and in ground water.

D. Atmospheric Pollutants:
1. Provide and maintain systems for controlling atmospheric pollutants related to the Work.
2. Prevent toxic concentrations of chemicals and vapors.
3. Prevent harmful dispersal of pollutants into atmosphere.

E. Solid Waste:
1. Provide and maintain systems for controlling and managing solid waste related to the Work.
2. Prevent solid waste from becoming airborne, and from discharging to surface waters and drainage routes.
3. Properly handle and dispose of solid waste.
4. Comply with requirements for cleaning and disposal of debris in the General Conditions, as may be modified by the Supplementary Conditions, and Section 01 74 05, Cleaning.

3.6 EROSION AND SEDIMENT CONTROLS

A. Installation and Maintenance of Erosion and Sediment Controls – General:
1. General:
a. Provide temporary erosion and sediment controls as shown and indicated on the Drawings and as indicated elsewhere in the Contract Documents. Provide erosion and sediment controls as the Work progresses into previously-undisturbed areas.
b. Installation of erosion and sediment controls shall be in accordance with the applicable regulatory requirements indicated in Article 1.2 of this Section, unless more-stringent methods are otherwise shown or indicated in the Contract Documents.
c. Use necessary methods to successfully control erosion and sedimentation, including ecology-oriented construction practices, vegetative measures, and mechanical controls. Use best management practices (BMP) in accordance with Laws and Regulations, and regulatory requirements indicated in Article 1.2 of this Section, to control erosion and sedimentation during the Project.
d. Plan and execute construction, disturbances of soils and soil cover, and earthwork by methods to control surface drainage from cuts and fills, and from borrow and waste disposal areas, to prevent erosion and sedimentation. Provide

temporary measures for controlling erosion and sedimentation, as indicated in the Contract Documents and as required for the Project.

e. Where areas must be cleared for storage of materials or equipment, or for temporary facilities, provide measures for regulating drainage and controlling erosion and sedimentation, subject to the ENGINEER'S approval.

f. Provide erosion and sediment controls, including stabilization of soils, at the end of each workday.

2. Coordination:
   a. Coordinate erosion and sediment controls with this Section's requirements on water control.
   b. Coordinate temporary erosion and sediment controls with construction of permanent drainage facilities and other Work to the extent necessary for economical, effective, and continuous erosion and sediment controls.
3. Before commencing activities that will disturb soil or soil cover at the Site, provide all erosion and sediment control measures required by the Contract Documents for the areas where soil or soil cover will be disturbed.
4. In general, implement construction procedures associated with, or that may affect, erosion and sediment control to ensure minimum damage to the environment during construction. CONTRACTOR shall implement any and all additional measures required to comply with Laws and Regulations, and Section 01 41 26, Storm Water Pollution Prevention Plan and Permit.
5. Vegetation Removal: Remove only those shrubs, grasses, and other vegetation that must be removed for construction. Protect remaining vegetation.
6. Access Roads and Parking Areas: When possible, access roads and temporary roads and parking shall be located and constructed to avoid adverse effects on the environment. Provide measures to regulate drainage, avoid erosion and sedimentation, and minimize damage to vegetation.
7. Earthwork and Temporary Controls:
   a. Perform excavation, fill, and related operations in accordance with Section 31 23 16, Trenching.
   b. Control erosion to minimize transport of silt from the Site into existing waterways and surface waters. Such measures shall include, but are not limited to, using berms, silt fencing, baled straw silt barriers, gravel or crushed stone, mulching and soil stabilization, slope drains, and other methods. Apply such temporary measures to erodible materials exposed by activities associated with the construction of the Project.
   c. Hold to a minimum the areas of bare soil exposed at one time.
   d. Construct fills and waste areas by selectively placing fill and waste materials to eliminate surface silts and clays that will erode.
   e. In performing earthwork, eliminate depressions that could serve as mosquito breeding pools.
   f. CONTRACTOR shall provide special care in areas with steep slopes, where disturbance of vegetation shall be minimized to maintain soil stability.
8. Inspection and Maintenance:
   a. Periodically inspect areas of earthwork and areas where soil or soil cover are disturbed to detect evidence of the start of erosion and sedimentation; promptly

implement corrective measures as required to control erosion and sedimentation. Continue inspections and corrective measures until soils are permanently stabilized and permanent vegetation has been established

b. Inspect not less often than the frequency indicated in Section 01 41 26, Storm Water Pollution Prevention Plan and Permit.

c. Repair or replace damaged erosion and sediment controls within 24 hours of CONTRACTOR becoming aware of such damage.

d. Periodically remove silt and sediment that has accumulated in or behind sediment and erosion controls. Properly dispose of silt and sediment.

9. Duration of Erosion and Sediment Controls:

a. Maintain erosion and sediment controls in effective working condition until the associated drainage area has been permanently stabilized.

b. Maintain erosion and sediment controls until the Site is restored and site improvements including landscaping, if any, are complete with underlying soils permanently stabilized.

10. Work Stoppage:

a. If the Work is temporarily stopped or suspended for any reason, CONTRACTOR shall provide additional temporary controls necessary to prevent environmental damage to the Site and adjacent areas while the Work is stopped or suspended.

11. Failure to Provide Adequate Controls:

a. In the event CONTRACTOR repeatedly fails to satisfactorily control erosion and sedimentation, OWNER reserves the right to employ outside assistance or to use OWNER's own forces for erosion and sediment control.

b. Cost of such work by OWNER, plus engineering and inspection costs, will be deducted from amounts due CONTRACTOR, as set-offs in accordance with the Contract Documents.

B. Erosion and Sediment Control Permit:

1. Texas Commission on Environmental Quality (TCEQ).

C. Silt Fencing:

1. Install and maintain silt fencing in a vertical plane, at the location(s) shown or indicated in the Contract Documents and where required.

2. Locations of Silt Fencing:

a. Where possible, install silt fencing along contour lines so that each given run of silt fencing is at the same elevation.

b. On slopes, install silt fencing at intervals that do not exceed the maximum intervals indicated in the following table:

Slope (percent)	**Maximum Length of Slope Above Each Silt Fence (feet)**
2 and less	150
2.1 to 5	100
5.1 to 10	50
10.1 to 20	25
20.1 to 25	20

25.1 to 40	15
40.1 to 50	10

c. Provide silt fencing around perimeter of each stockpile of topsoil, general fill material, and excavated material. Install silt fencing before expected precipitation and maintain until stockpile is removed.
d. Do not install silt fencing at the following types of locations:
   1) Area of concentrated storm water flows such as ditches, swales, or channels.
   2) Where rock or rocky soils prevent full and uniform anchoring of silt fencing.
   3) Across upstream or discharge ends of storm water piping or culverts.

3. Installation:
   a. Securely fasten wire mesh to posts, and securely fasten filter cloth to wire mesh.
   b. When two sections of filter cloth abut each other, fold over edges and overlap by not less than six inches and securely fasten to wire mesh.
   c. Embed posts in the ground to the depth necessary for proper controls; embed posts to not less than 16 inches below ground.
   d. Filter cloth and wire mesh shall extend not less than eight inches below ground and not less than 16 inches above ground.
   e. Remove sediment accumulated at silt fencing as required. Repair and reinstall silt fencing as required.
4. Maintenance:
   a. Do not allow formation of concentrated storm water flows on slopes above silt fencing unless so shown or indicated in the Contract Documents. If unauthorized concentrated storm water flows occur, stabilize the slope via earthmoving and other stabilization measures as required to prevent flow of concentrated storm water flows toward silt fencing.

D. Straw Bale Dike.
1. Install straw bale dikes where shown or indicated, including in swales, along contours, and along toe of slopes.
2. Install straw bales in shallow excavation as wide as the bale and approximately four to six inches below surrounding grade.
3. Ends of straw bales shall tightly abut ends of adjacent straw bales.
4. Securely install straw bales using two support posts per straw bale, driven into the ground not less than 1.5 to two feet below bottom of straw bale. Top of post shall be flush with top of straw bale. Angle first post for each straw bale toward the previously-installed straw bale.
5. Frequently inspect straw bales and repair or replace as required. Remove accumulated silt and debris from behind straw bales.

E. Mulching and Soil Stabilization:
1. Use mulching to temporarily stabilize exposed soil and fill material.
   a. Immediately following final grading, provide mulch and stabilize with mats or netting, or sprayed soil stabilization emulsion with fiber additive.
   b. Application of mulching for soil stabilization shall be as follows.
      1) Unrotted Straw or Salt Hay: 1.5 to two tons per acre.

2) Soil stabilization emulsions, when used, shall be applied in accordance with manufacturer's instructions, and shall be applied with mulch or stabilization fibers.
3) Wood-fiber or Paper-fiber Application: 1,500 lbs. per acre, installed by hydroseeding.

c. Where mats or netting are used:
1) Cover entire area to be stabilized with mats or netting.
2) Provide anchoring trenches at the top and bottom of slopes to receive mats or netting. Bury at least the top and bottom ends of mat or netting, four inches or wider, at top and bottom of slope. Tamp trench full of soil. Four inches from trench, secure mat or netting with appropriate staples spaced at intervals of 10 inches.
3) Overlap adjacent strips of mat or netting by not less than four inches.

F. Protection of Storm Water Drainage Inlets and Catch Basins:
1. Protect each drainage inlet and catch basin that has the potential to receive storm water runoff from exposed soils, and does not discharge into a storm water settlement basin.
2. Install inlet filter bags inside of drainage inlet or catch basin in accordance with manufacturer's instructions. Secure inlet filter bag with the structure's grate or by other acceptable means.
3. Inlet filter bags shall not pose any obstruction above the pre-construction elevation of the drainage inlet or catch basin grate requiring barricades or flashers.
4. When removing silt and sediment from inlet filter bag, do not dump filter bag's contents into the drainage inlet or catch basin.
5. Remove silt and sediment from inlet filter bag, or replace inlet filter bag, when inlet filter bag is not more than half full.

G. Filter Bag on Dewatering Pump Discharge:
1. Provide dewatering of excavations in compliance with Division 31.
2. Locate filter bags and temporary pump discharge lines to avoid interfering with the public, use of private property, and OWNER's and facility manager’s operations. Relocate filter bags and appurtenances when required.
3. Filter bag discharge shall be directed to appropriate storm water drainage route. Do not discharge into roadways, driveways, access roads, parking areas, or overland. When temporary settlement basin is used, locate filter bags to discharge to temporary settlement basin when practicable.
4. Provide filter bag on discharge of each dewatering pump drawing from an excavation.
5. Securely attach filter bag to pump discharge pipe or hose.
6. Maintain, clean out, and replace filter bags as required.

H. Temporary Stone Construction Entrance:
1. Where shown on the Drawings, and where construction vehicles will regularly transit to paved surfaces from unstabilized surfaces, provide temporary stone construction entrance. CONTRACTOR vehicles shall use temporary stone construction entrances.
2. Provide temporary stone construction entrances of the width, length, and thickness shown or indicated on the Drawings. When not shown or indicated on the Drawings,

temporary stone construction entrance shall be not less than 50 feet long, by 20 feet wide, by eight inches deep.

3. Installation:
   a. Ensure that subgrade under each temporary stone construction entrance is suitably dense for the intended purpose. Suitably prepare subgrade as required for temporary stone construction entrance.
   b. Provide on subgrade a layer of geotextile separation fabric, installed in accordance with geotextile separation fabric manufacturer's recommendations for separation.
   c. Provide stone on installed geotextile separation fabric. Grade the stone for passage of vehicles.
4. Maintenance:
   a. Maintain temporary stone construction entrance at not less than the minimum required thickness. Add stone as required to maintain thickness.
   b. When upper layer of temporary stone construction entrance becomes contaminated with soil, remove the contaminated material and replace with clean stone.
   c. Using water to wash down temporary construction entrance or paved areas onto which soil material has been tracked is unacceptable.

3.7 REMOVAL OF TEMPORARY CONTROLS

A. Removals – General:
   1. Upon completion of the Work, remove temporary controls and restore Site to specified condition; if condition is not specified, restore Site to pre-construction condition.
   2. After soils are permanently stabilized, remove from the Site temporary erosion and sediment controls.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 61 00

COMMON PRODUCT REQUIREMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes:
      a. Common requirements for materials and equipment.
      b. Compatibility of materials and equipment.

1.2 REQUIREMENTS FOR MATERIALS AND EQUIPMENT

A. Unless otherwise indicated in the Contract Documents, furnish materials and equipment that:
   1. have not previously been incorporated into another project or facility; and
   2. have not changed ownership after initial shipment from the manufacturer's factory or facility; and
   3. if stored since their manufacture or fabrication, have, while in storage, been properly maintained and serviced in accordance with the manufacturer's recommendations for long-term storage; submit documentation as required by ENGINEER that such maintenance and service has been performed; and
   4. that the item(s) have not been subject to degradation or deterioration since manufacture; and
   5. are the current model(s) or type(s) furnished by the Supplier.

B. To the extent possible, furnish from a single source those materials and equipment that are of the same generic kind.

C. Furnish materials and equipment complete with accessories, trim, finish, fasteners, and other items shown, indicated, or required for a complete installation for the indicated use and performance.

D. Standard Items: When available, and unless custom or nonstandard options are specified or indicated, furnish standard materials and equipment of types that have been produced and used successfully in similar situations on other projects.

E. Visual Matching: Where required in the Contract Documents, furnish materials and equipment that match (as determined by ENGINEER) referenced existing construction, and mock-ups and Sample(s) approved by ENGINEER.

F. Where the Contract Documents include the phrase “as selected” for color of materials or equipment, finish pattern, option, or similar phrase, provide materials and equipment selected by ENGINEER as follows:
   1. Standard Range: Where the Contract Documents include the phrase “standard range of colors, patterns, textures” or similar wording, provide color, pattern, density, or texture selected by ENGINEER from manufacturer’s product line that does not include premium items.
   2. Full Range: Where the Contract Documents include the phrase “full range of colors, patterns, textures” or similar wording, ENGINEER will select color, pattern, density, or texture from manufacturer’s entire product line, including standard and premium items.

1.3 COMPATIBILITY

A. Similar materials and equipment by the same Supplier shall be compatible with each other, unless otherwise indicated in the Contract Documents or approved by ENGINEER.

B. Provide materials and equipment compatible with items previously selected or installed on the Project.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 62 00

PRODUCT OPTIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes:
      a. CONTRACTOR's options for selecting materials and equipment.
      b. Requirements for consideration of "or-equal" materials and equipment.

1.2 PRODUCT OPTIONS

A. For materials and equipment specified only by reference standard or description, without reference to Supplier, furnish materials and equipment complying with such standard, by a Supplier or from a source that complies with the Contract Documents.

B. For materials and equipment specified by naming one or more items or Suppliers, furnish the named materials and equipment that comply with the Contract Documents, unless an "or-equal" or substitute item is approved by ENGINEER.

C. For materials and equipment specified by naming one or more items or Suppliers and the term, "or-equal", when CONTRACTOR proposes a material or equipment item or Supplier as an "or-equal", submit to ENGINEER a request for approval of an "or-equal" item or Supplier.

1.3 "OR-EQUAL" ITEMS

A. Procedure:
   1. For proposed materials and equipment not named in the Contract Documents and considered as an "or-equal" in accordance with the General Conditions, CONTRACTOR shall request in writing ENGINEER's approval of the "or-equal".
   2. Request for approval of an "or-equal" item shall accompany the Shop Drawing or product data submittal for the proposed item.

B. Requests for approval of "or-equals" shall include:
   1. CONTRACTOR's written request that the proposed item be considered as an "or-equal" in accordance with the General Conditions, accompanied by CONTRACTOR's certifications required in the General Conditions.
   2. Documentation adequate to demonstrate to ENGINEER that proposed item does not require extensive revisions to the Contract Documents, that proposed item is consistent with the Contract Documents, and that proposed item will produce

results and performance required in the Contract Documents, and that proposed item is compatible with other portions of the Work.

3. Detailed comparison of significant qualities of proposed item with the materials and equipment and manufacturers named in the Contract Documents. Significant qualities include attributes such as performance, weight, size, durability, visual effect, and specific features and requirements shown or indicated.
4. Evidence that proposed item's manufacturer will furnish warranty equal to or better than that specified, if any.
5. List of similar installations for completed projects with project names and addresses, and names and address of design professionals and owners, when requested.
6. Samples, when requested by ENGINEER.
7. Other information requested by ENGINEER.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 64 00

OWNER-FURNISHED PRODUCTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements and procedures for OWNER-furnished materials and equipment to be installed by CONTRACTOR.
   2. CONTRACTOR shall provide labor, materials, tools, equipment, and incidentals shown, specified, and required for accepting, handling, storing as required, installing, checking out and starting-up, and completing OWNER-furnished materials and equipment.

B. Coordination:
   1. Review installation procedures for OWNER-furnished materials and equipment and coordinate installation of items to be installed with or before OWNER-furnished materials and equipment.
   2. Notify other contractors in advance of installing OWNER-furnished materials and equipment to provide other contractors with sufficient time for installing items included in their contracts to be installed with or before OWNER-furnished materials and equipment.

C. Scheduling:
   1. Schedule and perform the Work to coordinate with anticipated delivery dates for OWNER-furnished materials and equipment, as indicated in OWNER's procurement contracts or purchase orders therefor.
   2. Where OWNER will furnish services of a manufacturer's representative for OWNER-furnished materials and equipment, schedule and perform the Work in accordance with scheduling constraints of manufacturer's representative.
   3. Comply with the Contract Times indicated in the Agreement and Section 01 13 13, Milestones.

1.2 OWNER-FURNISHED MATERIALS AND EQUIPMENT

A. Items of equipment and materials to be furnished by OWNER for installation by CONTRACTOR are:
   1. 18,000-gallon fiberglass reinforced plastic (FRP) tank by Red Ewald, Inc.

B. Delivery:
   1. Materials and equipment indicated in Paragraph 1.2.A of this Section will be furnished F.O.B. to the Site.

2. OWNER-furnished materials and equipment will be available to CONTRACTOR, and as required thereafter to maintain the Progress Schedule accepted by ENGINEER.

C. CONTRACTOR's Responsibilities:
1. Responsibilities for OWNER-furnished materials and equipment delivered to the Site will begin upon CONTRACTOR's commencing to unload and handle OWNER-furnished materials and equipment at that location.
2. Inspect for completeness or damage, jointly with OWNER, and reject defective items. OWNER reserves the right to accept OWNER-furnished items rejected by CONTRACTOR and to authorize their use in the Work.
3. Handle, store, and maintain OWNER-furnished materials and equipment.
4. Repair or replace OWNER-furnished materials and equipment that are missing, lost, or damaged after receipt by CONTRACTOR. Replacements shall be in accordance with OWNER's procurement contract documents.
5. Coordinate with seller's shop drawings, samples, and other submittals, including seller's installation drawings, reviewed and approved by OWNER or ENGINEER, as applicable.
6. Install, connect, and start up OWNER-furnished materials and equipment in accordance with manufacturer's instructions, unless otherwise specified.

1.3 ASSIGNED PROCUREMENT CONTRACTS (NOT USED)

1.4 HANDLING AND STORAGE

A. Handling:
1. Handle OWNER-furnished materials and equipment in accordance with the Contract Documents and the manufacturer's instructions.

B. Storage:
1. Store OWNER-furnished materials and equipment in accordance with the Contract Documents and the manufacturer's instructions.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 65 00

PRODUCT DELIVERY REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes general requirements for preparing for shipping, delivering, and handling materials and equipment to be incorporated into the Work.
   2. CONTRACTOR shall make all arrangements for transporting, delivering, and handling of materials and equipment required for prosecution and completion of the Work.
   3. When required, move stored materials and equipment without changes to the Contract Price or Contract Times.

1.2 SUBMITTALS

A. Refer to individual Specifications Sections for submittal requirements relative to delivering and handling materials and equipment.

1.3 PREPARING FOR SHIPMENT

A. When practical, factory-assemble materials and equipment. Mark or tag separate parts and assemblies to facilitate field-assembly. Cover machined and unpainted parts that may be damaged by the elements or climate with strippable, protective coating.

B. Package materials and equipment to facilitate handling, and protect materials and equipment from damage during shipping, handling, and storage. Mark or tag outside of each package and crate to indicate the associated purchase order number, bill of lading number, contents by name, OWNER's contract designation, CONTRACTOR name, equipment number, and approximate weight. Include complete packing lists and bills of materials with each shipment.

C. Protect materials and equipment from exposure to the elements and damage by climate, and keep thoroughly dry and dust-free at all times. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Lubricate bearings and other items requiring lubrication in accordance with manufacturer's instructions.

D. Advance Notification of Shipments:
   1. Keep ENGINEER informed of delivery of all materials and equipment to be incorporated in the Work.

2. Upon receipt of Supplier's advance notice of shipment, not less than seven days prior to delivery of materials and equipment, provide ENGINEER written notification of anticipated date and place of arrival of the following:
   a. Piping and appurtenances.

E. Do not ship materials and equipment until:
   1. Related Shop Drawings, Samples, and other submittals required by the Contract Documents have been approved or accepted (as applicable) by ENGINEER, including, but not necessarily limited to, all Action Submittals associated with the materials and equipment being delivered.
   2. Manufacturer's instructions for handling, storing, and installing the associated materials and equipment have been submitted to and accepted by ENGINEER in accordance with the Specifications.
   3. Results of source quality control testing (factory testing), when required by the Contract Documents for the associated materials or equipment, have been submitted to and accepted by ENGINEER.
   4. Facilities required for handling materials and equipment in accordance with the Contract Documents and manufacturer's instructions are in place and available.
   5. Required storage facilities have been provided.

1.4 DELIVERY

A. Scheduling and Timing of Deliveries:
   1. Arrange deliveries of materials and equipment in accordance with the Progress Schedule accepted by ENGINEER and in ample time to facilitate inspection and observation prior to installation.
   2. Schedule deliveries to minimize space required for and duration of storage of materials and equipment at the Site or other delivery location, as applicable.
   3. Coordinate deliveries to avoid conflicting with the Work and conditions at Site, and to accommodate the following:
      a. Work of other contractors and OWNER.
      b. Storage space limitations.
      c. Availability of equipment and personnel for handling materials and equipment.
      d. OWNER's use of premises.
   4. Deliver materials and equipment to the Site during regular working hours.
   5. Deliver materials and equipment to avoid delaying the Work and the Project, including work of other contractors, as applicable. Deliver anchor system materials, including anchor bolts to be embedded in concrete or masonry, in ample time to avoid delaying the Work.

B. Deliveries:
   1. Shipments shall be delivered with CONTRACTOR's name, Subcontractor's name (if applicable), Site name, Project name, and contract designation (example: "ABC Construction Co., City of Happy Beach, Idaho, Wastewater Treatment Plant

Primary Clarifier Improvements, Contract 25, General Construction") clearly marked.

2. Site may be listed as the "ship to" or "delivery" address; but OWNER shall not be listed as recipient of shipment unless otherwise directed in writing by ENGINEER.
3. Provide CONTRACTOR's telephone number to shipper; do not provide OWNER's telephone number.
4. Arrange for deliveries while CONTRACTOR's personnel are at the Site. CONTRACTOR shall receive and coordinate shipments upon delivery. Shipments delivered to the Site when CONTRACTOR is not present will be refused by OWNER, and CONTRACTOR shall be responsible for the associated delays and additional costs, if incurred.

C. Containers and Marking:
1. Have materials and equipment delivered in manufacturer's original, unopened, labeled containers.
2. Clearly mark partial deliveries of component parts of materials and equipment to identify materials and equipment, to allow easy accumulation of parts, and to facilitate assembly.

D. Inspection of Deliveries:
1. Immediately upon delivery, inspect shipment to verify that:
   a. Materials and equipment comply with the Contract Documents and approved or accepted (as applicable) submittals.
   b. Quantities are correct.
   c. Materials and equipment are undamaged and of the required quality.
   d. Containers and packages are intact and labels are legible.
   e. Materials and equipment are properly protected.
2. Promptly remove damaged materials and equipment from the Site and expedite delivery of new, undamaged materials and equipment, and remedy incomplete or lost materials and equipment. Furnish materials and equipment in accordance with the Contract Documents, to avoid delaying progress of the Work.
3. Advise ENGINEER in writing when damaged, incomplete, or defective materials and equipment are delivered, and advise ENGINEER of the associated impact on the Progress Schedule.

1.5 HANDLING OF MATERIALS AND EQUIPMENT

A. Provide equipment and personnel necessary to handle materials and equipment, including those furnished by OWNER, by methods that prevent soiling or damaging materials and equipment and packaging.

B. Provide additional protection during handling as necessary to prevent scraping, marring, and otherwise damaging materials and equipment and surrounding surfaces.

C. Handle materials and equipment by methods that prevent bending and overstressing.

D. Lift heavy components only at designated lifting points.

E. Handle materials and equipment in safe manner and as recommended by the manufacturer to prevent damage. Do not drop, roll, or skid materials and equipment off delivery vehicles or at other times during handling. Hand-carry or use suitable handling equipment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 66 00

PRODUCT STORAGE AND HANDLING REQUIREMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes general requirements for storing and protecting materials and equipment.
   2. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals to store and handle materials and equipment to be incorporated into the Work, and other materials and equipment at the Site.

1.2 STORAGE

A. Store and protect materials and equipment in accordance with manufacturer's recommendations and the Contract Documents, with seals and labels intact and legible. Storage instruction shall be studied by the CONTRACTOR and reviewed with the ENGINEER by him. Instructions shall be carefully followed and a written record of this kept by the CONTRACTOR for each product and pieces of equipment.

B. General:
   1. CONTRACTOR shall make all arrangements and provisions necessary for, and pay all costs for, storing materials and equipment.
   2. Excavated materials, construction equipment, and materials and equipment to be incorporated into the Work shall be placed to avoid injuring the Work and existing facilities and property, and so that free access is maintained at all times to all parts of the Work and to public utility installations in vicinity of the Work.
   3. Store materials and equipment neatly and compactly in locations that cause minimum inconvenience to OWNER, facility manager, other contractors, public travel, and owners, tenants, and occupants of adjoining property.
   4. Store materials and equipment to become OWNER's property to ensure preservation of quality and fitness of the Work, including proper protection against damage by freezing, moisture, and with outdoor ambient air high temperatures as high as 105 degrees F; temperature and humidity inside crates, containers, storage sheds, and packaging may be significantly higher than the outdoor ambient air temperature.
   5. Store all materials and equipment subject to damage by moisture, humidity, heat, cold, and other elements in indoor, climate-controlled storage areas, unless otherwise acceptable to OWNER.
   6. When placing orders to Suppliers for equipment and controls containing computer chips, electronics, and solid-state devices, CONTRACTOR shall obtain, coordinate, and comply with specific temperature and humidity limitations on materials and

equipment, because temperature inside cabinets and components stored in warm temperatures can approach 200 degrees F.

7. CONTRACTOR shall be fully responsible for loss or damage (including theft) to stored materials and equipment.
8. Keep manufacturer's containers closed until time of installation, unless recommended by the manufacturer or otherwise specified in the Contract Documents.
9. Periodically inspect to make sure products and equipment are undamaged and are maintained under specified conditions.
10. Arrange storage in manner to allow easy access for any additional inspection by ENGINEER and/or Resident Project Representative (RPR).
11. Comply with requirements of Article 1.3 of this Section.

C. Storage Location:
1. Areas available at the Site for storing materials and equipment are as acceptable to ENGINEER.
2. Restrictions:
   a. Do not store materials or equipment in structures being constructed unless approved by ENGINEER in writing.
   b. Do not use lawns or other private property for storage without written permission of the owner or other person in possession or control of such premises.

1.3 PROTECTION – GENERAL

A. Equipment to be incorporated into the Work shall be boxed, crated, or otherwise completely enclosed and protected during shipping, handling, and storage, in accordance with Section 01 65 00, Product Delivery Requirements.

B. Store all materials and equipment off the ground (or floor) on raised supports such as skids or pallets.

C. Protect painted surfaces against impact, abrasion, discoloration, and other damage. Painted equipment surfaces that are damaged or marred shall be repainted in their entirety in accordance with equipment manufacturer and paint manufacturer requirements, to the satisfaction of ENGINEER.

D. Protect electrical equipment, controls, and instrumentation against moisture, water damage, humidity, heat, cold, and dust. Space heaters provided in equipment shall be connected and operating at all times until equipment is placed in operation and permanently connected.

1.4 UNCOVERED STORAGE

A. The following types of materials may be stored outdoors without cover on supports so there is no contact with the ground:
1. Precast concrete materials.
2. Castings.

3. Piping, except PVC or chlorinated PVC (CPVC) pipe.

1.5 COVERED STORAGE

A. The following materials and equipment may be stored outdoors on supports and completely covered with covering impervious to water:
   1. Grout and mortar materials.
   2. Masonry units.
   3. Rough lumber.
   4. Soil materials and granular materials such as aggregate.
   5. PVC and CPVC pipe.
   6. Filter media.

B. Tie down covers with rope, and install covering properly sloped to prevent accumulation of water.

C. Store loose granular materials, with covering impervious to water, in well-drained area or on solid surfaces to prevent mixing with foreign matter.

1.6 FULLY PROTECTED STORAGE

A. Store all material and equipment not indicated in Articles 1.4 and 1.5 of this Section on supports in buildings or trailers that have concrete or wooden flooring, roof, and fully-closed walls on all sides. Covering with visquine plastic sheeting or similar material in space without floor, roof, and walls is unacceptable. Comply with the following:
   1. Provide heated storage for materials and equipment that could be damaged by low temperatures or freezing.
   2. Provide air-conditioned storage for materials and equipment that could be damaged by high temperatures or humidity.
   3. Protect mechanical and electrical equipment from being contaminated by dust, dirt, and moisture.
   4. Maintain humidity at levels recommended by manufacturers for electrical and electronic equipment.

B. Storage of Major Equipment:
   1. Storage of the equipment indicated below shall comply with Paragraph 1.6.A of this Section:
      a. PVC piping and appurtenances.
      b. Materials for completion of any cement-related Work.
   2. Storage shall be in third-party owned, bonded, insured, climate-controlled warehouse in El Paso County.

1.7 HAZARDOUS MATERIALS AND EQUIPMENT

A. Prevent contamination of personnel, storage areas, and the Site. Comply with Laws and

Regulations, manufacturer's instructions for Hazardous Materials, and other provisions of the Contract Documents.

1.8 MAINTENANCE OF STORAGE

A. On a scheduled basis, periodically inspect stored materials and equipment to ensure that:
   1. Condition and status of storage facilities is adequate to provide required storage conditions.
   2. Required environmental conditions are maintained on continuing basis.
   3. Materials and equipment exposed to elements are not adversely affected.

B. Provide protective maintenance all equipment during storage including:
   1. Manually exercising equipment.
   2. Inspecting mechanical surfaces for signs of corrosion or other damage.
   3. Lubricating.
   4. Applying any coatings as recommended by the manufacturer necessary for its protection.
   5. All other precautions to assure proper protection of materials and equipment stored for compliance with manufacturer's requirements related to warranties.

C. Log all protective maintenance for each piece of equipment in the written record noted above.

1.10 RECORDS

A. Keep up-to-date account of materials and equipment in storage to facilitate preparation of Applications for Payment, if the Contract Documents provide for payment for materials and equipment not incorporated in the Work but delivered and suitably stored at the Site or at another location agreed to in writing.

B. Keep up-to-date written record including log of instructions followed and log of protective maintenance.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 71 33

PROTECTION OF THE WORK AND PROPERTY

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes general requirements for safety and protection that augment the requirements of the General Conditions, as may be modified by the Supplementary Conditions. This Section also includes requirements for barricades and warning signals, and protection of trees and plants, existing structures, floors, roofs, installed items, and landscaping.
   2. CONTRACTOR shall be responsible for taking all precautions, providing all programs, and taking all actions necessary to protect personnel health and safety, and to protect the Work and all public and private property and facilities from damage, as specified in the General Conditions, Supplementary Conditions, and the Specifications.
   3. To prevent damage, injury, or loss, CONTRACTOR's actions shall include the following:
      a. Provide measures for safety of personnel at the Site, including workers engaged in the Work, delivery personnel, testing and inspection personnel, personnel of authorities having jurisdiction, other visitors to the Site, the public, OWNER's personnel, facility manager's personnel (if different from OWNER), ENGINEER, and Resident Project Representative (if any).
      b. Storing apparatus, materials, supplies, and equipment in an orderly, safe manner that does not unduly interfere with progress of the Work or work of other contractors, utility owners, and owners of transportation rights-of-way.
      c. Providing suitable storage facilities for materials and equipment subject to damage or degradation by exposure to climate, temperature, theft, breakage, or other cause.
      d. Placing upon the Work or any part thereof only loads consistent with the safety and integrity of that portion of the Work and existing construction.
      e. Frequently removing and disposing of refuse, rubbish, scrap materials, and debris caused by CONTRACTOR's operations so that, at all times, the Site is safe, orderly, and workmanlike in appearance.
      f. Providing temporary barricades, fencing, and guard rails around the following: openings, scaffolding, temporary stairs and ramps, around excavations, for elevated walkways, and other areas that may present a fall-hazard or hazard to vehicles.
   4. Do not, except after written consent from proper parties, enter or occupy privately-owned property or premises with personnel, tools, materials or equipment, except on lands and easements provided by OWNER.

5. CONTRACTOR has full responsibility for preserving public and private property and facilities on and adjacent to the Site. Direct or indirect damage done by, or on account of, any act, omission, neglect, or misconduct by CONTRACTOR in executing the Work, shall be remedied by CONTRACTOR, at his expense, to condition equal to that existing before damage was done.
6. Owner May Remedy:
   a. Should CONTRACTOR fail to protect and safeguard property and the Work after requests from ENGINEER or OWNER, OWNER may implement measures to protect property and the Work.
   b. Cost of such OWNER-implemented measures shall be paid by CONTRACTOR. OWNER may deduct from payments due CONTRACTOR such amounts as set-offs in accordance with the Contract Documents.
   c. Such right, however, shall not result in any obligation by OWNER or ENGINEER to continuously monitor or have responsibility for protection of property and the Work, which responsibility is exclusively CONTRACTOR's.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 BARRICADES AND WARNING SIGNALS

A. Barricades and Warning Signals – General:
   1. Where the Work is performed on or adjacent to roadway, access road or driveway, right-of-way, or public place:
      a. Provide temporary barricades, fences, lights, warning signs, danger signals, watchmen, and take other precautionary measures for protecting persons, property, and the Work.
      b. Use appropriately colored and reflective barricades, or paint barricades accordingly, to be visible at night.
      c. From sunset to sunrise, provide and maintain not less than one temporary light at each barricade.
      d. Erect sufficient barricades to keep vehicles from being driven on or into Work under construction.
      e. Furnish watchmen in sufficient numbers to protect the Work.
   2. Provide temporary barricades to protect personnel and property for Work not in or adjacent to transportation routes and vehicular travel areas, including indoor work, in accordance with Laws and Regulations.
   3. CONTRACTOR's responsibility for maintaining temporary barricades, signs, lights, and for providing watchmen shall continue until the Work is substantially complete in accordance with the Contract Documents, unless other provision for security and protection is agreed to by the parties. After Substantial Completion, protect Work and property during periods when final Work or corrective Work is underway.

B. Temporary Fencing: Refer to Section 01 57 33, Security.

3.2 TREE AND PLANT PROTECTION

A. Tree and Plant Protection – General:
   1. Protect existing trees, shrubs, and plants on or adjacent to the Site, shown or designated to remain in place, against unnecessary cutting, breaking, damage, or skinning of trunk, branches, bark, and roots.
   2. Do not store materials or equipment or park construction equipment and vehicles within foliage drip lines.
   3. In areas subject to traffic, provide temporary fencing or temporary barricades to protect trees and plants.
   4. Open fires are not allowed onsite.
   5. Within the limits of the Work, water trees and plants that are to remain to maintain their health during construction operations.
   6. Cover exposed roots with burlap, and keep such burlap continuously wet. Cover exposed roots with earth as soon as possible. Protect root systems from mechanical damage and damage by erosion, flooding, runoff, and noxious materials in solution.
   7. If branches or trunks are damaged, prune branches immediately and protect cut or damaged areas with emulsified asphalt compounded specifically for horticultural use, in manner acceptable to ENGINEER.
   8. When directed by ENGINEER, remove and dispose of at location away from the Site damaged trees and plants that die or suffer permanent injury, and replace each damaged tree or plant with specimen of equal or better species and quality.

3.3 PROTECTION OF EXISTING STRUCTURES

A. Underground Facilities:
   1. Underground Facilities known to OWNER and ENGINEER, except water, gas, sewer, electric, and communications services to individual buildings and properties, are shown. Information shown for Underground Facilities is the best available to OWNER and ENGINEER but, in accordance with the General Conditions, as may be modified by the Supplementary Conditions, is not guaranteed to be correct or complete.
   2. CONTRACTOR shall explore ahead of trenching and excavating Work and shall sufficiently uncover Underground Facilities that will or may interfere with the Work to determine their location, to prevent damage to Underground Facilities, and to prevent service interruption to structures and properties served by Underground Facilities. If CONTRACTOR damages an Underground Facility, CONTRACTOR shall restore it to its pre-construction condition, in accordance with requirements of the owner of the damaged facility and the Contract Documents.
   3. Necessary changes in the location of the Work may be directed by ENGINEER to avoid Underground Facilities not shown or indicated on the Contract Documents.

4. If permanent relocation of an existing Underground Facilities is required and is not otherwise shown or indicated in the Contract Documents, CONTRACTOR may be directed in writing to perform the required work. When such relocation Work results in a change in the Contract Price, Contract Times, the associated Contract modification procedures and payment for such Work shall be in accordance with the Contract Documents.

B. Surface Structures:
1. Surface structures are existing buildings, structures, and other facilities at or above ground surface, including their foundations and any extension below ground surface. Surface structures include, but are not limited to, buildings, tanks, walls, bridges, roads, dams, channels, open drainage routes, exposed piping and utilities, poles, exposed wires, posts, signs, markers, curbs, walks, fencing, and other facilities visible at or above ground surface.
2. Existing surface facilities, including but not limited to guard rails, posts, guard cables, signs, poles, markers, curbs, and fencing, that are temporarily removed to facilitate the Work shall be replaced and restored to their pre-construction condition at CONTRACTOR's expense.

C. Protection of Underground Facilities and Surface Structures:
1. CONTRACTOR shall sustain in their places and protect from direct or indirect injury all Underground Facilities and surface structures located within or adjacent to the limits of the Work. Such sustaining and supporting shall be done carefully and as required by the party owning or controlling such structure or facility.
2. Before proceeding with the Work of sustaining and supporting such structure or facility, CONTRACTOR shall satisfy ENGINEER that methods and procedures to be used have been approved by party owning same.
3. CONTRACTOR shall bear all risks attending the presence or proximity of all Underground Facilities and surface structures within or adjacent to limits of the Work, in accordance with the Contract Documents.
4. CONTRACTOR shall be responsible for damage and expense for direct or indirect injury, caused by CONTRACTOR's activities, to structures and facilities. CONTRACTOR shall promptly repair damage caused by CONTRACTOR's activities, to the satisfaction of owner of damaged structure or facility.
5. Protection of Underground Facilities Under Roads and Parking Areas: Provide temporary, heavy-duty steel roadway plates to protect existing manholes, handholes, valve boxes, vaults, and other Underground Facilities near to or visible at the ground surface.

3.4 PROTECTION OF FLOORS AND ROOFS

A. Protection of Floors and Roofs – General:
1. Use proper protective covering when moving equipment, handling materials or other loads, when painting, handling mortar or grout, and when cleaning walls, ceilings, or structure contents.

2. Use metal pans to collect oil and cuttings from piping, conduits, and rod threading machines, and under metal cutting machines.
3. Do not load concrete floors less than 28 days old without written permission of ENGINEER. Do not load floors, roofs, or slabs in excess of design loading.
4. Do not load roofs without written permission of ENGINEER.
5. Restrict access to roofs, and keep CONTRACTOR personnel off existing roofs, except as required for the Work.
6. If access to roofs is required, roofing, parapets, openings, and all other construction on or adjacent to roof shall be protected with suitable plywood or other acceptable means.

3.5 PROTECTION OF INSTALLED MATERIALS, EQUIPMENT, AND LANDSCAPING

A. Protect installed Work to prevent damage from subsequent operations. Remove protective items when no longer needed, prior to Substantial Completion of the Work.

B. Control traffic to prevent damage to equipment, materials, and surfaces.

C. Coverings:
   1. Provide temporary coverings to protect materials and equipment from damage.
   2. Cover projections, wall corners and jambs, sills, and soffits of openings, in areas used for traffic and for passage of materials and equipment in subsequent work.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 73 19

INSTALLATION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section describes general requirements for installing materials and equipment. Additional installation requirements are included in the various Specifications Sections in Divisions 02 through 46 and elsewhere in the Contract Documents.
   2. CONTRACTOR shall provide all labor, materials, equipment, services, tools, and incidentals required to install materials and equipment.

1.2 QUALITY ASSURANCE

A. General:
   1. Provide appropriate quality assurance for installing materials and equipment, and provide quality control over Suppliers, materials and equipment, services, Site conditions, and workmanship, to provide Work of the required quality.

B. Qualifications:
   1. Installer:
      a. Installers shall be experienced in the types of Work required, including, but not limited to, the requirements of Division 02 through 46 Specifications where the particular element of the Work is specified.

C. Regulatory Requirements: Comply with the following:
   1. 29 CFR 1910, OSHA.

PART 2 – PRODUCTS

2.1 EQUIPMENT DRIVE GUARDS

A. Equipment Drive Guards – General:
   1. Unless otherwise shown or indicated, provide all-metal guards complying with 29 CFR 1910, Subpart O, with equipment driven by open shafts, belts, chains, pulleys, sheaves, or gears. Guards shall enclose drive and driven mechanism.
   2. If material of guards are not otherwise specified, guards shall be galvanized sheet steel, galvanized woven wire, or expanded metal set in a frame of galvanized steel members, as appropriate.
   3. Secure guards in position by steel braces or straps, securely fastened to frame of equipment, floor, or wall as required.

4. Fastenings shall allow removal of guards for servicing equipment.

2.2 MISCELLANEOUS MATERIALS

A. Shims shall be Type 304L stainless steel, clean and free of slag.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
   1. Installation Instructions and Requirements:
      a. Install materials and equipment in accordance with approved Shop Drawings and CONTRACTOR's other submittals approved by ENGINEER, the Contract Documents, and manufacturer's installation instructions. When manufacturer's installation instructions conflict with the Contract Documents, obtain interpretation or clarification from ENGINEER before proceeding.
      b. Manufacturer's installation instructions include manufacturer's written instructions; drawings; illustrative, wiring and schematic diagrams; diagrams identifying external connections, terminal block numbers and internal wiring; and other such information pertaining to installation of materials and equipment. Included are all of manufacturer's printed installation instructions, including those that may be attached to equipment upon delivery.
      c. Separate dissimilar metals from each other by a permanent separation as recommended by the manufacturer.
   2. Prior to installing materials and equipment, complete preparation of surfaces on which materials and equipment are to be installed. Prior to installing materials and equipment on new concrete, concrete shall achieve sufficient compressive strength to support the materials and equipment.
   3. Maintain the work area in a broom-clean condition while installing materials and equipment.
   4. Use proper tools to assemble materials and equipment. Do not deform or mar surface of shafts, nuts, and other parts.
   5. Do not support rigging from building or structure without written permission of ENGINEER. CONTRACTOR is responsible for and shall repair damage to building or structure resulting from CONTRACTOR's operations, in accordance with Section 01 71 33, Protection of Work, Property, and Traffic.
   6. During installation, maintain materials and equipment in neutral position and do not exert undue stress on materials and equipment.
   7. Tighten connections requiring gaskets evenly all around to ensure uniform stress over entire gasket.
   8. Use only an oil bath heater to expand couplings, gears, and other mechanical components to be expanded for installation. Do not force or drive couplings, gears, and other mechanical components onto equipment shafts, or subject such items to open flame or torch.

9. Do not alter or repair materials and equipment and do not burn or weld materials and equipment unless required in the Contract Documents or allowed by ENGINEER.
10. Provide plugs in lubrication holes to prevent entry of foreign matter.

B. Setting and Erection:
1. Install materials and equipment plumb, level, true, and free of rack unless otherwise shown or indicated, and demonstrate plumbness and level to ENGINEER. Bring parts to proper bearing after installation and erection.
2. Anchorages:
   a. Provide anchorage setting drawings in time to coordinate with fabrication of materials and equipment and the Work.
   b. Anchorages shall comply to manufacturer's recommendations. Requests for approval of substitute materials or methods of anchorage shall be in accordance with the General Conditions, Supplementary Conditions, and Section 01 25 00, Substitution Procedures.
3. Shimming:
   a. Wedging is not allowed.
   b. During installation, use the minimum number of shims required for leveling the equipment.
   c. Provide shims, filling pieces, keys, packing, grouting of the type required by the Contract Documents, and other materials and equipment necessary to properly align, level, and secure apparatus in place.
4. Installing Equipment onto Foundations:
   a. Using experienced millwrights, carefully set and align equipment on foundations, after equipment soleplates or baseplates (as applicable) have been shimmed to true alignment at anchorages.
   b. Set anchorages in place and tighten nuts against shims.
   c. Check bedplates or wing feet of equipment after securing to foundations and, after confirming alignments, grout soleplates or baseplates (as applicable) in place in accordance with the Contract Documents.
5. Ream misaligned holes. Do not "force" bolts or keys.
6. Where applicable, properly align equipment with associated piping and utility connections, without exerting undue stress on connecting piping and utilities.

C. Alignment and Leveling:
1. Verify that all shafts, couplings, and sheaves are properly aligned and adjust to required tolerances.
2. Align couplings while equipment is free of external loads.
3. Check angular and parallel alignment and record actual alignment and submit to ENGINEER. Alignment shall be within tolerances specified in Contract Documents and as recommended by Supplier of the material or equipment item.
4. Use laser indicators or dial indicators for checking angular and parallel alignment. Using dial indicators requires that, during rotation of half-couplings in performing testing, dial indicator shall be maintained in same relative position, and dial indicator readings taken at same place on circumference of coupling.

D. Threaded Connections:
   1. Apply a molybdenum disulfide, anti-seize compound to threads in mechanical connections such as bolts, studs, cap screws, tubing, and other threads, unless otherwise shown or indicated.

3.2 FIELD QUALITY CONTROL

A. Supplier's Services:
   1. When specified, provide competent, qualified representatives of material or equipment Supplier to perform services required, including: supervising installation, checking the completed installation, adjusting, testing of materials and equipment, and where required instructing operations and maintenance personnel in the use and care of materials and equipment.

+ + END OF SECTION + +

SECTION 01 73 24

CONNECTIONS TO EXISTING FACILITIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for connections to existing facilities. Requirements for tie-ins and shutdowns necessary to complete the Work are in Section 01 14 16, Coordination with Owner's Operations.
   2. CONTRACTOR shall provide labor, materials, tools, equipment, and incidentals shown, specified, and required for performing connections to existing facilities.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate Work that will be performed with or before the Work specified in this Section.

C. Related Sections:
   1. Section 01 14 16, Coordination with Owner's Operations.
   2. Section 01 73 29, Cutting and Patching.
   3. Section 40 05 05, Exposed Piping Installation.

D. General:
   1. Requirements for shutdowns, tie-ins, and other provisions on connections to existing facilities, are indicated in Section 01 14 16, Coordination with Owner's Operations.
   2. Requirements for temporary pumping for connections to existing facilities are in Section 01 14 16, Coordination with Owner's Operations.
   3. Requirements for cutting and patching are in Section 01 73 29, Cutting and Patching.
   4. Requirements for exposed piping are in Section 40 05 05, Exposed Piping Installation.
   5. To extent possible, materials, equipment, systems, piping, and appurtenances that will be placed into service upon completion of connection to existing facilities shall be checked, successfully tested, and in condition for operation prior to making connections to existing facilities, if valves, gates, or similar watertight and gastight isolation devices are not provided at the connection point.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 73 29

CUTTING AND PATCHING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes general requirements for cutting and patching Work.
   2. CONTRACTOR shall perform cutting and coring, and rough and finish patching of holes and openings in existing construction.
   3. Provide cutting, coring, fitting and patching, including attendant excavation and fill, required to complete the Work, and to:
      a. remove and replace defective Work;
      b. remove samples of installed Work as specified or required for testing;
      c. remove construction required to perform required alterations or additions to existing construction;
      d. uncover the Work for ENGINEER's observation of covered Work, testing or inspection by testing entities, or observation by authorities having jurisdiction;
      e. connect to completed Work not performed in proper sequence;
      f. remove or relocate existing utilities and piping that obstruct the Work in locations where connections are to be made;
      g. make connections or alterations to existing or new facilities.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Cutting and Patching Request:
      a. Submit written request to ENGINEER, well in advance of executing cutting or alteration that affects one or more of the following:
         1) Design function or intent of Project.
         2) Work of OWNER or other contractors.
         3) Structural value or integrity of an element of the Project.
         4) Integrity or effectiveness of weather-exposed or moisture-resistant elements or systems.
         5) Efficiency, operational life, maintenance, or safety of operational elements.
         6) Visual qualities of sight-exposed elements.
      b. Request shall include:
         1) Identification of Project and Contract designation.
         2) Description of affected Work of CONTRACTOR and work of others (if any).
         3) Necessity for cutting.
         4) Effect on work or operations of OWNER, other contractors (if any), and on structural or weatherproof integrity of Project.

5) Description of proposed Work, describing: scope of cutting and patching; trades who will be executing the Work; materials and equipment to be used; extent of refinishing; schedule of operations; alternatives to cutting and patching, if any, and net effect on aesthetics following completion of finishing Work.
6) Designation of entity responsible for cost of cutting and patching, when applicable.
7) Written permission of other prime contractors (if any) whose work will or may be affected.

2. Recommendation Regarding Cutting and Patching:
   a. Should conditions of work or schedule indicate a change of materials or methods, submit written recommendation to ENGINEER including:
      1) Conditions indicating change.
      2) Recommendations for alternative materials or methods.
      3) Items required with request for approval of substitute, in accordance with the substitution request requirements of the Contract Documents.
3. Product Data:
   a. Submit manufacturer's data for the protective compound to be applied to core-drilled surfaces and cut concrete surfaces.
   b. When not required under other Sections, submit manufacturer's data on materials to be used for finishing around the cut or patched area.
   c. Furnish submittals for patching materials under the associated Specifications Section.

B. Informational Submittals: Submit the following:
   1. Written Notification of Cutting and Patching:
      a. Submit written indication designating the day and time that the construction associated with cutting and patching will be uncovered to allow for observation. Do not begin cutting or patching operations until submittal is accepted by ENGINEER.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Materials - General:
   1. Use materials that comply with the Contract Documents.
   2. If not shown or indicated in the Contract Documents, use materials that are identical to existing materials affected by cutting and patching Work.
   3. For exposed surfaces, use materials that visually match existing adjacent surfaces to fullest extent possible. If identical materials are unavailable or cannot be used, use materials whose installed performance will equal or surpass that of existing materials.
   4. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using materials that do not void required or existing warranties.

B. Compound Applied to Core-Drilled Surfaces and Cut Concrete Surfaces:
   1. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with solvent-free, two-component, protective, epoxy resin coating.
   2. Color shall approximate the finish color of the existing surface to be coated.
   3. Product and Manufacturer: Provide one of the following:
      a. Sikagard 62, by Sika Corporation.
      b. Or equal.

PART 3 – EXECUTION

3.1 GENERAL

A. Perform cutting and coring in such manner that limits extent of patching required.

B. Structural Elements:
   1. Do not cut or patch structural elements in manner that would change the element's structural load-carrying capacity as load deflection ratio.

C. Operating Elements:
   1. Do not cut or patch operating elements in manner that would reduce their capacity to perform as intended.
   2. Do not cut or patch operating elements or related components in manner that would increase maintenance requirements or decrease operational life or safety.

D. Replace, patch, and repair materials and surfaces cut or damaged during cutting and patching operations, using methods that do not void required or existing warranties.

3.2 INSPECTION

A. Examine surfaces to be cut or patched, and conditions under which cutting or patching will be performed before starting cutting or patching Work.

B. Report unsatisfactory or questionable conditions to ENGINEER in writing. Do not proceed with cutting or patching Work until unsatisfactory conditions are corrected.

3.3 PREPARATION

A. Provide temporary support required to maintain structural integrity of facilities, to protect adjacent work from damage during cutting, and to support the element(s) to be cut.

B. Protection of Existing Construction during Cutting and Patching:
   1. Protect existing construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of the Project and facility that will be exposed during cutting and patching operations.

2. Avoid interference with use of adjoining areas or interruption of free passage to adjoining areas.
3. Do not cut existing pipe, conduit, ductwork, or other utilities serving facilities scheduled to be removed or relocated until provisions have been made to bypass them.

3.4 CORING

A. Use core-drilling to make penetrations through concrete and masonry walls, slabs, or arches, unless otherwise accepted by ENGINEER in writing.

B. Coring:
1. Perform coring with non-impact rotary tool using diamond core-drills. Size holes for pipe, conduit, sleeves, equipment or mechanical seals, as required, to be installed through the penetration.
2. Do not core-drill through electrical conduit or other utilities embedded in walls or slabs without approval of ENGINEER. To extent possible, avoid cutting reinforcing steel in slabs and walls.

C. Protection:
1. Protect existing equipment, utilities, and adjacent areas from water and other damage caused by or resulting from core-drilling operations.
2. After core-drilling and before installing the utility or equipment through the penetration, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Section. Apply protective coating in accordance with manufacturer's instructions.

D. Cleaning:
1. After core-drilling, vacuum or otherwise remove slurry and tailings from the work area.

3.5 CUTTING

A. Cutting – General:
1. Cut existing construction using methods least-likely to damage elements retained and adjoining construction and that provide proper surfaces to receive subsequent installation or repair.
2. In general, use hand tools or small power tools suitable for sawing or grinding. When possible, avoid using hammering and avoid chopping.
3. Cut holes and slots as small as possible, neatly to the size required, and with minimum disturbance of adjacent surfaces.
4. Prior to started cutting, provide adequate bracing of area to be cut.
5. To avoid marring existing finished surfaces, cut or drill from exposed or finished side into concealed side.
6. Provide equipment of adequate size to remove the cut panel or "coupon".
7. Provide temporary covering over cut openings where not in use.

B. Cutting – Concrete and Masonry:
   1. Cut through concrete and masonry using concrete wall saw with diamond saw blades.
   2. On both of the elements being cut, provide for control of slurry generated during sawing.
   3. After cutting concrete and before installing subsequent construction on or through the opening, coat exposed concrete and steel with protective coating material indicated in Paragraph 2.1.B of this Section. Apply protective coating in accordance with manufacturer's instructions.

3.6 PATCHING

A. Patching – General:
   1. Patch construction by filling, repairing, refinishing, closing-up, and similar operations following performance of other Work.
   2. Patch with durable seams that are as inconspicuous as possible. Provide materials and comply with installation requirements indicated in the Contract Documents.
   3. Patch to provide airtight and watertight connections to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
   4. Where feasible, test patched areas to demonstrate integrity of installation.

B. Restoration:
   1. Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in manner that eliminates evidence of patching and refinishing.
   2. For continuous surfaces, refinish to nearest intersection.
   3. For an assembly, refinish the entire unit that was patched.
   4. Patch, repair, or rehang existing ceilings as necessary to provide an even-plane surface of uniform appearance.

3.7 CLEANING

A. Cleaning and Restoration:
   1. Clean areas and spaces where cutting, coring, or patching were performed.
   2. Clean piping, conduit, and similar constructions before applying paint or other finishing materials.
   3. Restore damaged coverings of pipe and other utilities to original condition.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 74 05

CLEANING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for keeping the Site free of accumulations of waste materials during construction ("progress cleaning") and cleaning for Substantial Completion and prior to final inspection (collectively, "closeout cleaning").
   2. CONTRACTOR shall perform cleaning during the Project, including progress cleaning, upon completion of the Work, and as required by the General Conditions, as may be modified by the Supplementary Conditions, and this Section.
   3. Maintain in a clean manner the Site, the Work, and areas adjacent to or affected by the Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NFPA 241, Safeguarding Construction, Alteration, and Demolition Operations.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PROGRESS CLEANING

A. General:
   1. Clean the Site, work areas, and other areas occupied by CONTRACTOR not less than weekly. Dispose of materials in accordance with the General Conditions, as may be modified by the Supplementary Conditions, and the following:
      a. Comply with NFPA 241 for removing combustible waste materials and debris.
      b. Do not hold non-combustible materials at the Site more than three days if the temperature is expected to rise above 80 degrees F. When temperature is less than 80 degrees F, dispose of non-combustible materials within seven days of their generation.
      c. Provide suitable containers for storage of waste materials and debris.
      d. Containerize hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately.

B. Site:
   1. Keep dust-generating areas wetted down or otherwise control dust emissions.
   2. Not less than weekly, brush-sweep roadways and paved areas at the Site that are used by construction vehicles or otherwise affected by construction activities.

3. Comply with dust control requirements of Section 01 57 05, Temporary Controls.

C. Work Areas:
1. Clean areas where the Work is in progress to maintain the extent of cleanliness necessary for proper execution of the Work.
2. Remove liquid spills promptly. Immediately report spills to OWNER, ENGINEER, and authorities having jurisdiction, in accordance with the Contract Documents and Laws and Regulations.
3. Where dust would impair proper execution of the Work, vacuum entire work area, as appropriate.
4. Concealed Spaces: Remove debris from concealed spaces before enclosing the space.

D. Installed Work:
1. Keep installed Work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of material or equipment installed, using only cleaning agents and methods specifically recommended by material or equipment manufacturer. If manufacturer does not recommend specific cleaning agents or methods, use cleaning agents and methods that are not hazardous to health and property and that will not damage exposed surfaces.

E. Exposed Surfaces: Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration until Substantial Completion.

F. Cutting and Patching:
1. Clean areas and spaces where cutting and patching are performed. Completely remove paint, mortar, oils, putty, trailings and cuttings, and similar materials.
2. Thoroughly clean piping, conduits, and similar features before applying patching material, paint, or other finishing materials. Restore damaged coverings on piping, ducting, and similar items to its pre-construction condition.

G. Waste Disposal:
1. Properly dispose of waste materials, surplus materials, debris, and rubbish off the Site.
2. Do not burn or bury rubbish and waste materials at the Site.
3. Do not discharge volatile or hazardous substances, such as mineral spirits, oil, or paint thinner, into storm sewers or sanitary sewers.
4. Do not discharge wastes into surface waters or drainage routes.
5. CONTRACTOR is solely responsible for complying with Laws and Regulations regarding storing, transporting, and disposing of waste generated by CONTRACTOR's operations or brought to the Site by CONTRACTOR.

H. During handling and installation of materials and equipment, clean and protect construction in progress and adjoining materials and equipment already in place. Apply protective covering where required for protection from damage or deterioration, until Substantial Completion.

I. Clean completed construction as frequently as necessary throughout the construction period.

3.2 CLOSEOUT CLEANING

A. Complete the following prior to requesting inspection for Substantial Completion:
   1. Clean and remove from the Site rubbish, waste material, debris, and other foreign substances.
   2. Sweep paved areas broom-clean. Remove petrochemical spills, stains, and other foreign deposits.
   3. Hose-clean sidewalks and loading areas.
   4. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
   5. Leave surface waterways, drainage routes, storm sewers, and gutters open and clean.
   6. Repair pavement, roads, sod, and other areas affected by construction operations and restore to specified condition; if condition is not specified, restore to pre-construction condition.
   7. Clean exposed exterior and interior hard-surfaced finishes to dirt-free condition, free of spatter, grease, stains, fingerprints, films, and similar foreign substances.
   8. Remove non-permanent tags and labels.
   9. Leave the Site clean, and in neat, orderly condition, satisfactory to OWNER and ENGINEER.

B. Complete the following prior to requesting final inspection:
   1. Following completion of the Work on the “punch list” of Work uncompleted at Substantial Completion, clean in accordance with Paragraph 3.2.A of this Section.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 75 11

CHECKOUT AND STARTUP PROCEDURES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall initially start up and place equipment and systems installed under the Contract into successful operation, in accordance with the equipment manufacturer's written instructions and as instructed by Supplier at the Site.
   2. Provide all material, labor, tools, and equipment required to complete equipment checkout and start-up.
   3. Provide chemicals, lubricants, and other required operating fluids.
   4. Provide fuel, electricity, water, filters, and other expendables required for start-up of equipment, unless otherwise specified.
   5. General activities by CONTRACTOR include the following:
      a. Cleaning, as required under other provisions of the Contract Documents.
      b. Removing temporary protective coatings.
      c. Flushing and replacing lubricants, where required by manufacturer.
      d. Lubrication.
      e. Checking shaft and coupling alignments and resetting where required.
      f. Checking and setting motor, pump, and other equipment rotation, safety interlocks, and belt tensions.
      g. Checking and correcting (as necessary) leveling plates, grout, bearing plates, anchorage devices, fasteners, and alignment of piping, conduits, and ducts that may place stress on the connected equipment.
      h. Performing all adjustments required.

B. Coordination:
   1. Coordinate checkout and start-up with other contractors, as necessary.
   2. Do not start up system or subsystem for continuous operation until all components of that system or subsystem, including instrumentation and controls, have been tested to the extent practicable and proven to be operable as intended by the Contract Documents.
   3. OWNER will furnish sufficient personnel to assist CONTRACTOR in starting up equipment, but responsibility for proper operation is CONTRACTOR's.
   4. Supplier shall be present during checkout, startup, and initial operation, unless otherwise acceptable to ENGINEER.
   5. Startup of heating equipment, air conditioning equipment, and other equipment that provides cooling or other temperature control, and systems is dependent upon the time

of year. Return to the Site at beginning of next heating or cooling season (as applicable) to recheck and start the appropriate systems.

6. Do not start up system, unit process, or equipment without submitting acceptable preliminary operations and maintenance manuals by CONTRACTOR in accordance with Section 01 78 23, Operations and Maintenance Data.

C. OWNER's Assumption of Responsibility for Equipment and Systems:
   1. OWNER will assume responsibility for the equipment upon Substantial Completion, unless otherwise mutually agreed upon by OWNER and CONTRACTOR or as documented in the certificate of Substantial Completion.
   2. Before turning over to OWNER responsibility for operating and maintaining system or equipment CONTRACTOR shall:
      a. Provide training of operations and maintenance personnel in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
      b. Complete performance of equipment and system field quality control testing in accordance with the Contract Documents, to the extent possible.
      c. Submit acceptable final operations and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
      d. Obtain from ENGINEER final certificate of Substantial Completion for either entire Work or the portion being turned over to OWNER.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:
   1. Certifications:
      a. Supplier's certification of installation in accordance with Paragraph 3.1.B of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 SERVICES OF SUPPLIER

A. When specified, furnish services of competent, qualified representatives of material and equipment manufacturers, including supervising installation, adjusting, checkout, startup, and testing of materials and equipment.

B. Certification:
   1. When services by Supplier are required at the Site, within 14 days after first test operation of equipment, submit to ENGINEER a letter from Supplier, on Supplier's letterhead, stating that materials and equipment are installed in accordance with

Supplier's requirements and installation instructions, and in accordance with the Contract Documents.

2. In lieu of Supplier letter, submit completed form attached to this Section.
3. Include in the final operations and maintenance manual for the associated equipment a copy of the letter or completed form, as applicable.

3.2 MINIMUM STARTUP REQUIREMENTS

A. Bearings and Shafting:
   1. Inspect for cleanliness, and clean and remove foreign matter.
   2. Verify alignment.
   3. Replace defective bearings and those that operate in a rough or noisy manner.
   4. Grease as necessary, in accordance with manufacturer's recommendations.

B. Drives:
   1. Adjust tension in V-belt drives and adjust vari-pitch sheaves and drives for proper equipment speed.
   2. Adjust drives for alignment of sheaves and V-belts.
   3. Clean and remove foreign matter before starting operation.

C. Motors:
   1. Check each motor for comparison to amperage nameplate value.
   2. Correct conditions that produce excessive current flow and conditions that exist due to equipment malfunction.

D. Pumps:
   1. Check glands and seals for cleanliness and adjustment before running pump.
   2. Inspect shaft sleeves for scoring.
   3. Inspect mechanical faces, chambers, and seal rings, and replace if defective.
   4. Verify that piping system is free of dirt and scale before circulating liquid through pump.

E. Valves:
   1. Inspect manual and automatic control valves, and clean bonnets and stems.
   2. Tighten packing glands to ensure no leakage, but allow valve stems to operate without galling.
   3. Replace packing in valves to retain maximum adjustment after system is determined to be complete.
   4. Replace packing on valves that continue to leak.
   5. Remove, correct, and replace bonnets that leak.
   6. After cleaning, coat packing gland threads and valve stems with surface preparation of "Molycote" or "Fel-Pro".

F. Verify that control valve seats are free of foreign matter and are properly positioned for intended service.

G. Pipe Joints and Other Connections:
   1. Tighten flanges and other pipe joints after system has been placed in operation.
   2. Replace gaskets that show signs of leakage after tightening.
   3. Inspect all joints for leakage.
   4. Promptly remake each joint that appears to be faulty; do not wait for rust other corrosion to form.
   5. Clean threads on both parts, and apply compound and remake joints.

H. After system has been placed in operation, clean strainers, drives, pockets, orifices, valve seats, and headers in fluid system to ensure freedom from foreign matter.

I. Open steam traps and air vents, where used, and remove operating elements. Clean thoroughly, replace internal parts, and place back into operation.

J. Remove rust, scale, and foreign matter from equipment and renew defaced surfaces.

K. Set and calibrate draft gauges of air filters and other equipment.

L. Inspect fan wheels for clearance and balance. Provide factory-authorized personnel for adjustment where needed.

M. Check each electrical control circuit to verify that operation complies with the Contract Documents.

N. Inspect each pressure gauge, thermometer, and other instruments for calibration. Replace items that are defaced, broken, or that read incorrectly.

O. Repair damaged insulation.

P. Excess Gasses and Fluids:
   1. Vent gasses trapped in systems.
   2. Verify that liquids are drained from all parts of gas or air systems.

3.3 ATTACHMENTS

A. The attachment listed below, following this Section's "End of Section" designation, is a part of this Specification Section.
   1. Supplier's Installation Certification Form (one page).

+ + END OF SECTION + +

SUPPLIER'S INSTALLATION CERTIFICATION

Contract No. and Name: _____

Equipment Specification Section: _____

Equipment Name: _____

Contractor: _____

Manufacturer of Equipment: _____

The undersigned Supplier of the equipment or system described above hereby certifies that Supplier has checked the installation of the equipment or system and that the equipment or system, as specified in the Contract Documents, has been provided in accordance with the manufacturer's recommendations and the Contract Documents, and that the trial operation of the equipment or system has been satisfactory.

Comments: _____

_____	_____
Date	Supplier Name (print)
	_____
	Signature of Supplier
_____	_____
Date	Contractor Name (print)
	_____
	Signature of Contractor

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 77 23

POST-FINAL INSPECTION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for the post-final inspection, and is coordinated with the payment provisions of the Agreement and Supplementary Conditions.
   2. Approximately one year after Substantial Completion, ENGINEER will schedule with OWNER and CONTRACTOR the post-final inspection and will advise OWNER and CONTRACTOR in writing of the date and time for post-final inspection.

B. CONTRACTOR's project manager shall attend the post-final inspection.

C. After post-final inspection, ENGINEER will furnish to CONTRACTOR a list of required correction Work that shall be completed by CONTRACTOR in accordance with the Contract Documents. Such successful completion of corrective Work is required before ENGINEER will recommend payment of final retainage by OWNER.

D. Submit "final" Application for Payment in accordance with the final Application for Payment procedures of the General Conditions, as may be modified by the Supplementary Conditions, and the Specifications, including furnishing all required Contract closeout documentation and completion of all Work except for the post-final inspection and associated correction Work (if any). OWNER will release remaining retainage withheld for post-final inspection following post-final inspection and completion of correction Work (if any), in accordance with progress payment procedures of the Contract, except that consent of surety to final payment shall accompany the last (pots-final inspection) Application for Payment.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 78 23

OPERATIONS AND MAINTENANCE DATA

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for manufacturers' operations and maintenance manuals and related data to be furnished by CONTRACTOR.
   2. CONTRACTOR shall submit operation and maintenance data, in accordance with this Section and in accordance with requirements elsewhere in the Contract Documents, as instructional and reference manuals by operations and maintenance personnel at the Site.
   3. Required operation and maintenance data groupings are listed in table(s) in Article 1.2 of this Section. At minimum, submit operation and maintenance data for:
      a. All equipment and systems.
      b. Valves, gates, actuators, and related accessories.
      c. Instrumentation and control devices.
      d. Electrical equipment.
   4. For each operation and maintenance manual, submit the following:
      a. Preliminary Submittal: Printed and bound copy of entire operation and maintenance manual, except for test data, service reports by Supplier, and submit electronic copies.
      b. Final Submittal: Printed and bound copy of complete operations and maintenance manual, including test data and service reports by Supplier, and submit electronic copies.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit the operations and maintenance data indicated in the Contract Documents, grouped into submittals as indicated in Table 01 78 23-A:

TABLE 01 78 23-A, REQUIRED OPERATIONS AND MAINTENANCE DATA

Name of O&M Manual/Data	For Materials or Equipment Specified in Section(s)
Rock Trap: FOG-TRP-001	
Grinder: FOG-GRD-001	
Unloading/Mixing Pump No.1: FOG-PMP-011	
Unloading/Mixing Pump No.2: FOG-PMP-012	
Flame Arrestor	

Name of O&M Manual/Data	For Materials or Equipment Specified in Section(s)
Activated Carbon Canister	
Metering Pump No 1: FG-PMP-021	
Metering Pump No 1: FG-PMP-021	
Corious Flowmeter: FOG-FM-001	

B. Quantity Required and Timing of Submittals:
   1. Preliminary Submittal:
      a. Printed Copies: 3 copies, exclusive of copies required by CONTRACTOR.
      b. Electronic Copies: In accordance with Section 01 31 26, Electronic Communication Protocols.
      b. Electronic Copies: 2 copies.
      c. Submit to ENGINEER by the earlier of: 90 days following approval of Shop Drawings and product data submittals, or 10 days prior to starting training of operations and maintenance personnel, or 10 days prior to field quality control testing at the Site.
   2. Final Submittal: Furnish final submittal prior to Substantial Completion, unless submittal is specified as required prior to an interim Milestone.
      a. Printed Copies: 3 copies.
      b. Electronic Copies: 2 copies.

1.3 FORMAT OF PRINTED COPIES

A. Binding and Cover:
   1. Bind each operation and maintenance manual in durable, permanent, stiff-cover binder(s), comprising one or more volumes per copy as required. Binders shall be not less than one inch wide and maximum of three inches wide. Binders for each copy of each volume shall be identical.
   2. Binders shall be locking three-ring/”D”-ring type, or three-post type. Three-ring binders shall be riveted to back cover and include plastic sheet lifter (page guard) at front of each volume.
   3. Do not overfill binders.
   4. Covers shall be oil-, moisture-, and wear-resistant, including identifying information on cover and spine of each volume.
   5 Provide the following information on cover of each volume:
      a. Title: “OPERATING AND MAINTENANCE INSTRUCTIONS”.
      b. Name or type of material or equipment covered in the manual.
      c. Volume number, if more than one volume is required, listed as “Volume __ of __”, with appropriate volume-designating numbers filled in.
      d. Name of Project and, if applicable, Contract name and number.
      e. Name of building or structure, as applicable.
   6 Provide the following information on spine of each volume:
      a. Title: “OPERATING AND MAINTENANCE INSTRUCTIONS”.
      b. Name or type of material or equipment covered in the manual.
      c. Volume number, if more than one volume is required, listed as “Volume __ of

__", with appropriate volume-designating numbers filled in.

d. Project name and building or structure name.

B. Pages:

1. Print pages in operations and maintenance manual on 30-pound (minimum) paper, 8.5 inches by 11 inches in size.
2. Reinforce binding holes in each individual sheet with plastic, cloth, or metal. When published, separately-bound booklets or pamphlets are part of the manual, reinforcing of pages within booklet or pamphlet is not required.
3. Furnish each page with binding margin not less than one inch wide. Punch each page with holes suitable for the associated binding.

C. Drawings:

1. Bind into the operation and maintenance manual drawings, diagrams, and illustrations up to and including 11 inches by 17 inches in size, with reinforcing specified for pages.

2. Documents larger than 11 inches by 17 inches shall be folded and inserted into clear plastic pockets bound into the manual. Mark pockets with printed text indicating content and drawing numbers. Include not more than three drawing sheets per pocket.

D. Copy Quality and Document Clarity:

1. Contents shall be original-quality copies. Documents in the operations and maintenance manual shall be either original manufacturer-printed documents or first-generation photocopies indistinguishable from originals. If original is in color, copies shall be in color. Manuals that contain copies that are unclear, not completely legible, off-center, skewed, or where text or drawings are cut by binding holes, are unacceptable. Pages that contain approval or date stamps, comments, or other markings that cover text or drawing are unacceptable. Faxed copies are unacceptable.
2. Clearly mark in ink to indicate all components of materials and equipment on catalog pages for ease of identification. In standard or pre-printed documents, indicate options furnished or cross out inapplicable content. Using highlighters to so indicate options furnished is unacceptable.

E. Organization:

1. Table of Contents:
   a. Provide table of contents in each volume of each operations and maintenance manual.
   b. In table of contents and not less than once in each chapter or section, identify materials and equipment by their functional names. Thereafter, abbreviations and acronyms may be used if their meaning is clearly indicated in a table bound at or near beginning of each volume. Using material or equipment model or catalog designations for identification is unacceptable.
2. Use dividers and indexed tabs between major categories of information, such as operating instructions, preventive maintenance instructions, and other major subdivisions of data in each manual.

1.4 FORMAT OF ELECTRONIC COPIES

A. Electronic Copies of Operation and Maintenance Manuals:
   1. Each electronic copy shall include all information included in the corresponding printed copy.
   2. Submit each electronic copy on a separate compact disc (CD) or portable USB "thumb drive".
   3. File Format:
      a. Files shall be in "portable document format" (PDF). Files shall be electronically searchable.
      b. Submit separate file for each separate document in the printed copy.
      c. Within each file, provide bookmarks for the following:
         1) Each chapter and subsection listed in the corresponding printed copy document's table of contents.
         2) Each figure.
         3) Each table.
         4) Each appendix.
   4. Also submit drawings and figures in one of the following formats: ".bmp", ".tif", ".jpg", or ".gif". When files are submitted on CD or portable USB "thumb drive", submit such files in a separate directory on the CD or portable USB "thumb drive".

B. Copies of Programming and Configuration Files:
   1. Furnish on CD or portable USB "thumb drive" copy of all software programming, such as programmable logic controller programs, prepared specifically for the Project. Third-party, licensed, commercially available software is excluded from requirements of this Article; submit copies of commercially-available, licensed, third-party software, where required, in accordance with the Contract Documents.
   2. Submit on CD or portable USB "thumb drive" copies of system configuration prepared specifically for the Project, such as plant monitoring system and SCADA display configurations.
   3. Submit programming and configuration files concurrently with electronic copies of operation and maintenance data.

1.5 CONTENT

A. General:
   1. Prepare each operations and maintenance manual specifically for the Project. Include in each manual all pertinent instructions, as-built drawings as applicable, bills of materials, technical bulletins, installation and handling requirements, maintenance and repair instructions, and other information required for complete, accurate, and comprehensive data for safe and proper operation, maintenance, and repair of materials and equipment furnished for the Project. Include in manuals specific information required in the Specification Section for the material or equipment, data required by Laws and Regulations, and data required by authorities having jurisdiction.

2. Completeness and Accuracy:
   a. Operation and maintenance manuals that include language stating or implying that the manual's content may be insufficient or stating that the manual's content is not guaranteed to be complete and accurate are unacceptable.
   b. Operations and maintenance manuals shall be complete and accurate.
   c. Operation and maintenance manuals shall indicate the specific alternatives and features furnished, and the specific operation and maintenance provisions for the material or equipment furnished.
3. Submit complete, detailed written operating instructions for each material or equipment item including: function; operating characteristics; limiting conditions; operating instructions for start-up, normal and emergency conditions; regulation and control; operational troubleshooting; and shutdown. Also include, as applicable, written descriptions of alarms generated by equipment and proper responses to such alarm conditions.

B. Submit written explanations of safety considerations relating to operation and maintenance procedures.

C. Submit complete, detailed, written preventive maintenance instructions including all information and instructions to keep materials, equipment, and systems properly lubricated, adjusted, and maintained so that materials, equipment, and systems function economically throughout their expected service life. Instructions shall include:
   1. Written explanations with illustrations for each preventive maintenance task such as inspection, adjustment, lubrication, calibration, and cleaning. Include pre-startup checklists for each equipment item and maintenance requirements for long-term shut-downs.
   2. Recommended schedule for each preventive maintenance task.
   3. Lubrication charts indicating recommended types of lubricants, frequency of application or change, and where each lubricant is to be used or applied.
   4. Table of alternative lubricants.
   5. Troubleshooting instructions.
   6. List of required maintenance tools and equipment.

D. Submit complete bills of material or parts lists for materials and equipment furnished. Lists or bills of material may be furnished on a per-drawing or per-equipment assembly basis. Bills of material shall indicate:
   1. Manufacturer's name, address, telephone number, fax number, and Internet website address.
   2. Manufacturer's local service representative's or local parts supplier's name, address, telephone number, fax number, Internet website address, and e-mail addresses, when applicable.
   3. Manufacturer's shop order and serial number(s) for materials, equipment or assembly furnished.
   4. For each part or piece include the following information:
      a. Parts cross-reference number. Cross-reference number shall be used to identify

the part on assembly drawings, Shop Drawings, or other type of graphic illustration where the part is clearly shown or indicated.

b. Part name or description.
c. Manufacturer's part number.
d. Quantity of each part used in each assembly.
e. Current unit price of the part at the time the operations and maintenance manual is submitted. Price list shall be dated.

E. Submit complete instructions for ordering replaceable parts, including reference numbers (such as shop order number or serial number) that will expedite the ordering process.

F. Submit manufacturer's recommended inventory levels for spare parts, extra stock materials, and consumable supplies for the initial two years of operation. Consumable supplies are items consumed or worn by operation of materials or equipment, and items used in maintaining the operation of material or equipment, including items such as lubricants, seals, reagents, and testing chemicals used for calibrating or operating the equipment. Include estimated delivery times, shelf life limitations, and special storage requirements.

G. Submit manufacturer's installation and operation bulletins, diagrams, schematics, and equipment cutaways. Avoid submitting catalog excerpts unless they are the only document available showing identification or description of particular component of the equipment. Where materials pertain to multiple models or types, mark the literature to indicate specific material or equipment supplied. Marking may be in the form of checking, arrows, or underlining to indicate pertinent information, or by crossing out or other means of obliterating information that does not apply to the materials and equipment furnished.

H. Submit original-quality copies of each approved and accepted Shop Drawing, product data, and other submittal, updated to indicate as-installed condition. Reduced drawings are acceptable only if reduction is to not less than one-half original size and all lines, dimensions, lettering, and text are completely legible on the reduction.

I. Submit complete electrical schematics and wiring diagrams, including complete point-to-point wiring and wiring numbers or colors between all terminal points.

J. Programmable Logic Controllers: If programmable logic controllers are furnished under the Contract:
1. Submit complete logic listings as described ins Section 40 64 00 format.
2. 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.
   a. For function block diagram, label each function block with understandable tags or descriptive labels. Describe purpose and action of each function block.
   a. For sequential function chart, include extensive comments for each step to describe program step function.

a. For instruction list and structured text, include extensive comments for each program line to describe program line function.

3. Submit complete programmable logic controller listing of all input/output address assignments, tag assignments, and pre-set constant values, with functional point descriptions.
4. Submit complete manufacturer's programming manuals.

K. Submit copy of warranty bond and service contract as applicable.

L. When copyrighted material is used in operations and maintenance manuals, obtain copyright holder's written permission to use such material in the operation and maintenance manual.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 78 36

WARRANTIES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This section describes general requirements for warranties required in the various Specifications.
   2. Provisions on the Contract's correction period, CONTRACTOR'S general warranty and guarantee, and CONTRACTOR's warranty of title are in the General Conditions, as may be modified by the Supplementary Conditions.
   3. This section includes general requirements for:
      a. Suppliers' standard warranties.
      b. Suppliers' special warranties.
      c. Implied warranties.
      d. Commencement and duration of warranties.

1.2 SUBMITTALS

A. General:
   1. For each item of equipment furnished under the Contract, submit Supplier's standard warranty, regardless of whether such warranty or submittal thereof is required by the associated Specifications for that item. Submit such warranties for materials where such submittal is required in the Specifications for the material.
   2. For each item of material or equipment where Supplier's special (or extended) warranty is required by the Contract Documents, submit appropriate special warranty that complies with the Contract Documents.
   3. Supplier's warranties shall be specifically endorsed solely to OWNER by the entity issuing such warranty.
   4. Submit Suppliers' standard warranties and special warranties as submittals in accordance with Schedule of Submittals accepted by ENGINEER.

1.3 SUPPLIERS' WARRANTIES FOR MATERIALS AND EQUIPMENT

A. Warranty Types:
   1. Required by the General Conditions:
      a. Warranties specified for materials and equipment shall be in addition to, and run concurrent with, CONTRACTOR's general warranty and guarantee and requirements for the Contract's correction period.
      b. Disclaimers and limitations in specific materials and equipment warranties do not limit CONTRACTOR's general warranty and guarantee, nor does such affect or limit CONTRACTOR's performance obligations under the correction period.

2. Material or equipment manufacturer's standard warranty is pre-printed, written warranty published by item's manufacturer and specifically endorsed by manufacturer to OWNER.
3. Special warranty is written warranty that either extends the duration of material or equipment manufacturer's standard warranty or provides other, increased rights to OWNER. Where the Contract Documents indicate specific requirements for warranties that differ from the manufacturer's standard warranty for that item, special warranty is implied.

B. Requirements for Special Warranties:
1. Submit written special warranty document that contains appropriate provisions and identification, ready for execution by material or equipment manufacturer and OWNER. Submit draft warranty with submittals required prior to fabrication and shipment of the item from the Supplier's facility.
2. Manufacturer's Standard Form: Modified to include Project-specific information and properly executed by product manufacturer and other entities as appropriate.
3. Specified Form: When specified forms for special warranties are included in the Contract Documents, prepare written document, properly executed by item manufacturer and OWNER, using the required form.
4. Refer to the Specifications for content and requirements for submitting special warranties.

1.4 IMPLIED WARRANTIES

A. Warranty of Title and Intellectual Property Rights:
1. Except as may be otherwise indicated in the Contract Documents, implied warranty of title required by Laws and Regulations is applicable to the Work and to materials and equipment incorporated therein.
2. Provisions on intellectual property rights, including patent fees and royalties, are in the General Conditions, as may be modified by the Supplementary Conditions.

B. Warranty of Merchantability:
1. Notwithstanding any other provision of the Contract to the contrary, implied warranties of merchantability required by Laws and Regulations apply to the materials and equipment incorporated into the Work.

C. Warranty of Fitness-for-Purpose:
1. When Supplier is aware of, or has reason to be aware of, specified materials or features of the Work that are contrary to the intended use, purpose, service, application, or environment in which the material or equipment item will be used, submit request for interpretation in accordance with Section 01 25 00, Substitution Procedures. Where appropriate, such request for interpretation shall indicate the apparent discrepancy and propose appropriate, alternative materials or equipment.

1.5 COMMENCEMENT AND DURATION OF WARRANTIES

A. Commencement of Warranties:
   1. Contract correction period and CONTRACTOR's general warranty commence as indicated in the General Conditions, as may be modified by the Supplementary Conditions.
   2. Suppliers' general warranties and special warranties commence running on the date that the associated item is certified by ENGINEER as substantially complete. In no event shall special warranties commence running prior to ENGINEER's review and acceptance of special warranty submittal for the item.
   3. Implied warranties commence in accordance with Laws and Regulations.

B. Duration of Warranties:
   1. Duration of correction period is in accordance with the General Conditions, as may be modified by the Supplementary Conditions.
   2. Duration of CONTRACTOR's general warranty and guarantee is in accordance with Laws and Regulations.
   3. Duration of Suppliers' general warranties is in accordance with the applicable general warranty document accepted by ENGINEER.
   4. Duration of required Suppliers' special warranties shall be in accordance with the requirements of the Contract Documents for the subject item.
   5. Duration of implied warranties shall be in accordance with Laws and Regulations.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 78 39

PROJECT RECORD DOCUMENTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes requirements for Project record documents, to supplement the requirements of the General Conditions, as may be modified by the Supplementary Conditions.
   2. CONTRACTOR shall provide all labor, materials, equipment, and services to maintain and submit to ENGINEER Project record documents in accordance with the Contract Documents.

B. Maintenance of Record Documents:
   1. Maintain in CONTRACTOR's field office, in clean, dry, legible condition, complete sets of the following record documents: Drawings, Specifications, and Addenda; Shop Drawings, Samples, and other CONTRACTOR submittals, including records of test results, approved or accepted as applicable, by ENGINEER; Change Orders, Work Change Directives, Field Orders, copies of all interpretations and clarifications issued, photographic documentation, survey data, and all other documents pertinent to the Work.
   2. Provide files and racks for proper storage and easy access to record documents. File record documents in accordance with the edition of the Construction Specification Institute's *MasterFormat*™ used for organizing the Project Manual, unless otherwise accepted by ENGINEER.
   3. Promptly make record documents available for observation and review upon request of ENGINEER or OWNER. Requirements for review of record documents status as a condition precedent to progress payments is in Section 01 29 73, Schedule of Values, and Section 01 29 76, Progress Payment Procedures.
   4. Do not use record documents for any purpose other than serving as Project record. Do not remove record documents from CONTRACTOR's field office without ENGINEER's approval.

1.2 SUBMITTALS

A. Closeout Submittals: Submit the following:
   1. Record Documents:
      a. Submit the following Project record documents:
         1) Drawings.
         2) Project Manual including Specifications and Addenda (bound).
      b. Prior to readiness for final payment, submit to ENGINEER one copy of Project's final record documents and obtain ENGINEER's acceptance of same. Submit complete record documents; do not make partial submittals.

d. Submit record documents with transmittal letter on CONTRACTOR letterhead in accordance with requirements in Section 01 33 00, Submittal Procedures.

1.3 RECORDING CHANGES

A. Recording Changes – General:
1. At the start of the Project, label each record document to be submitted as, "PROJECT RECORD" using legible, printed letters. Letters on record copy of the Drawings shall be two inches high.
2. Keep record documents current and consistent with the progress of the Work. Make entries on record documents within two working days of receipt of information required to record the change.
3. Do not permanently conceal the Work until required information has been recorded for Project record documents.
4. Accuracy of record documents shall be such that future searches for items shown on the record documents may rely reasonably on information obtained from ENGINEER-accepted record documents.
5. Marking of Entries:
   a. Use erasable, colored pencils (not ink or indelible pencil) for marking changes, revisions, additions, and deletions to record documents.
   b. Clearly describe the change by graphic line and make notations as required. Use straight-edge to mark straight lines. Writing shall be legible and sufficiently dark to allow scanning of record documents into legible electronic files in portable document format (".PDF").
   c. Date each entry on record documents.
   d. Indicate changes by drawing a "cloud" around the change(s) indicated.
   e. Mark initial revisions in red. In the event of overlapping changes, use different colors for subsequent changes.

B. Drawings:
1. Record changes on copy of the Drawings. Submittal of CONTRACTOR-originated or -produced drawings as a substitute for recording changes on a copy of the Drawings is unacceptable.
2. Record changes on plans, sections, elevations, schematics, schedules, and details as required for clarity, making reference dimensions and elevations (to Project datum) for complete record documentation.
3. Record actual construction including:
   a. Depths of various elements of foundation relative to Project datum.
   b. Horizontal and vertical location of Underground Facilities referenced to permanent surface improvements and project elevation datum. For each Underground Facility, including pipe fittings, show and indicate dimensions to not less than two permanent, visible surface improvements.
   c. Location of exposed utilities and appurtenances concealed in construction, referenced to visible and accessible features of structure and, where applicable, to Project elevation datum.

d. Changes in structural and architectural elements of the Work, including changes in reinforcing.
e. Field changes of dimensions, arrangements, and details.
f. Changes made in accordance with Addenda, Change Orders, Work Change Directives, and Field Orders.
g. Changes in details on the Drawings. Submit additional details prepared by CONTRACTOR when required to document such changes.

4. Recording Changes for Schematic Layouts:
   a. In some cases on the Drawings, arrangements of conduits, circuits, piping, ducts, and similar items are shown schematically and are not intended to portray physical layout. For such cases, the final physical arrangement shall be determined by CONTRACTOR subject to acceptance by ENGINEER.
   b. Record on the Project record documents all revisions to schematics on the Drawings, including: piping schematics, process and instrumentation diagrams, and other schematics when included in the Drawings. Show and indicate actual locations of piping, bends, slopes, valves, tie-ins, fencing, and other pertinent data.
   c. When dimensioned plans and dimensioned sections or elevations on the Drawings show the Work schematically, indicate on the record documents, by dimensions accurate to within one inch in the field, centerline location of items of Work such as piping and similar items.
      1) Clearly identify each item of the Work by accurate notations such as “cast iron drain”, “rigid electrical conduit”, “copper waterline”, and similar descriptions.
      2) Show by symbol or by note the vertical location of each item of the Work; for example, “embedded in slab”, “under slab”, “in ceiling plenum”, “exposed”, and similar designations. For piping, indicate elevation dimension relative to Project elevation datum.
      3) Descriptions shall be sufficiently detailed to be related to the Specifications.
   d. ENGINEER may furnish written waiver of requirements relative to schematic layouts shown on plans, sections, and elevations when, in ENGINEER’s judgment, dimensioned layouts of Work shown schematically will serve no useful purpose. Do not rely on such waiver(s) being issued.
5. Supplemental Drawings:
   a. In some cases, drawings produced during construction by ENGINEER or CONTRACTOR supplement the Drawings and shall be included with Project record documents submitted by CONTRACTOR. Supplemental record drawings shall include drawings or sketches that are part of Change Orders, Work Change Directives, and Field Orders and that cannot be incorporated into the Drawings because of space limitations.
   b. Supplemental drawings submitted with record drawings shall be integrated with the Drawings and include necessary cross-references between drawings. Supplemental record drawings shall be on sheets the same size as the Drawings.
   c. When supplemental drawings developed by CONTRACTOR using computer-aided drafting/design (CADD) software are to be included in record drawings, submit electronic files for such drawings. Label such files, “Supplemental

Record Drawings", including CONTRACTOR's name, Project name, and Contract designation.

C. Specifications and Addenda:
   1. Mark each Specifications Section to record:
      a. Manufacturer, trade name, catalog number, and Supplier of each material and equipment item actually provided.
      b. Changes made by Addendum, Change Orders, Work Change Directives, and Field Orders.

1.4 ELECTRONIC FILES FURNISHED BY ENGINEER

A. CADD files of the Drawings will be furnished by ENGINEER upon the following conditions:
   1. CONTRACTOR shall submit to ENGINEER a letter on CONTRACTOR letterhead requesting CADD files of the Drawings and indicating specific definition(s) or description(s) of how such files will be used, and specific description of benefits to OWNER (including credit proposal, if applicable) if the request is granted.
   2. CONTRACTOR shall execute ENGINEER's standard agreement for release of electronic files and shall abide by the provisions of such agreement for release of electronic files.
   3. Layering system incorporated in CADD files shall be maintained as transmitted by ENGINEER. CADD files transmitted by ENGINEER containing cross-referenced files shall not be bound by CONTRACTOR. Drawing cross-references and paths shall be maintained. If CONTRACTOR alters layers or cross-reference files, CONTRACTOR shall restore all layers and cross-references prior to submitting record documents to ENGINEER.
   4. CONTRACTOR shall submit record drawings to ENGINEER in same CADD format that files were furnished to CONTRACTOR.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 01 78 43

SPARE PARTS AND EXTRA MATERIALS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section includes administrative and procedural requirements for furnishing spare parts, extra materials, maintenance supplies, and special tools required for maintenance (collectively, "spare parts and extra materials") required by the Contract Documents.
   2. CONTRACTOR shall furnish spare parts, extra materials, and associated information, for materials and equipment furnished in accordance with the Contract Documents. Furnish such items in accordance with the requirements of this Section and the Specifications sections in which such items are indicated.
   3. CONTRACTOR shall be fully responsible for loss and damage to spare parts and extra materials until such items are received by OWNER's facility manager.
   4. Promptly replace spare parts and extra materials furnished by OWNER to CONTRACTOR for use in remedying defective Work.

B. List of Spare Parts and Extra Materials:
   1. With the Shop Drawings and product data submittals for each Specifications section, submit a complete listing of spare parts and extra materials required for maintenance for two years of operation, together with unit prices in current United States funds, and source(s) of supply for each.
   2. Also include listing of spare parts and extra materials, with pricing and sources, in the operations and maintenance data submitted in accordance with Section 01 78 23, Operations and Maintenance Data.

1.2 SUBMITTALS

A. Maintenance Material Submittals: Submit the following:
   1. Spare Parts and Extra Materials:
      a. Furnish to OWNER in accordance with requirements of this Section, and the Specifications section in which the spare parts and extra materials are specified.
   2. Transfer Documentation: For each delivery of spare parts and extra materials, submit to ENGINEER the following:
      a. Submit, on CONTRACTOR's letterhead, a letter of transmittal for spare parts and extra materials furnished under each Specifications section. Letter of transmittal shall accompany spare parts and extra materials. Do not furnish letter of transmittal separate from associated spare parts and extra materials.

b. Furnish three original, identical, signed letters of transmittal for each delivery of spare parts and extra materials furnished under each Specifications section. Upon delivery of specified quantities and types of spare parts and extra materials to OWNER, designated person from OWNER will countersign each original letter of transmittal indicating OWNER's receipt of spare parts and extra materials in the quantity, type, and quality required by the Contract Documents. OWNER will retain one fully-signed original, CONTRACTOR shall submit one fully-signed original to ENGINEER. CONTRACTOR shall retain one fully-signed original for CONTRACTOR's records.

c. Letter of transmittal shall include the following:
   1) Information required for letters of transmittal in Section 01 33 00, Submittal Procedures.
   2) Transmittal shall list spare parts and extra materials furnished under each Specifications Section. List each individual part, material, equipment item, tool, and product and the associated quantity furnished.
   3) Include space for countersignature by OWNER as follows: space for signature, space for printed name, and date.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Packaging and Labeling of Spare Parts and Extra Materials:
   1. Furnish spare parts and extra materials in manufacturer's unopened cartons, boxes, crates, or other original, protective covering suitable for preventing corrosion and deterioration for maximum length of storage normally anticipated by manufacturer.
   2. Packaging of spare parts and extra materials shall be clearly marked and identified with name of manufacturer, applicable material or equipment, part number, part description, and part location in the equipment or system.
   3. Protect and package spare parts and extra materials for maximum shelf life normally anticipated by manufacturer.

B. Storage Prior to Delivery to Owner:
   1. Prior to furnishing spare parts and extra materials to OWNER, store spare parts and extra materials in accordance with the Contract Documents and manufacturers' recommendations.

C. Procedure for Delivery to Owner:
   1. Deliver spare parts and extra materials to OWNER's permanent storage rooms at the Site or area(s) at the Site designated by OWNER.
   2. When spare parts and extra materials are delivered, CONTRACTOR and OWNER will mutually inventory the spare parts and extra materials delivered to verify compliance with the Contract Documents regarding quantity, part numbers, and quality.
   3. Additional procedures for delivering spare parts and extra materials to OWNER, if required, will be developed by ENGINEER and complied with by CONTRACTOR.
   4. CONTRACTOR shall reimburse OWNER for all costs and expenses incurred by OWNER, including professional services, for delivery of inadequate, incorrect, or

defective spare parts and extra materials. OWNER may withhold such amounts from payments due CONTRACTOR via set-offs in accordance with the Contract Documents.

D. Delivery Time and Eligibility for Payment:
   1. Deliver to OWNER spare parts and extra materials prior to date of Substantial Completion for materials and equipment associated therewith.
   2. Do not deliver spare parts and extra materials before commencing startup for associated material or equipment.
   2. Spare parts and extra materials are not eligible for payment until delivered to OWNER and CONTRACTOR's receipt of OWNER's countersignature on letter of transmittal.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 79 23

INSTRUCTION OF OPERATIONS AND MAINTENANCE PERSONNEL

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall furnish services of Supplier's operation and maintenance training specialists to instruct OWNER's and facility manager's personnel in recommended operating and maintenance procedures for materials and equipment furnished, in accordance with the Contract Documents.
   2. Supplier shall provide a combination of classroom and field training at the Site, unless otherwise required elsewhere in the Contract Documents.
   3. OWNER or facility manager reserves the right to record training sessions on video for OWNER's later use in instructing OWNER's or facility manager's personnel.

B. Scheduling of Training Sessions:
   1. General:
      a. CONTRACTOR shall coordinate training services with start-up and initial operation of materials and equipment on days and times, and in manner, acceptable to OWNER, in accordance with the Contract Documents.
      b. Training may be required outside of normal business hours to accommodate schedules of operations and maintenance personnel. Furnish training services at the required days and times at no additional cost to OWNER.

   2. Prerequisites to Training:
      a. Training of facility operations and maintenance personnel shall commence after preliminary operation and maintenance data has been submitted and accepted by ENGINEER, and Work required in Section 01 75 11, Checkout and Startup Procedures, is complete.
      b. At option of OWNER or ENGINEER, training may be allowed to take place before, during, or after equipment startup.
   3. Training Schedule Submittal:
      a. Training Schedule Required: CONTRACTOR shall prepare and submit proposed training schedule for review and acceptance by ENGINEER and OWNER. Proposed training schedule shall show and indicate all training required in the Contract Documents, and shall demonstrate compliance with specified training requirements relative to number of hours of training for various elements of the Work, number of training sessions, and scheduling.
      c. Timing of Training Schedule Submittal: Submit initial training schedule not less than 60 days before scheduled start of first training session. Submit final training

schedule, incorporating revisions in accordance with ENGINEER's comments, not later than 30 days prior to starting the first training session.

d. OWNER reserved the right to modify personnel availability for training in accordance with process or emergency needs at the facility.

1.2 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer's Instructors:
   a. Shall be factory-trained by manufacturer of material or equipment.
   b. Manufacturer's instructors shall be proficient and experienced in performing training of the type required.
   c. Instructors shall be proficient in spoken and written English language.
   d. Qualifications of instructors are subject to acceptance by ENGINEER. If ENGINEER does not accept qualifications of proposed instructor, furnish services of replacement instructor with acceptable qualifications.

B. Training Scheduling Conference:

1. Prior to preparing initial training schedule submittal, schedule and hold training scheduling conference at the location where progress meetings are held, to review:
   a. Training requirements indicated in the Contract Documents.
   b. Work to be completed prior to starting training.
   c. Work progress and Progress Schedule relative to startup and training.
   d. Scheduling constraints for OWNER's personnel, relative to days and times of training sessions.
   e. Preferred days for training.
   f. Location where training will be performed and facilities available.
   g. Required submittals relative to training.
   h. Other issues relative to training of operations and maintenance personnel.
2. Attendance is mandatory for the following:
   a. CONTRACTOR's project manager.
   b. CONTRACTOR's Site superintendent.
   c. Project manager of Subcontractors responsible for furnishing materials and equipment for which training of operations and maintenance personnel is required.
   d. Manufacturers and other Suppliers invited by CONTRACTOR.
   f. ENGINEER.
   g. Facility manager's staff responsible for training coordination, and staff responsible for scheduling operations and maintenance personnel.
3. If additional information must be developed to adequately cover agenda items, reconvene conference as soon as possible.
4. CONTRACTOR shall prepare minutes summarizing the discussions of conference, decisions made, and agreements and disagreements, and submit the minutes to each conference attendee.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Training Schedule: Detailed schedule of training sessions, demonstrating compliance with number of training sessions, hours required in the Contract Documents, and complying with the Contract Times. Submit training schedule submittals in accordance with time frames specified in this Section.

B. Informational Submittals: Submit the following:
   1. Lesson Plan: Acceptable lesson plan for training on each material or equipment item, in accordance with Table 01 79 23-A and the Contract Documents. Lesson plan shall comply with requirements of this Section as may be supplemented by Specifications Sections where materials and equipment are specified. Include with lesson plan copy of handouts that will be used during training sessions. Furnish lesson plan submittals in accordance with time frames specified in this Section.
   2. Qualifications:
      a. Credentials of manufacturer's proposed operations and maintenance instructor(s). Credentials shall demonstrate compliance with requirements of this Section and shall include brief resume' and specific details of instructor's operating, maintenance, and training experience relative to the specific material and equipment for which instructor will provide training.
   3. Minutes of training scheduling conference.

C. Closeout Submittals: Submit the following:
   1. Trainee sign-in sheets for each training session. Submit to OWNER's training coordinator with copy to ENGINEER.

1.4 LESSON PLAN

A. Supplier's lesson plan shall describe specific instruction topics, system components for which training will be furnished, and training procedures. Handouts, if any, to be used in training shall be included with the lesson plan. Describe in lesson plan "hands-on" demonstrations planned for training sessions.

B. Submit acceptable lesson plan not less than 14 days prior to starting associated training.

C. Indicate in lesson plan estimated duration of each training segment.

D. Lesson plan shall include the following:
   1. Material and Equipment Overview (required for all types of operations and maintenance training):
      a. Describe material and equipment's operating (process) function and performance objectives.
      b. Describe material and equipment's fundamental operating principles and dynamics.

c. Identify equipment's mechanical, electrical, and electronic components and features. Group related components into subsystems and describe function of subsystem and subsystem's interaction with other subsystems.
d. Identify all support materials and equipment associated with operation of subject equipment, such as air intake filters, valve actuators, motors, and other appurtenant items and equipment.
e. Identify and describe safety precautions and potential hazards related to operation.
f. Identify and describe in detail safety and control interlocks.

2. Operations Personnel Training:
   a. Material and Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
   b. Operation:
      1) Describe operating principles and practices.
      2) Describe routine operating, startup, and shutdown procedures.
      3) Describe abnormal or emergency startup, operating, and shutdown procedures that may apply.
      4) Describe alarm conditions and responses to alarms.
      5) Describe routine monitoring and recordkeeping procedures.
      6) Describe recommended housekeeping procedures.
   c. Troubleshooting:
      1) Describe how to determine if corrective maintenance or an operating parameter adjustment is required.
3. Mechanical Maintenance Training:
   a. Material and Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
   b. Material and Equipment Preventive Maintenance:
      1) Describe preventative maintenance inspection procedures required to:
         a) Inspect materials and equipment in operation.
         b) Identify potential trouble symptoms and anticipate breakdowns.
         c) Forecast maintenance requirements (predictive maintenance).
      2) Define recommended preventative maintenance intervals for each component.
      3) Describe lubricant and replacement part recommendations and limitations.
      4) Describe appropriate cleaning practices and recommend intervals.
      5) Identify and describe use of special tools required for maintenance of materials and equipment.
      6) Describe component removal, installation, and disassembly and assembly procedures.
      7) Perform "hands-on" demonstrations of preventive maintenance procedures.
      8) Describe recommended measuring instruments and procedures, and provide instruction on interpreting alignment measurements, as appropriate.
      9) Define recommended torquing, mounting, calibrating, and aligning procedures and settings, as appropriate.
      10) Describe recommended procedures to check and test equipment following corrective maintenance.

c. Equipment Troubleshooting:
   1) Define recommended systematic troubleshooting procedures.
   2) Provide component-specific troubleshooting checklists.
   3) Describe applicable materials and equipment testing and diagnostic procedures to facilitate troubleshooting.
   4) Describe common corrective maintenance procedures with "hands-on" demonstrations.

4. Instrumentation/Controls and Electrical Maintenance Training:
   a. Materials and Equipment Overview: As described in Paragraph 1.4.D.1 of this Section.
   b. Preventative Maintenance and Troubleshooting of Instrumentation and Control Systems: In accordance with Section 40 90 09, Plant Monitoring and Control System Training. ENGINEER may grant waiver(s) to allow all training for a given system to be at the location of OWNER's training facility.
   c. Preventative Maintenance and Troubleshooting of Other Electrical Systems: In accordance with requirements for Paragraph 1.4.D.3 of this Section.

1.5 TRAINING AIDS

A. Manufacturer's instructor shall incorporate training aids as appropriate to assist in the instruction. Furnish handouts of text, tables, graphs, and illustrations as required. Other appropriate training aids include:
   1. Audio-visual aids, such as videos, Microsoft PowerPoint presentations, overhead transparencies, posters, drawings, diagrams, catalog sheets, or other items.
   2. Equipment cutaways and samples, such as spare parts and damaged equipment.
   3. Tools, such as repair tools, customized tools, and measuring and calibrating instruments.

B. Handouts:
   1. Manufacturer's instructor shall distribute and use descriptive handouts during training. Customized handouts developed especially for training for the Project are encouraged.
   2. Photocopied handouts shall be good quality and completely legible.
   3. Handouts should be coordinated with the instruction, with frequent references made to the handouts.
   4. Provide not less than 15 copies of each handout for each training session.

C. Audio-visual Equipment: Training provider shall provide audio-visual equipment required for training sessions. If suitable equipment is available at the Site, OWNER may make available OWNER's audio-visual equipment; however, do not count on OWNER providing audio-visual equipment. Audio-visual equipment that training provider shall provide, as required, includes:
   1. Laptop computer, presentation software, and suitable projector.
   2. As required, extension cords and spare bulb for projector.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 TRAINING DELIVERY

A. General:
   1. Instructors shall be fully prepared for the training sessions. Training delivery shall be communicative, clear, and proceed according to lesson plan accepted by ENGINEER, with lesson content appropriate for trainees. If OWNER or ENGINEER deems that training delivery does not to comply with the Contract Documents, training shall be postponed, rescheduled, and re-performed in acceptable manner at no additional cost to OWNER.
   2. Trainee Sign-in Sheets: In format acceptable to OWNER, furnish sign-in sheet for trainees for each session. Sign-in sheets shall include the Project name, equipment or system for which training was furnished, and type of training (e.g., operations, mechanical maintenance, instrumentation/controls maintenance, or other), and name of each trainee. Upon completion of training, submit copy of each sign-in sheet as indicated to OWNER's training coordinator and one copy to ENGINEER.

B. "Hands-on" Demonstrations:
   1. Manufacturer's instructor shall present "hands-on" demonstrations of operations and maintenance of materials and equipment for each training session, in accordance with lesson plan accepted by ENGINEER.
   2. CONTRACTOR and manufacturer shall furnish tools necessary for demonstrations.

3.2 TRAINING SCHEDULE

A. Manufacturer shall furnish not less than the hours of training and number of sessions indicated in Table 01 79 23-A of this Section. Travel time and expenses are responsibility of manufacturer and are excluded from required training time indicated in the Contract Documents.

B. Shifts and Training Sessions Required:
   1. Operations at the Site take place 24 hours per day, divided into three shifts as follows: day, evening, and night shift.
   2. Training Sessions per Shift:
      a. Operators: Maximum training per day is four hours; sessions longer than four hours shall be spread over multiple, preferably consecutive, days. Provide identical training sessions as follows:
         1) Two identical sessions during day shift, each session in different weekdays.
         2) One session during evening shift.
      b. Instrument/Controls and Electrical Maintenance: Provide one training sessions during day shift. Maximum training per day is four hours; sessions longer than

four hours will be spread over multiple, preferably consecutive, days.

TABLE 01 79 23-A, TRAINING SUMMARY TABLE

Material or Equipment	***Specification Section***	***Total Training Time (hours)***	***Training Sessions Required***		
			Operations	***Mechanic Maint.***	***Instrument/ Controls & Electrical Maint.***
FOG Receiving Station		*4 max*	*2*	*1*	*1*
Total					

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 01 91 00

COMMISSIONING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall comply with the requirements for commissioning of the following systems, subsystems, and equipment.
      a. Haskell WWTP FOG Receiving Station System including, but not limited to, unloading nozzle, rock trap, grinder, mixing pumps, davit crane, carbon canister and flame arrester, and transfer pumps.
   2. Owner's Project Requirements (OPR) and Basis-of-Design (BoD) documents provided to CONTRACTOR are supplementary information that includes information relative to commissioning. The OPR and BoD are not Contract Documents.

B. Coordination:
   1. Review start-up and commissioning procedures under other Specification Sections and coordinate with the Work specified in this Section.
   2. Notify other contractors in advance of commissioning to provide them sufficient time for installing, starting-up, commissioning, and coordinating interrelated items and systems included in their work that must be coordinated with commissioning.

C. Related Sections:
   1. Section 01 78 23, Operations and Maintenance Data.
   3. Section 01 79 23, Instruction of Operations and Maintenance Personnel.

1.2 DEFINITIONS AND TERMINOLOGY

A. Definitions: The following terms are defined for this Section:
   1. BoD: Basis of Design. BoD documents are the design solution statements corresponding to the OPR statements. BoD documents are explanations of ENGINEER's ideas and concepts to fulfill the OPR and are derived from the OPR. BoD applies to systems, subsystems, and equipment associated with the building or structure.
   2. Commissioning Plan: Document prepared by CxA, with input from others as required, that outlines schedule, allocation of resources, and documentation requirements for commissioning.
   3. Commissioning Report: Document prepared by CxA that records the results of commissioning process including unresolved issues and performance of systems, subsystems, and equipment.

4. CxA: Commissioning Authority. Person or entity overseeing commissioning for OWNER.
5. OPR: Owner's Project Requirements. OPR is a document that includes statements of facility's planned use, operational expectations, and performance. OPR applies to systems, subsystems, and equipment associated with the building or structure, not the processes housed within building or structure.
6. Systems Manual: Document prepared by CxA that includes the OPR, BoD; record documents; final Commissioning Plan; Commissioning Report; and operation and maintenance data.

B. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. "Commissioning" is systematic process for achieving, verifying, and documenting that facility and its systems, subsystems, and equipment are planned, designed, installed, tested, and are capable of being operated and maintained according to the OPR.
   2. "Systems, subsystems, and equipment": Where these terms are used together or separately, means "as-built" systems, subsystems, and equipment.
   3. TAB: Testing, Adjusting, and Balancing.

1.3 CxA AND COMMISSIONING TEAM

A. In addition to CONTRACTOR responsibilities, this Section presents responsibilities of other parties, to improve CONTRACTOR's understanding of how CONTRACTOR's responsibilities relate to commissioning.

B. CxA will be engaged by OWNER to document and coordinate system acceptance testing. CxA will be an individual not directly responsible for the Project's design or construction management, and will not direct the CONTRACTOR in means or methods of construction or scheduling of the Work. CONTRACTOR shall submit for acceptance the name and qualifications of CxA. CxA will assist in coordinating the parties involved with commissioning. Duties, rights, and responsibilities of CxA are described in this Section and elsewhere in the Contract Documents.

C. Commissioning Team Members Appointed by CONTRACTOR: Individuals, each having authority to act on behalf of the entity he or she represents, explicitly organized to implement Commissioning through coordinated actions, shall be designated in writing by the CONTRACTOR. The Commissioning team shall consist of, but not be limited to, representatives of CONTRACTOR, including the CONTRACTOR's superintendent, Subcontractors, Suppliers, and specialists designated by the CONTRACTOR and deemed appropriate by the CxA.

D. Commissioning team members appointed by OWNER are:
   1. CxA.
   2. Representatives of OWNER's operation and maintenance personnel.
   3. ENGINEER.

4. Resident Project Representative (RPR).

1.4 OWNER'S RESPONSIBILITIES FOR COMMISSIONING

A. Provide OPR documentation to CxA and CONTRACTOR for use in developing the Commissioning Plan; Systems Manual; operation and maintenance training plans, and testing plans and checklists.

B. Assign operation and maintenance personnel and schedule them to participate in commissioning activities including:
   1. Attending coordination meetings and other meetings related to commissioning.
   2. Training for operation and maintenance of systems, subsystems, and equipment.
   3. Field quality control testing sessions.
   4. Demonstrating for CxA the operation of systems, subsystems, and equipment.

C. Utilities and Consumables:
   1. Utilities and consumables for starting and placing systems, subsystems, and equipment into operation, and performing field quality control testing, shall be paid by the entity designated in the Contract Documents.
   2. OWNER will pay for utilities and consumables required for operating systems, subsystems, and equipment for commissioning other than required for starting and placing systems, subsystems, and equipment into operation, and performing field quality control testing, unless otherwise indicated in the Contract Documents.

D. Provide BoD documents to CxA and CONTRACTOR for use in developing the Commissioning Plan, Systems Manual, and operation and maintenance training plan.

1.5 QUALITY ASSURANCE

A. Qualifications:
   1. Instructors: Provide services of factory-trained authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment, in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

B. Commissioning Meetings: The following meetings are in addition to other meetings required by the Contract Documents:
   1. Attend initial coordination meeting in accordance with Article 1.10 of this Section.
   2. Attend commissioning coordination meetings throughout the Project in accordance with Article 1.12 of this Section.
   3. Attend pre-testing meetings in accordance with Article 1.12 of this Section.
   4. Attend final review at acceptance conference in accordance with Article 3.1 of this Section.
   5. Attend training preparation conference in accordance with Article 3.1 of this Section.

1.6 SUBMITTALS

A. Informational Submittals: Submit the following:
   1. Schedule for operation and maintenance data submittals, equipment start up, and testing for incorporation into the Commissioning Plan. Schedule shall be consistent with the accepted Progress Schedule and accepted Schedule of Submittals.
   2. Certificates:
      a. Certificate of Readiness: Certify that systems, subsystems, and equipment, including associated controls, are ready for testing. Certificate of readiness shall be signed by CONTRACTOR, Subcontractors, Suppliers, and CxA certifying that systems, subsystems, equipment, and associated controls are ready for testing. Completed test checklists signed by responsible parties shall accompany this certificate. Submit certificate of readiness simultaneously to ENGINEER and CxA.
      b. Certify that the Work is Substantially Complete and systems are operational according to the Contract Documents. ENGINEER will forward submittal to CxA for review with copy of ENGINEER's certificate of Substantial Completion.
   3. Site Quality Control Submittals:
      a. Evaluations and proposed corrective actions for performance deficiencies found during field testing.
   4. Qualifications Statements:
      a. Technicians familiar with the construction and operation of systems, subsystems, and equipment to develop specific test procedures and participate in testing of systems, subsystems, and equipment.

B. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit operation and maintenance data in accordance with Section 01 78 23, Operations and Maintenance Data, for systems, subsystems, and equipment. Of the copies submitted, submit 3 copies directly to CxA simultaneous with submittal to ENGINEER.
   2. Record Documentation:
      a. Submit updated record documents as testing and commissioning progresses, as required, in accordance with Section 01 78 39, Project Record Documents.

1.7 CONTRACTOR'S RESPONSIBILITIES FOR COMMISSIONING

A. Coordinate this Article with requirements specified in Division 01 Section "Summary of Multiple Contracts" for Project Coordinator's responsibilities. Retain first paragraph below or third paragraph in "Owner's Responsibilities" Article. Provide utility services required for commissioning in accordance with the Contract Documents.

B. Assign representatives to participate in and perform commissioning team activities including:

1. Provide information to CxA for developing construction-phase Commissioning Plan.
2. Attend commissioning coordination meetings in accordance with Article 1.12 of this Section.
3. Provide equipment overview in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel, and Section 23 05 93, Testing, Adjustment and Balancing for HVAC, if applicable.
4. Provide operation and maintenance training in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
5. Participate in final review at acceptance meeting in accordance with Article 1.12 of this Section.
6. Provide copy of updated record documents to CxA. as record documents are submitted to and accepted by ENGINEER.
7. Submit operation and maintenance data for systems, subsystems, and equipment, as specified in this Section and in Section 01 78 23, Operations and Maintenance Data.
8. Provide technicians familiar with construction and operation of installed systems, subsystems, and equipment and develop specific test procedures and participate in testing of systems, subsystems, and equipment being commissioned
9. Submit schedule for operation and maintenance data submittals, equipment start-up, and testing for CxA's use in the Commissioning Plan. Schedules shall be consistent with the accepted Progress Schedule and accepted Schedule of Submittals. Update schedule of operation and maintenance submittals throughout construction and submit to CxA concurrent with for the Schedule of Submittals updates specified in Section 01 33 00, Submittal Procedures.
10. Upon receipt of ENGINEER's certification of Substantial Completion and ENGINEER's notice of acceptability, CONTRACTOR shall furnish to CxA a certificate, signed by CONTRACTOR, that the Work is complete and systems are operational in accordance with the Contract Documents, including calibration of instrumentation and controls, in accordance with Contract Documents.
11. Evaluate performance deficiencies identified in test reports and recommend corrective action.
12. Review and approve final commissioning documentation, in accordance with Contract Documents.

1.8 CxA'S RESPONSIBILITIES

A. Organize and lead the commissioning team. This does not infringe upon or affect CONTRACTOR's responsibilities under the Contract Documents.

B. Prepare construction Commissioning Plan to supplement design-phase Commissioning Plan that outlines procedures to ensure that goals of OPR and BoD are achieved. Collaborate with CONTRACTOR to develop test and inspection procedures in accordance with LEED requirements. Include design changes and scheduled commissioning activities coordinated with the accepted Progress Schedule. Identify commissioning team member responsibilities, by name, firm, and trade specialty, for performance of each commissioning task.

C. Review and comment to ENGINEER and OWNER (as applicable) on submittals from CONTRACTOR for compliance with the OPR, BoD, Contract Documents, and construction-phase Commissioning Plan. Review and comment on performance expectations of systems, subsystems, and equipment and interfaces between systems relating to OPR and BOD. This does not infringe upon or affect responsibilities of ENGINEER, OWNER, or CONTRACTOR under the Contract Documents.

D. Convene commissioning team meetings for coordination, communication, and conflict resolution; discuss progress of commissioning. Arrange for facilities, preparing agenda and attendance lists, and notifying participants. Prepare and distribute minutes to commissioning team members and attendees within 10 days of each commissioning meeting.

E. At beginning of construction, conduct an initial coordination meeting to review commissioning and discuss with CONTRACTOR and others as appropriate establishment of tentative schedules for operation and maintenance submittals; operation and maintenance training; testing and balancing; and Project completion. Upon agreement of the parties involved, this meeting may be combined with the pre-construction conference.

F. In cooperation with ENGINEER, observe the Work and report progress and deficiencies relative to commissioning. In addition to complying with OPR, BoD, and Contract Documents, observes systems, subsystems, and equipment installation for adequate accessibility for maintenance and component replacement or repair.

G. Prepare test and inspection procedures and checklists in accordance with Contract Documents. Coordinate these activities with Work required under Section 23 05 93, Testing, Adjustment, and Balancing for HVAC, if applicable. This does not infringe upon or affect CONTRACTOR's responsibilities under the Contract Documents.

H. Coordinate with CONTRACTOR regarding scheduling of tests, and in cooperation with ENGINEER relative to witnessing and documenting tests and start-up for building systems, subsystems, and equipment.

I. Compile test data, inspection reports, and certificates and include them in the Systems Manual and Commissioning Report.

J. Assist the ENGINEER with verifying when the Work has achieved Substantial Completion relative to commissioning and, upon ENGINEER's issuance of the certificate of Substantial Completion, CxA will certify Substantial Completion in accordance with the Contract Documents relative to start of warranties and the correction period relative to building systems, subsystems, and equipment undergoing commissioning.

K. In cooperation with ENGINEER, review record documents relative to commissioning. Request through ENGINEER revisions from CONTRACTOR to conform to the Contract Documents.

L. In cooperation with ENGINEER, review and comment on operation and maintenance documentation and Systems Manual outline as specified in this Section and in Section 01 78 23, Operations and Maintenance Data, for compliance with OPR, BoD, and the Contract Documents.

M. In cooperation with ENGINEER, review CONTRACTOR's proposed training program for training of OWNER's personnel, and instructors for operation and maintenance training.

N. Provide videography of construction progress including hidden shafts.

O. Provide videography, with associated video editing, of training sessions. See Section 01 79 23 for recording of training sessions by OWNER.

P. Prepare Commissioning Reports.

Q. Assemble copies of final commissioning documentation, including the Commissioning Report, and record documents submitted by CONTRACTOR to ENGINEER.

1.9 SUBMITTALS BY CxA

A. Preliminary Commissioning Plan: Submit one copy each to CONTRACTOR, OWNER, and ENGINEER. Submittal will have sufficient detail to allow evaluation of data collection and arrangement process. CONTRACTOR shall review submittal and provide comments to CxA with copy of comments to OWNER and ENGINEER. CxA will consider comments in preparing final construction-phase Commissioning Plan.

B. Commissioning Plan, Final Submittal: Submit one hardcopy each to OWNER and ENGINEER. Final submittal will include copy of Preliminary Commissioning Plan submittal comments and response to each comment.

C. Test Checklists and Report Forms: Submit copy of each sample checklist and report forms to CONTRACTOR for review and comment. CONTRACTOR shall provide review comments from CONTRACTOR's staff member responsible for coordinating testing of systems, subsystems, and equipment, and from Subcontractors and Suppliers as required.

D. Test and Inspection Reports: Submit test and inspection reports to OWNER and ENGINEER.

E. Corrective Action Documents: Submit corrective action documents to OWNER and ENGINEER.

F. Pre-final Commissioning Report Submittal: Submit copies to OWNER and ENGINEER. Include copy of preliminary submittal review comments and CxA's response to each. Review comments, if any, will be provided to CxA by OWNER and ENGINEER for final submittal.

G. Final Commissioning Report Submittal: Submit hardcopies of final Commissioning Report to OWNER and ENGINEER Final submittal will address previous review comments and will include copy of pre-final submittal review comments and response to each.

1.10 COORDINATION OF COMMISSIONING

A. Coordinating Meetings: CxA will conduct a coordination meeting of commissioning team to review progress on the Commissioning Plan, discuss scheduling conflicts, and discuss commissioning activities. This meeting may be combined with coordination meetings required elsewhere in the Contract Documents.

B. Pre-testing Meetings: CxA will conduct pre-test meetings of commissioning team to review start-up reports, pre-test inspection results, testing procedures, testing personnel and instrumentation requirements, and Supplier services for each system, subsystem, equipment, and component to be tested. Number of pre-testing meetings will depend on number of systems, subsystems, and equipment undergoing commissioning and schedule and quality of submittals. Pre-testing meetings may be combined with coordination meetings or progress meetings required elsewhere in the Contract Documents.

C. Testing Coordination: With CONTRACTOR and ENGINEER, CxA will coordinate sequence of testing activities to accommodate required Site or field quality-control.
   1. Schedule times for tests, inspections, obtaining samples, and similar activities not included in the Work. CxA’s services do not infringe upon or affect CONTRACTOR’s responsibilities under the Contract Documents.

D. Suppliers’ Field Services: With CONTRACTOR, CxA will assist in coordinating services of manufacturers’ field services.

E. Systems Acceptance Meeting: CxA will conduct systems acceptance meeting of commissioning team to review start-up reports and test inspection results for each system, subsystem, equipment, and component to be tested.

PART 2 – PRODUCTS

2.1 TEST EQUIPMENT CALIBRATION

A. Test Equipment Calibration:
   1. Permanent Metering and Monitoring Equipment Used for Testing: Comply with the Contract Documents.
   2. Temporary Metering and Monitoring Equipment: Comply with test equipment manufacturer's calibration procedures. Calibrate test instruments immediately following instrument repair. Affix calibration tags to test instruments. Calibrate instruments within six months prior to testing.

PART 3 – EXECUTION

3.1 OPERATION AND MAINTENANCE PERSONNEL TRAINING

A. Comply with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

B. Training Preparation Conference: Before start of training of OWNER's personnel, CxA will convene training preparation conference that will include the following attendees: OWNER's operation and maintenance personnel coordinator(s), CONTRACTOR, Subcontractors, and Suppliers as required. This meeting may be combined with the training scheduling conference required under Section 01 79 23, Instruction of Operations and Maintenance Personnel. CxA will:
   1. Review relationship of OPR and BoD, and requirements of these documents, to the training program, and present how training program is to be structured to comply with such requirements.
   2. Review installed systems, subsystems, and equipment relative to commissioning and Contract Documents.
   3. Review instructor qualifications relative to commissioning and Contract Documents, concurrent with ENGINEER's review of qualifications of proposed instructors submitted under Section 01 79 23, Instruction of Operations and Maintenance Personnel.
   4. Review instructional methods and procedures.
   5. Review training module outlines and contents.
   6. Review course materials (including operation and maintenance manuals).
   7. Visit and discuss locations and other facilities required for training.
   8. Review training schedule and resolve scheduling issues, and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
   9. For instruction that will occur outdoors, review forecasted weather conditions and procedures to follow if conditions are unfavorable.

C. Training Modules: Develop an instruction program that includes individual training modules for each system, subsystem, and equipment in accordance with Section

01 79 23, Instruction of Operations and Maintenance Personnel, and submit program to ENGINEER, who will forward it to CxA for review and acceptance.

+ + END OF SECTION + +

SECTION 02 41 00

DEMOLITION

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required for demolition, removal, and disposal Work.
   2. The Work under this 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, CMU walls, appurtenances, paving, curbs, and similar existing facilities.
      b. Demolition and removal or relocation of all Underground Facilities underneath, and above-grade piping and utilities in the structures shown or indicated for demolition, unless the Underground Facilities or above-grade facilities are shown or indicated as to remain.
      c. Remove from slabs, foundations, walls, and footings that are to be demolished all utilities and appurtenances embedded in such construction.
   3. Demolitions and removals specified under other Sections shall comply with requirements of this 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.

B. Coordination:
   1. Comply with Section 01 14 16, Coordination with Owner's Operations.
   2. Review procedures under this and other Sections and coordinate the Work that will be performed with or before demolition and removals.

1.2 QUALITY ASSURANCE

A. Qualifications:
   1. Electrical Removals: Entity and personnel performing electrical removals shall be electrician 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 legally qualified to perform plumbing construction and plumbing work in the jurisdiction where the Site is located

B. Regulatory Requirements:
   1. Demolition, removal, 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.

1.3 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.
         5) Planned demolition operating sequences.
         6) Detailed schedule of demolition Work in accordance with the accepted Process Schedule.
   2. Notification of Intended Demolition Start: Submit in accordance with Paragraph 3.1.A of this Section.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 PREPARATION

A. Notification:
   1. At least 48 hours prior to commencing demolition or removal, notify ENGINEER in writing of planned start of demolition Work. Do not start removals without permission of ENGINEER.

B. Protection of Surrounding 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.
   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 barriers, lighting, sidewalk sheds, and other necessary protection.

4. Repair damage to facilities that are to remain.

C. Existing Utilities: In addition to requirements of the General Conditions, Supplementary Conditions, and Division 01 Specifications, do the following:
   1. Should uncharted or incorrectly charted 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 Sewer: Before proceeding with demolition, locate and cap all sewer lines and service laterals discharging from the building or structure being demolished.
   3. Storm Water: Existing storm water system shall remain in place until demolitions of existing building or structure is completed. Upon completing demolition, cut and cap storm sewer laterals 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.
   4. Water Piping: Before proceeding with demolition, locate and cap all potable and non-potable waterlines and service laterals serving the building or structure being demolished.
   5. Other Utilities: Before proceeding with demolition, locate and cap as required all other utilities, such as fuel and gas; 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 OWNER as required relative to contacting utility owners.

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 57 05, Temporary 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 74 05, Cleaning.

C. Comply with Section 01 73 29, Cutting and Patching.

D. Demolition of Site Improvements:
   1. Pavement, Sidewalks, Curbs, and Gutters: 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.
   3. Manholes, Vaults, Chambers, and Handholes: Remove to the limits shown or indicated on the Drawings.
   4. Underground Facilities Other than Manholes, Vaults, Chambers, and Handholes: Remove to the extent shown or indicated on the Drawings. Unless otherwise shown or indicated, cap ends of piping to remain in place in accordance with the "Mechanical Removals" Article in this Section.

E. Salvage and Ownership:
   1. Refer to Section 01 11 13, Summary of Work, for requirements on salvage, ownership, and handling of equipment and materials removed during demolition and removal Work.
   2. Materials and equipment to remain OWNER's property, such as the existing FOG Receiving Tank, shall be carefully removed and appropriately handled by CONTRACTOR to avoid damage and invalidation of warranties in effect, and shall be cleaned and stored at the Site (or other site specified in the Contract Documents) at place designated by ENGINEER or OWNER.

F. 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 ENGINEER.

3.3 STRUCTURAL REMOVALS

A. Remove structures to lines and grades shown or indicated, unless otherwise directed by ENGINEER. 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 expense and such excess removals shall be reconstructed to satisfaction of ENGINEER without additional cost to OWNER.

B. After removing concrete and masonry walls or portions thereof, slabs, and similar construction that ties into the Work or to existing construction, neatly repair the junction point to leave exposed only finished edges and finished surfaces.

C. 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.

D. Where equipment or material anchored to concrete or masonry are removed and anchors are not to be re-used, remove the anchors 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. 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 ENGINEER.

E. 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.

F. 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 Section, unless specified elsewhere in the Contract Documents.

3.4 MECHANICAL REMOVALS

A. Mechanical demolition and removal Work includes dismantling and removing existing piping, tank, and appurtenances as shown, indicated, and required for completion of the Work. Mechanical removals include cutting and capping as required, except that cutting of existing piping to make connections is included under Section 01 14 16, Coordination with Owner's Operations; Section 01 73 29, Cutting and Patching; and applicable Sections of Division 40, Process Integration.

B. Demolition and Removals of Piping, Ductwork, and Similar Items:
1. Purge piping and tanks (as applicable) of chemicals or fuel (as applicable) and make safe for removal and capping. Remove to the extent shown or indicated existing process, water, waste and vent, chemical, gas, fuel, and other piping. Remove piping to the nearest solid piping support, and provide caps on ends of remaining piping.
2. Caps, Closures, Blind Flanges, and Plugs:
   a. Provide closure pieces, such as blind flanges and caps, where shown or required to complete the Work.

b. Where used in this 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 to which the cap is attached, 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 Section only when so shown or indicated in the Contractor Documents or when allowed by ENGINEER.

3. When Underground Facilities are altered or removed, properly cut and cap piping left in place, unless otherwise shown or indicated.

C. Equipment Demolition and Removals:
1. Remove existing FOG Storage Tank.
2. Provide required means to remove equipment from building or structure.
3. Remove equipment supports as applicable, anchorages, base, grout, and piping. Remove anchorage systems in accordance with the "Structural Removals" Article in this Section.

3.6 DISPOSAL OF DEMOLITION DEBRIS

A. Remove from the Site all debris, waste, rubbish, and material resulting from demolition operations and equipment used in demolition Work. Comply with the General Conditions, Supplementary Conditions, and Section 01 74 05, Cleaning.

B. Transportation and Disposal:
1. Non-hazardous Material: Properly transport and dispose of non-hazardous demolition debris at appropriate landfill or other suitable location, in accordance with Laws and Regulations. Non-hazardous material does not contain Asbestos, PCBs, Petroleum, Hazardous Waste, Radioactive Material, or other material designated as hazardous in Laws and Regulations.

+ + END OF SECTION + +

SECTION 03 00 05

CONCRETE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install concrete, reinforcing, and related materials.
   2. The Work includes:
      a. Providing concrete consisting of portland cement, fine and coarse aggregates, water, and approved admixtures; combined, mixed, transported, placed, finished, and cured.
      b. Fabricating and placing reinforcing, including ties and supports.
      c. Design, erection, and removal of formwork.
      d. Building into the concrete all sleeves, frames, anchorage devices, inserts, and other items required to be embedded in concrete.
      e. Providing openings in concrete as required to accommodate Work under this and other Sections.

B. Coordination:

   1. Review installation procedures under other Sections and coordinate installation of items to be installed in the concrete Work.

C. Classifications of Concrete:
   1. Class “A” concrete shall be steel-reinforced and includes all concrete unless otherwise shown or indicated.
   2. Class “B” concrete shall be placed without forms or with simple forms, with little or no reinforcing and includes the following:
      a. Concrete fill.
      b. Duct banks.
      c. Pipe Encasements.
      d. Curbs and gutters.
      e. Sidewalks.
      f. Thrust blocks.

D. Related Sections:
   1. Section 05 05 33, Anchor Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 224R, Control of Cracking in Concrete Structures.
   2. ACI 301, Specifications for Structural Concrete for Buildings.
   3. ACI 304R, Guide for Measuring, Mixing, Transporting and Placing Concrete.
   4. ACI 305R, Specification for Hot Weather Concreting.
   5. ACI 306R, Cold Weather Concreting.
   6. ACI 309R, Guide for Consolidation of Concrete.
   7. ACI 318, Building Code Requirements for Structural Concrete and Commentary.
   8. ACI 347, Guide to Formwork for Concrete.
   9. ACI SP-66, ACI Detailing Manual.
   10. ASTM A82/A82M, Specification for Steel Wire, Plain, for Concrete Reinforcement.
   11. ASTM A185/A185M, Specification for Steel Welded Wire Reinforcement, Plain, for Concrete.
   12. ASTM A615/A615M, Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
   13. ASTM C31/C31M, Practice for Making and Curing Concrete Test Specimens in the Field.
   14. ASTM C33/C33M, Specification for Concrete Aggregates.
   15. ASTM C39/C39M, Test Method for Compressive Strength of Cylindrical Concrete Specimens.
   16. ASTM C42/C42M, Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete.
   16. ASTM C94/C94M, Specification for Ready-Mixed Concrete.
   17. ASTM C138/C138M, Test Method for Density (Unit Weight), Yield, and Air Content (Gravimetric) of Concrete.
   18. ASTM C143/C143M, Test Method for Slump of Hydraulic-Cement Concrete.
   19. ASTM C150/C150M, Specification for Portland Cement.
   20. ASTM C172, Practice for Sampling Freshly Mixed Concrete.
   21. ASTM C231, Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method.
   22. ASTM C260, Specification for Air-Entraining Admixtures for Concrete.
   23. ASTM C309, Specification for Liquid Membrane-Forming Compounds for Curing Concrete.
   24. ASTM C494/C494M, Specification for Chemical Admixtures for Concrete.
   25. ASTM C579, Methods for Compressive Strength of Chemical-Resistant Mortars, Grouts, Monolithic Surfacings, and Polymer Concretes.
   26. ASTM C1064/C1064M, Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete.
   27. ASTM D1752, Specification for Preformed Sponge Rubber Cork and Recycled PVC Expansion Joint Fillers for Concrete Paving and Structural Construction.
   28. ASTM E96/E96M, Test Methods for Water Vapor Transmission of Materials

29. ASTM E154, Test Methods for Water Vapor Retarders Used in Contact with Earth Under Concrete Slabs, on Walls, or as Ground Cover.
30. CRD-C 572, U. S. Army Corps of Engineers Specification for Polyvinylchloride Waterstops.
31. CRSI 1MSP, Manual of Standard Practice.

1.3 QUALITY ASSURANCE

A. Laboratory Trial Batch:
   1. Employ independent testing laboratory experienced in design and testing of concrete materials and mixes to perform material evaluation tests and to design concrete mixes.
   2. Each concrete mix design specified shall be verified by laboratory trial batch, unless indicated otherwise.
   3. Perform the following testing on each trial batch:
      a. Aggregate gradation for fine and coarse aggregates.
      b. Slump.
      c. Air content.
      d. Compressive strength based on three cylinders each tested at seven days and at 28 days.
   4. Submit for each trial batch the following information:
      a. Project identification name and number (if applicable).
      b. Date of test report.
      c. Complete identification of aggregate source of supply.
      d. Tests of aggregates for compliance with the Contract Documents.
      e. Scale weight of each aggregate.
      f. Absorbed water in each aggregate.
      g. Brand, type, and composition of cementitious materials.
      h. Brand, type, and amount of each admixture.
      i. Amounts of water used in trial mixes.
      j. Proportions of each material per cubic yard.
      k. Gross weight and yield per cubic yard of trial mixtures.
      l. Measured slump.
      m. Measured air content.
      n. Compressive strength developed at seven days and 28 days, from not less than three test cylinders cast for each seven day and 28-day test, and for each design mix.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. List of concrete materials and concrete mix designs proposed for use. Include results of tests performed to qualify the materials and to establish the mix designs. Do not start laboratory trial batch testing until this submittal is approved by ENGINEER.

b. Laboratory Trial Batch Reports: Submit laboratory test reports for concrete cylinders, materials, and mix design tests.
c. Concrete placement drawings showing the location and type of all joints.
d. Drawings for fabricating, bending, and placing concrete reinforcing. Comply with ACI SP-66. For walls and masonry construction, provide elevations to a minimum scale of 1/4-inch to one foot. Show bar schedules, stirrup spacing, adhesive dowels, splice lengths, diagrams of bent bars, arrangements, and assemblies, as required for fabricating and placing concrete reinforcing.

2. Product Data:
   a. Manufacturer's specifications with application and installation instructions for proprietary materials and items, including admixtures and bonding agents.
3. Samples:
   a. Samples: Submit samples of materials as specified and as otherwise requested by ENGINEER, including names, sources, and descriptions.

B. Informational Submittals: Submit the following:
   1. Site Quality Control Submittals:
      a. Report of testing results for testing of field concrete cylinders for each required time period. Submit within 24 hours after completion of associated test. Test report shall include results of all testing required at time of sampling.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Transportation, Delivery, and Handling:
   1. Deliver concrete reinforcing products to Site bundled, tagged, and marked. Use metal tags indicating bar size, lengths, and other information corresponding to markings on approved Shop Drawings.
   2. Materials used for concrete shall be clean and free from foreign matter during transportation and handling, and kept separate until measured and placed into concrete mixer.
   3. Implement suitable measures during hauling, piling, and handling to ensure that segregation of coarse and fine aggregate particles does not occur and grading is not affected.
   4. Deliver grout materials from manufacturers in unopened containers that bear intact manufacturer labeling.
   5. Comply with Section 01 65 00, Product Delivery Requirements.

B. Storage:
   1. Store formwork materials above ground on framework or blocking. Cover wood for forms and other accessory materials with protective, waterproof covering. Provide for adequate air circulation or ventilation under cover.
   2. Store concrete reinforcing materials to prevent damage and accumulation of dirt and excessive rust. Store on heavy wood blocking so that reinforcing does

not come into contact with the ground. Space framework or blocking supports to prevent excessive deformation of stored materials.

3. Store concrete joint materials on platforms or in enclosures or covered to prevent contact with ground and exposure to weather and direct sunlight.
4. For storage of concrete materials, provide bins or platforms with hard, clean surfaces.

PART 2 – PRODUCTS

2.1 CONCRETE MATERIALS

A. Portland Cement: ASTM C150/C150M, Type I/II.

B. Aggregates: ASTM C33/C33M.
   1. Fine Aggregate: Clean, sharp, natural silica sand free of loam, clay, lumps, and other deleterious substances. Dune sand, bank run sand, and manufactured sand are unacceptable.
   2. Coarse Aggregate:
      a. Clean, uncoated, processed aggregate containing no clay, mud, loam, or foreign matter.
      b. Coarse aggregate shall comply with the following:
         1) Crushed stone, processed from natural rock or stone.
         2) Washed gravel, either natural or crushed. Slag, pit gravel, and bank-run gravel are not allowed.
      c. Coarse Aggregate Size: ASTM C33/C33M, Nos. 57 or 67, unless otherwise approved by ENGINEER.

C. Water: Clean, potable.

D. Admixtures:
   1. Air-Entraining Admixture: ASTM C260.
   2. Water-Reducing Admixture: ASTM C494/C494M, Type A.
   3. Water Reducing and Set-Adjusting Admixtures: ASTM C494/C494M, Types D and E.
   4. High Range Water-Reducing Admixture: ASTM C494/C494M, Type F/G.
   5. Use only admixtures that have been tested and approved in the mix designs.
   6. Do not use calcium chloride or admixtures containing chloride ions.

E. Cementitious Materials:
   a. Fly Ash ASTM C618, Class F, content in cementitious material up to 25% by weight.
   b. Slag ASTM C989, Grade 120, content in cementitious material up to 25% by weight.

2.2 CONCRETE MIX

A. General:
   1. Normal weight: 145 pounds per cubic foot.
   2. Use air-entraining admixture in all concrete. Provide not less than four percent, nor more than eight percent, entrained air for concrete exposed to freezing and thawing, and provide from three to five percent entrained air for other concrete.

B. Proportioning and Design of Class “A” Concrete Mix:
   1. Minimum compressive strength at 28 days: 4,500 psi.
   2. Maximum water-cement ratio by weight: 0.42.
   3. Minimum cement content: 564 pounds per cubic yard.

C. Proportioning and Design of Class “B” Concrete Mix:
   1. Minimum compressive strength at 28 days: 3,000 psi.
   2. Maximum water-cement ratio by weight: 0.50.
   3. Minimum cement content: 517 pounds per cubic yard.

D. Slump Limits:
   1. Proportion and design mixes to result in concrete slump at point of placement of not less than one inch and not more than four inches.
   2. When using high-range water reducers, slump prior to addition of admixture shall not exceed three inches. Slump after adding admixture shall not exceed eight inches at point of placement.

E. Adjustment of Concrete Mixes:
   1. Concrete mix design adjustments may be requested by CONTRACTOR when warranted by characteristics of materials, Site conditions, weather, test results, or other, similar circumstances.
   2. Submit for ENGINEER’s approval laboratory test data for adjusted concrete mix designs, including compressive strength test results.
   3. Implement adjusted mix designs only after ENGINEER’s approval.
   4. Adjustments to concrete mix designs shall not result in additional costs to OWNER.

2.3 FORM MATERIALS

A. Provide form materials with sufficient stability to withstand pressure of placed concrete without bow or deflection. CONTRACTOR shall be responsible for designing the formwork system to resist all applied loads including pressures from fluid concrete and construction loads.

B. Smooth Form Surfaces: Acceptable panel-type to provide continuous, straight, smooth, as-cast surfaces in accordance with ACI 301.

C. Unexposed Concrete Surfaces: Material to suit project conditions.

D. Provide 3/4-inch chamfer at all external corners. Chamfer is not required at re-entrant corners unless otherwise shown or indicated.

E. Form Ties:
   1. Provide factory-fabricated, removable, or snap-off metal form ties, that prevent form deflection and prevent spalling of concrete surfaces upon removal. Materials used for tying forms are subject to approval of ENGINEER.
   2. Unless otherwise shown or indicated, provide ties so that portion remaining within concrete after removal of exterior parts is at least 1.5 inches from outer surface of concrete. Unless otherwise shown or indicated, provide form ties that, upon removal, will leave a uniform, circular hole not larger than one-inch diameter in the concrete surface.
   3. Ties for exterior walls, below-grade walls, and walls subject to hydrostatic pressure shall be provided with waterstops.
   4. Wire ties are unacceptable.

2.4 REINFORCING MATERIALS

A. Reinforcing Bars: ASTM A615/A615M, Grade 60 deformed bars.

B. Welded Wire Fabric: ASTM A185/A185M.

C. Steel Wire: ASTM A82/A82M.

D. Provide supports for reinforcing including bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing in place.
   1. Use wire bar-type supports complying with CRSI MSP1 recommendations, except as specified in this Section. Do not use wood, brick, or other unacceptable materials.
   2. For slabs on grade, use precast concrete blocks, four inches square minimum with compressive strength equal to or greater than the surrounding concrete, or supports with sand plates or horizontal runners where base materials will not support chair legs.
   3. For all concrete surfaces where legs of supports are in contact with forms, provide supports having either hot-dip galvanized, plastic-protected, or stainless steel legs in accordance with CRSI MSP1.
   4. Provide precast concrete supports over waterproof membranes.

E. Adhesive Dowels:
   1. Dowels:
      a. Dowel reinforcing bars shall comply with ASTM A615, Grade 60.
   2. Adhesive:
      a. For requirements for adhesive, refer to Section 05 05 33, Anchor Systems.

2.5 RELATED MATERIALS

A. Waterstops:
   1. PVC Waterstops:
      a. Manufacturers: Provide products of one of the following:
         1) W.R. Meadows, Inc.
         2) Greenstreak Plastic Products Company.
         3) Or approved equal.
      b. Waterstops shall comply with CRD-C 572. Do not use reclaimed or scrap material.
      c. Minimum Thickness: 3/8-inch.
      d. Provide waterstops with minimum of seven ribs equally spaced at each end on each side with the first rib located at the edge. Each rib shall be minimum 1/8-inch in height.
      e. Construction Joints: Waterstops shall be six-inch wide flat-strip type.
      f. Expansion Joints: Waterstops shall be nine-inch wide centerbulb type.
   2. Hydrophilic Waterstops:
      a. Products and Manufacturers: Provide one of the following:
         1) Duroseal Gasket, by BBZ USA, Inc.
         2) Adeka Ultraseal MC-2010M, by Asahi Denka Kogyo K.K.
         3) Hydrotite, by Greenstreak Plastic Products Company.
         4) Or approved equal.
      b. Hydrophilic waterstop materials shall be bentonite-free and shall expand by minimum of 80 percent of dry volume in the presence of water to form a watertight joint seal without damaging the concrete in which it is cast.
      c. Waterstop material shall be composed of resins and polymers that absorb water and cause a completely reversible and repeatable increase in volume.
      d. Waterstop material shall be dimensionally stable after repeated wet-dry cycles with no deterioration of swelling potential.
      e. Select material in accordance with manufacturer's recommendations for type of liquid to be contained.
      f. Minimum cross-sectional dimensions: 3/16-inch by 3/4-inch.
      g. Location of hydrophilic waterstops shall be as shown or indicated on the Drawings, or where approved by ENGINEER.
      h. Hydrophilic Sealant: Shall adhere firmly to concrete, metal, and PVC in dry or damp condition and be indefinitely elastic when cured.
         1) Products and Manufacturers: Provide one of the following:
            a) Duroseal Paste, by BBZ USA, Inc.
            b) Adeka Ultraseal P-201, by Asahi Denka Kogyo K.K.
            c) Hydrotite, by Greenstreak Plastic Products Company.
            d) Or approved equal.

B. Vapor Retarder:
   1. Products and Manufacturers: Provide one of the following:

a. Stego Wrap 10-mil Vapor Retarder, by Stego Industries LLC.
b. Griffolyn 10-mil, by Reef Industries.
c. Moistop Ultra, by Fortifiber Industries.
d. Or approved equal.

2. Vapor retarder membrane shall comply with the following.
   a. Water Vapor Transmission Rate, ASTM E96/E96M: 0.04 perms or lower.
   b. Water Vapor Retarder, ASTM E1745: Meets or exceeds Class C.
   c. Thickness of Retarder (plastic), ACI 302 1R: Not less than 10 mils.
   d. Provide accessories by same manufacturer as vapor retarder.

C. Membrane-Forming Curing Compound: ASTM C309, Type I.

D. Epoxy Bonding Agent:
1. Two-component epoxy resin bonding agent.
2. Products and Manufacturers: Provide one of the following:
   a. Sikadur 32, Hi-Mod LPL, by Sika Corporation.
   b. Eucopoxy LPL, by the Euclid Chemical Company.
   c. Or approved equal.

E. Epoxy-Cement Bonding Agent:
1. Three-component blended epoxy resin-cement bonding agent.
2. Products and Manufacturers: Provide one of the following:
   a. Sika Armatec 110 EpoCem, by Sika Corporation.
   b. Duralprep A.C., by Euclid Chemical Company.
   c. Or approved equal.

F. Preformed Expansion Joint Filler:
1. Provide preformed expansion joint filler complying with ASTM D1752, Type I (sponge rubber) or Type II (cork).

G. Joint Sealant and Accessories:
1. For joint sealants and accessories used on isolation joints, control joints, and expansion joints, refer to Section 07 92 00, Joint Sealants.

2.6 GROUT

A. Non-shrink Grout:
1. Pre-packaged, non-metallic, cementitious grout requiring only the addition of water at the Site.
2. Minimum 28-day Compressive Strength: 7,000 psi.
3. Products and Manufacturers: Provide one of the following:
   a. NS Grout by Euclid Chemical Company.
   b. Set Grout by Master Builders, Inc.
   c. NBEC Grout by Five Star Products, Inc.
   d. Or approved equal.

B. Epoxy Grout:
   1. Pre-packaged, non-shrink, non-metallic, 100 percent solids, solvent-free, moisture-insensitive, three-component epoxy grouting system.
   2. Minimum Seven-day Compressive Strength: 14,000 psi, when tested in accordance with ASTM C579.
   3. Products and Manufacturers: Provide one of the following:
      a. Euco High Strength Grout, by Euclid Chemical Company.
      b. Sikadur 42, Grout Pak, by Sika Corporation.
      c. Five Star Epoxy Grout, by Five Star Products, Inc.
      d. Or approved equal.

C. Grout Fill:
   1. Grout mix shall consist of cement, fine and coarse aggregates, water, and admixtures complying with requirements specified in this Section for similar materials in concrete.
   2. Proportion and mix grout fill as follows:
      a. Minimum Cement Content: 564 pounds per cubic yard.
      b. Maximum Water-Cement Ratio: 0.45.
      c. Maximum Coarse Aggregate size: 1/2-inch, unless otherwise indicated.
      d. Minimum 28-day Compressive Strength: 4,000 psi.

PART 3 – EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall examine the substrate and the conditions under which the Work will be performed and notify ENGINEER in writing of unsatisfactory conditions. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 FORMWORK

A. Construct formwork in accordance with ACI 347 such that concrete members and structures are of correct size, shape, alignment, elevation, and position.

B. Provide openings in formwork to accommodate the Work of other trades. Accurately place and securely support items required to be built into formwork.

C. Clean and adjust forms prior to placing concrete. Apply form release agents or wet forms as required. Re-tighten forms during and after concrete placing, when required, to eliminate cement paste leaks.

D. Removing Formwork:

1. Comply with ACI 301 and ACI 347, except as otherwise indicated in the Contract Documents.
2. Do not remove formwork and shoring until supported concrete members have acquired minimum of 90 percent of specified compressive strength. Results of suitable quality control tests of field-cured specimens may be submitted to ENGINEER for review as evidence that concrete has attained sufficient strength for removal of supporting formwork and shoring prior to removal times indicated in the Contract Documents.
3. Removal time for formwork is subject to ENGINEER's acceptance.
4. Repair form tie-holes following in accordance with ACI 301.

3.3 REINFORCING, JOINTS, AND EMBEDDED ITEMS

A. Comply with the applicable recommendations of Laws and Regulations and standards referenced in this Section, including CRSI MSP1, for details and methods of placing and supporting reinforcing.

B. Clean reinforcing to remove loose rust and mill scale, earth, ice, and other materials which act to reduce or destroy bond between reinforcing material and concrete.

C. Position, support, and secure reinforcing against displacement during formwork construction and concrete placing. Locate and support reinforcing by means of metal chairs, runners, bolsters, spacers, and hangers, as required.
   1. Place reinforcing to obtain minimum concrete coverages as shown on the Drawings and as required in ACI 318. Arrange, space, and securely tie bars and bar supports together with 16-gage wire to hold reinforcing accurately in position during concrete placing. Set with ties so that twisted ends are directed away from exposed concrete surfaces.
   2. Do not secure reinforcing to formwork using wire, nails or other ferrous metal. Metal supports subject to corrosion shall not be in contact with formed or exposed concrete surfaces.

D. Provide sufficient quantity of supports of strength required to carry reinforcing. Do not place reinforcing more than two inches beyond the last leg of continuous bar support. Do not use supports as bases for runways for concrete conveying equipment and similar construction loads.

E. Splices: Provide standard reinforcing splices by lapping ends, placing bars in contact, and tying tightly with wire. Comply with requirements shown or indicated for minimum lap of spliced bars, as shown on Drawings.

F. Install welded wire fabric in lengths as long as practical, lapping adjoining sections a minimum of one full mesh.

G. Do not place concrete until reinforcing is inspected and ENGINEER indicates that conditions are acceptable for placing concrete. Concrete placed in violation of this

paragraph will be rejected. Notify ENGINEER in writing at least two working days prior to proposed concrete placement.

H. Joints:
1. Provide construction, isolation, expansion, and control joints as indicated or required. Locate construction joints so as to not impair the strength and appearance of the structure. Place isolation and control joints in slabs-on-grade to stabilize differential settlement and random cracking.
2. In walls, locate joints at a maximum spacing of 40 feet and approximately 12 feet from corners.
3. In foundation slabs and slabs-on-grade, locate joints at intervals of approximately 40 feet.
4. In mats and structural slabs and beams, locate joints in compliance with ACI 224R.
5. Locations of joints shall be in accordance with the Contract Documents and as approved by ENGINEER in the Shop Drawings.
6. Where construction joints are indicated to be roughened, intentionally roughen surfaces of previously-placed concrete to amplitude of 1/4-inch.

I. Installation of Embedded Items: Set and build into the Work anchorage devices and embedded items required for other Work that is attached to, or supported by, cast-in-place concrete. Use setting diagrams, templates, and instructions provided under other Sections and, when applicable, other contracts for locating and setting. Refer to Paragraph 1.1.B of this Section. Do not embed in concrete uncoated aluminum items. Where aluminum items are in contact with concrete surfaces, coat aluminum to prevent direct contact with concrete.

J. Adhesive Dowels:
1. Adhesive dowels shall be reinforcing bar dowels set in an adhesive in hole drilled into hardened concrete. Comply with adhesive system manufacturer's installation instructions regarding hole diameter, drilling method, embedment depth required to fully develop required tensile strength, and hole cleaning and preparation instructions. Unless more-stringent standards are required by adhesive system manufacturer, comply with the following.
2. Drill holes to adhesive system manufacturer's recommended diameter and depth to develop required tensile strength. Holes shall not be more than 1/4-inch greater than nominal bar diameter, and hole depth shall not be less than twelve times nominal bar diameter. Hammer-drill holes. Cored holes are not allowed.
3. Embedment depths shall be based on concrete compressive strength of 4,000 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.
4. Determine location of existing reinforcing steel in vicinity of proposed holes prior to drilling. Adjust location of holes to be drilled to avoid drilling through or damaging existing reinforcing bars only when approved by ENGINEER.

5. Before setting adhesive dowel, hole shall be free of dust and debris using method recommended by adhesive system manufacturer. Hole shall be brushed, with manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.
6. Inject adhesive into hole through injection system mixing nozzle and necessary extension tubes, placed to bottom of hole. Withdraw discharge end as adhesive is placed, but keep end of tube immersed to prevent forming air pockets. Fill hole to depth that ensures that excess material is expelled from hole during dowel placement.
7. Twist dowels during insertion into partially-filled hole to guarantee full wetting of bar surface with adhesive. Insert bar slowly to avoid developing air pockets.

3.4 CONCRETE PLACING

A. Site Mixing: Use drum-type batch machine mixer, mixing not less than 1.5 minutes for one cubic yard or smaller capacity. Increase required mixing time by minimum of 15 seconds for each additional cubic yard or fraction thereof.

B. Ready-Mixed Concrete: Comply with ASTM C94/C94M.

C. Concrete Placing:
   1. Place concrete in a continuous operation within planned joints or sections in accordance with ACI 304R.
   2. Do not begin placing concrete until work of other trades affecting concrete is completed.
   3. Wet concrete and subgrade surfaces to saturated surface dry condition immediately prior to placing concrete.
   4. Deposit concrete as near its final location as practical to avoid segregation due to re-handling or flowing.
   5. Avoid separation of the concrete mixture during transportation and placing. Concrete shall not free-fall for distance greater than four feet during placing.
   6. Complete concrete placing within 90 minutes of addition of water to the dry ingredients.

D. Consolidate placed concrete in accordance with ACI 309R using mechanical vibrating equipment supplemented with hand rodding and tamping, such that concrete is worked around placing and other embedded items and into all parts of formwork. Insert and withdraw vibrators vertically at uniformly-spaced locations. Do not use vibrators to transport concrete within the formwork. Vibration of formwork or placing is not allowed.

E. Protect concrete from physical damage or reduced strength due to weather extremes during mixing, placing, and curing.
   1. In hot weather comply with ACI 305R.
   2. In cold weather comply with ACI 306R.

3.5 QUALITY OF CONCRETE WORK

A. Make concrete solid, compact, smooth, and free of laitance, cracks, and cold joints.

B. Concrete for liquid-retaining structures and concrete in contact with earth, water, or exposed directly to the elements shall be watertight.

C. Cut out and properly replace to extent directed by ENGINEER, or repair to satisfaction of ENGINEER, surfaces that contain cracks or voids, are unduly rough, or are in defective in any way. Patches or plastering are unacceptable.

D. Repair, removal and replacement of defective concrete directed by ENGINEER shall be at no additional cost to OWNER.

3.6 CURING

A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72 hours. Continue curing by using moisture-retaining cover or membrane-forming curing compound. Cure formed surfaces by moist curing until formwork is removed. Provide protection, as required, to prevent damage to exposed concrete surfaces. Total curing period shall not be less than seven days. Curing methods and materials shall be compatible with scheduled finishes.

3.7 FINISHING

A. Slab Finish:
   1. After placing concrete slabs, do not work the surface further until ready for floating. Begin floating when surface water has disappeared or when concrete has stiffened sufficiently. Use a wood float only. Check and level surface plane to a tolerance not exceeding 1/4-inch in ten feet when tested with a ten foot straightedge placed on the surface at not less than two different angles. Cut down high spots and fill low spots. Uniformly slope surfaces to drains. Immediately after leveling, re-float the surface to a uniform, smooth, granular texture. Slab surfaces shall receive a float finish. Provide additional trowel finishing as required in this Section.
   2. After floating, begin first trowel finish operation using power-driven trowel. Begin final troweling when surface produces a ringing sound as trowel is moved over the surface.
   3. Consolidate concrete surface by the final hand troweling operation. Finish shall be free of trowel marks, uniform in texture and appearance, and with a surface plane tolerance not exceeding 1/8-inch in ten feet when tested with a ten-foot straightedge. Grind smooth surface defects that would telegraph through applied floor covering system.
   4. Use trowel finish for the following:

a. Interior exposed slabs, unless otherwise shown or indicated.
b. Apply non-slip broom finish, after troweling, to exterior concrete slab and elsewhere as shown.

B. Apply chemical floor hardener to exposed interior concrete floor areas when cured and dry, in accordance with hardener manufacturer's instructions.

C. Formed Finish:
1. Provide smooth form concrete finish at exposed surfaces. Use largest practical form panel sizes to minimize form joints. Exposed surfaces include interior water-contacting surfaces of tanks, whether or not directly visible. All surfaces shall be considered as exposed, unless buried or covered with permanent structural or architectural material. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/8-inch in height. Where surface will be coated or will receive further treatment, remove all fins flush with concrete surface.
2. Provide rough form finish at all unexposed surfaces. After removing forms, patch form tie holes and defects in accordance with ACI 301. Remove fins exceeding 1/2-inch in height.

3.8 GROUT PLACING

A. Place grout as shown and indicated, and in accordance with grout manufacturer's instructions and recommendations. If grout manufacturer's instructions conflict with the Contract Documents, notify ENGINEER and not proceed until obtaining ENGINEER's clarification.

B. Dry-packing is not allowed, unless otherwise indicated.

C. Manufacturers of proprietary grout materials shall make available upon 72 hours notice the services of qualified, full-time, factory-trained employee to aid in ensuring proper use of grout materials at the Site.

D. Placing grout shall comply with temperature and weather limitations described in Article 3.4 of this Section.

3.9 FIELD QUALITY CONTROL

A. Site Testing Services:
1. CONTRACTOR shall employ independent testing laboratory to perform field quality control testing for concrete. ENGINEER will direct where samples are obtained.
2. Testing laboratory will provide all labor, material, and equipment required for sampling and testing concrete, including: scale, glass tray, cones, rods, molds, air tester, thermometer, and other incidentals required.
3. CONTRACTOR shall provide curing and necessary cylinder storage .

B. Quality Control Testing During Construction:
   1. Perform sampling and testing for field quality control during concrete placing, as follows:
      a. Sampling Fresh Concrete: ASTM C172.
      b. Slump: ASTM C143/C143M; one test for each concrete load at point of discharge.
      c. Concrete Temperature: ASTM C1064/C1064M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed. Test each load when time from batching to placement exceeds 75 minutes.
      d. Air Content: ASTM C231; one for every two concrete load at point of discharge, and when a change in the concrete is observed.
      e. Unit Weight: ASTM C138/C138M; one for every two concrete loads at point of discharge, and when a change in the concrete is observed.
      f. Compression Test Specimens:
         1) In accordance with ASTM C31/C31M, make one set of compression cylinders for each 50 cubic yards of concrete, or fraction thereof, of each mix design placed each day. Each set shall be four standard cylinders, unless otherwise directed by ENGINEER.
         2) Cast, store, and cure specimens in accordance with ASTM C31/C31M.
      g. Compressive Strength Tests:
         1) In accordance with ASTM C39/C39M; one specimen tested at seven days, and three specimens tested at 28 days.
         2) Concrete that does not comply with strength requirements will be considered as defective Work.
      h. Submit test results from certified by testing laboratory to ENGINEER within 24 hours of completion of test.
      i. When there is evidence that strength of in-place concrete does not comply with the Contract Documents, CONTRACTOR shall employ the services of concrete testing laboratory to obtain cores from hardened concrete for compressive strength determination. Cores and tests shall comply with ASTM C42/C42M and the following:
         1) Testing of Adhesive Dowels: OWNER will employ testing agency to perform field quality control testing of drilled dowel installations. After adhesive system manufacturer's recommended curing period and prior to placing connecting reinforcing, proof-test for pullout ten percent of adhesive dowels installed. Adhesive dowels shall be tensioned to 60 percent of specified yield strength. Where dowels are located less than six bar diameters from edge of concrete, ENGINEER will determine tensile load required for test. If one or more dowels fail, retest all dowels installed for the Work. Dowels that fail shall be reinstalled and retested at CONTRACTOR's expense.

+ + END OF SECTION + +

SECTION 05 05 33

ANCHOR SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install anchor systems.
   2. This Section includes all anchor systems required for the Work, but not specified under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before anchor systems Work.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ACI 318, Building Code Requirements for Structural Concrete.
   2. ACI 350, Code Requirements for Environmental Engineering Concrete Structures.
   3. ACI 355.2, Qualification of Post-Installed Mechanical Anchors in Concrete.
   4. ANSI B212.15, Cutting Tools - Carbide-tipped Masonry Drills And Blanks For Carbide-tipped Masonry Drills.
   5. ANSI/MSS SP-58, Pipe Hangers and Supports – Materials, Design, Manufacture, Selection, Application, and Installation.
   6. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   7. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   8. ASTM A493, Specification for Stainless Steel Wire and Wire Rods for Cold Heading and Cold Forging.
   9. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   10. ASTM A1011/A1011M, 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.
   11. ASTM B633, Specification for Electrodeposited Coatings of Zinc on Iron and Steel.
   12. ASTM C307, Test Method for Tensile Strength of Chemical-Resistant Mortar, Grouts, and Monolithic Surfacings.
   13. ASTM C881/C881M, Specification for Epoxy-Resin-Base Bonding Systems for Concrete.

14. ASTM D695, Test Method for Compressive Properties of Rigid Plastics.

15. ASTM D790, Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
16. ASTM E329, Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection.
17. ASTM E488, Test Methods for Strength of Anchors in Concrete and Masonry Elements.
18. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
19. ASTM F594, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs.
20. ASTM F1554, Specification for Anchor Bolts, Steel, 36, 55 and 105-ksi Yield Strength.
21. FS A-A-1922A, Shield, Expansion (Caulking Anchors, Single Lead).
22. FS A-A-1923A, Concrete Expansion Anchors.
23. FS A-A-1925A, Shield, Expansion (Nail Anchors).
24. FS A-A-55614, Shield, Expansion (non-drilling expansion anchors).
25. ICC-ES AC01, Acceptance Criteria for Expansion Anchors in Masonry Elements.
26. ICC-ES AC58, Acceptance Criteria for Adhesive Anchors in Masonry Elements.
27. ICC-ES AC60, Acceptance Criteria for Anchors in Unreinforced Masonry Elements.
28. ICC-ES AC193, Acceptance Criteria for Mechanical Anchors in Concrete Elements.
29. ICC-ES AC308, Acceptance Criteria for Post-Installed Adhesive Anchors in Concrete Elements.
30. ISO 3506-1, Mechanical Properties of Corrosion-Resistant Stainless Steel Fasteners -- Part 1: Bolts, Screws and Studs.
31. NSF/ANSI 61, Drinking Water System Components – Health Effects.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Testing Laboratory: Shall comply with ASTM E329 and shall be experienced in tension testing of post-installed anchoring systems.
   2. Post-installed Anchor Installer:
      a. Mechanical Anchors: Installer shall be experienced and trained by post-installed anchor system manufacturer in proper installation of manufacturer's products. Product installation training by distributors or manufacturer's representatives is unacceptable unless the person furnishing the training is qualified as a trainer by the anchor manufacturer.
      b. Adhesive Anchors: Installation shall be performed by personnel certified under an applicable certification program. Certification shall

include written and performance tests in accordance with the ACI/CRSI Adhesive Anchors Installer Certification Program, or equivalent. Description of equivalent programs shall be submitted for ENGINEER's approval and acceptance by the building official having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of all anchor systems products intended for use in the Work including product type, intended location in the Project, and embedded lengths.
   2. Product Data:
      a. Manufacturer's specifications, load tables, dimension diagrams, acceptable base material conditions, acceptable drilling methods, and acceptable bored hole conditions.
      b. When required by ENGINEER, copies of valid ICC ES reports that presents load-carrying capacities and installation requirements for anchor systems.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. For each type of anchor bolt or threaded rod, submit copies of laboratory test reports and other data required to demonstrate compliance with the Contract Documents.
         1) Reports shall demonstrate compliance with ductile steel element definition of ACI 350, Appendix D, Section D.1.
      b. Post-installed anchor system manufacturer's certification that installer received training in the proper installation of manufacturer's products required for the Work.
      c. For each adhesive anchor installer, submit ACI/CRSI Adhesive Anchor Installer Certification.
   2. Manufacturer's Instructions:
      a. Installation instructions for each anchor system product proposed for use, including bore hole cleaning procedures and adhesive injection, cure and gel time tables, and temperature ranges (storage, installation and in-service).
   3. Field Quality Control Submittals:
      a. Submit results of field quality control testing and inspections performed by testing laboratory.

1.5 DELIVERY, STORAGE AND HANDLING

A. Storage and Protection:
   1. Keep materials dry during delivery and storage.
   2. Store adhesive materials within manufacturer's recommended storage temperature range.
   3. Protect anchor systems from damage at the Site. Protect products from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. At locations where conditions dictate that Work specified in other Sections is to be of corrosion resistant materials, provide associated anchor systems of stainless steel materials, unless other corrosion-resistant anchor system material is specified. Provide anchor systems of stainless steel materials where stainless steel materials are required in the Contract Documents.
   2. Stainless Steel Nuts:
      a. For anchor bolts and adhesive anchors, provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts for stainless steel anchors used for anchoring equipment, gates, and weirs, and other locations, if any, where the attachment will require future removal for operation or maintenance. Provide lock washer or double nuts on each anchorage device provided for equipment, as required by equipment manufacturer.
      b. For other locations, provide for each anchorage device a nut as specified or as required by anchor manufacturer. When ASTM A194/A194M, Grade 8S (Nitronic 60) nuts are not required for anchor bolts and adhesive anchors as specified in this Section, provide anti-seizing compound where stainless steel rods are used with stainless steel nuts of the same type.
   3. Materials that can contact potable water or water that will be treated to become potable shall be listed in NSF/ANSI 61.

B. Design Criteria
   1. Size, Length, and Load-carrying Capacity: Comply with the Contract Documents. When size, length or load-carrying capacity of anchor system is not otherwise shown or indicated, provide the following:
      a. Anchor Bolts (Cast-In-Anchors): Provide size, length, and capacity required to carry design load based on values and requirements of Paragraph 3.2.A of this Section. For conditions outside limits of critical edge distance and spacing in Paragraph 3.2.A of this Section, minimum anchor bolt embedment as shown or indicated in Paragraph

3.2.A of this Section apply and capacity shall be based on requirements of Laws and Regulations, including applicable building codes.

b. Adhesive Anchors, Expansion Anchors, or Concrete Inserts: Provide size, length, type, and capacity required to carry design load. Anchor capacity shall be based on the procedures required by the building code in effect at the Site. Where Evaluation Service Reports issued by the ICC Evaluation Service are required in this Section, anchor capacities shall be based on design procedure required in the applicable ICC Evaluation Service Report.

1) General: Determine capacity considering reductions due to installation and inspection procedures, embedment length, strength of base fastening materials, spacing, and edge distance, as indicated in the manufacturer's design guidelines. For capacity determination, concrete shall be assumed to be in the cracked condition, unless calculations demonstrate that the anchor system will be installed in an area that is not expected to crack under any and all conditions of design loading.

2) Concrete Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of the greater of the following: required to develop tensile strength of anchor, or a minimum embedment of 10 anchor diameters; and minimum anchor spacing and edge distance of 12 anchor diameters.

3) Concrete Masonry Adhesive Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.

4) Concrete Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum embedment depth of six anchor diameters, and minimum anchor spacing and edge distance of seven anchor diameters.

5) Concrete Masonry Expansion Anchors: Unless otherwise shown or indicated in the Contract Documents or approved by ENGINEER, provide minimum anchor spacing and edge distance as indicated in anchor manufacturer's instructions.

6) Concrete Undercut Anchors: Unless otherwise shown or indicated in the Contract Documents, or approved by ENGINEER, provide minimum anchor spacing and edge distance as tabulated in anchor manufacturer's instructions.

2. Design Loads. Comply with the Contract Documents. When design load of supported material, equipment, or system is not otherwise shown or indicated, provide the following:

a. Equipment Anchors: Use design load recommended by equipment manufacturer. When equipment can be filled with fluid, use loads that incorporate equipment load and load imposed by fluid.

b. Pipe Hangers and Supports: Use full weight of pipe, and fluid contained in pipe that are tributary to the support plus the full weight of valves and accessories located between the hanger or support being anchored and the next hanger or support.
c. Hangers and Supports for Electrical Systems, and HVAC, Plumbing, and Fire Suppression Systems and Piping: Use the full weight of supported system that is tributary to the support plus the full weight of accessories located between the hanger or support being anchored and the next hanger or support. When piping or equipment is to be filled with fluid, anchor systems shall be sized to support such loads in addition to the weight of the equipment, piping, or system, as applicable.
d. Delegated Design: When anchor systems are used for supporting materials, equipment, or systems delegated to a design professional retained by CONTRACTOR, Subcontractor, or Supplier, provide anchor system suitable for loads indicated in delegated design documents and consistent with the design intent expressed in the Contract Documents.

C. Application:
1. Anchor Bolts (Cast-In-Anchors):
a. Where anchor bolt is shown or indicated, use cast-in-place anchor bolt unless another anchor type is approved by ENGINEER.
b. Provide anchor bolts as shown or indicated, or as required to secure structural element to appropriate anchor surface.
2. Concrete Adhesive Anchors:
a. Use where adhesive anchors are shown or indicated for installation in concrete.
b. Suitable for use where subject to vibration.
c. Suitable for use in exterior locations or locations subject to freezing.
d. Suitable for use in submerged, intermittently submerged, or buried locations.
e. Do not use in overhead applications, unless otherwise shown or approved by ENGINEER.
f. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
3. Concrete Masonry Adhesive Anchors:
a. Use where adhesive anchors are shown or indicated for installation in grout-filled or hollow masonry units.
b. Suitable for use where subject to vibration.
c. Suitable for use in exterior locations or locations subject to freezing.
d. Do not use for pipe hangers, unless otherwise shown or approved by ENGINEER.
4. Concrete Wedge Expansion Anchors:
a. Use where expansion anchors are shown or indicated for installation in concrete.

b. Do not use where subject to vibration.
c. Do not use in exterior locations or locations subject to freezing.
d. Do not use in submerged, intermittently submerged, or buried locations.
e. Suitable for use in overhead applications.

5. Grout-filled Concrete Masonry Wedge Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation on the interior face of grout-filled unit masonry.
   b. Do not use where subject to vibration.
   c. Do not use in exterior locations or locations subject to freezing.
6. Hollow Concrete Masonry Sleeve Expansion Anchors:
   a. Use where expansion anchors are shown or indicated for installation in hollow concrete unit masonry or solid brick.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use in exterior locations or locations subject to freezing.
7. Drop-in Expansion Anchors:
   a. Use drop-in expansion anchors installed in concrete where light-duty anchors are required to support piping or conduit two-inch diameter or smaller.
   b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
   c. Do not use where subject to vibration.
   d. Do not use at submerged, intermittently submerged, or buried locations.
   e. Do not use in exterior locations or locations subject to freezing.
   f. Suitable for use in overhead applications.
8. Concrete Undercut Anchors:
   a. Use where undercut anchors are shown or indicated for installation in concrete.
   b. Suitable for use where subject to vibration.
   c. Do not use in submerged, intermittently submerged, or buried locations.
   d. Do not use in exterior locations or locations subject to freezing.
   e. Suitable for use in overhead applications.
9. Concrete Inserts:
   a. Use only where shown or indicated in the Contract Documents.
   b. Allowed for use to support pipe hangers and pipe supports for pipe size and loading recommended by the concrete insert manufacturer.
10. Drive-In Expansion Anchors:
    a. Use drive-in expansion anchors installed in concrete, precast concrete, grouted masonry units, or brick, where light-duty anchors are required to support piping or conduit one-inch diameter and smaller.

b. Do not use for attaching safety-related systems, such as piping conveying hazardous or potentially hazardous materials, or fire suppression systems.
c. Do not use in overhead applications.

11. For Use in Precast Concrete Planks:
    a. To support piping or conduit six-inch diameter and smaller, use low-profile drop-in anchors, hollow concrete masonry adhesive anchors, or through-bolts.
    b. For piping greater than six-inch diameter, or to support safety-related systems, use through-bolts. Each through-bolt shall consist of threaded rod, nuts, washers, and bearing plate.

2.2 MATERIALS

A. Anchor Bolts (Cast-In-Anchors):
1. Interior Dry Non-corrosive Locations: Provide straight threaded carbon steel rods complying with ASTM F1554, Grade 55, with heavy hex nuts complying with ASTM A563 Grade55, unless otherwise shown or indicated on the Drawings. Hooked anchor bolts are unacceptable.
2. Exterior, Buried, Submerged Locations, or When Exposed to Wastewater: Provide stainless steel straight threaded rods complying with ASTM F593, AISI Type 316, Condition A, with ASTM F594, AISI Type 316, stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required. Other AISI types may be used when approved by ENGINEER. Hooked bolts are unacceptable.
3. Equipment: Provide anchor bolts complying with material requirements of this Section and equipment manufacturer's requirements relative to size, embedment length, and anchor bolt projection. Anchor bolts shall be straight threaded rods with washers and nuts as specified in this Section. Hooked bolts are unacceptable.
4. Anchoring of Structural Elements: Provide anchor bolts of size, material, and strength shown or indicated in the Contract Documents.

B. Concrete Adhesive Anchors:
1. General:
    a. Adhesive anchors shall consist of threaded rods anchored into hardened concrete using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
    a. HIT-RE 500-V3 Injection Epoxy Adhesive Anchoring System, by Hilti Fastening Systems, Inc.
    b. HIT-HY 200-A and HIT-HY 200-R Adhesive Anchoring System, by Hilti Fastening Systems, Inc
    c. SET-XP Adhesive anchoring system, by Simpson Strong-Tie Company, Inc.
    d. Or approved equal.

3. Adhesive:
   a. Adhesive system shall use two-component adhesive mix.
   b. Adhesives shall have a current evaluation report by ICC Evaluation Service for use in both cracked and uncracked concrete with seismic recognition for SDC A through F as tested and assessed in accordance with ICC-ES AC308, which incorporates the requirements of ACI 355.4-11
4. Anchor:
   a. Provide continuously-threaded, AISI Type 316 stainless steel adhesive anchor rod. Threaded rods shall comply with the concrete adhesive anchor manufacturer's specifications as included in the ICC Service Evaluation Report for the anchor submitted. Nuts shall have specified proof load stresses equal to or greater than the minimum tensile strength of the stainless steel threaded rod used. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.

C. Concrete Masonry Adhesive Anchors:
1. General:
   a. Grout-filled concrete masonry adhesive anchors shall consist of threaded rods anchored into grout-filled concrete block masonry using an adhesive system.
   b. Hollow concrete masonry adhesive anchors shall consist of threaded rods with a cylindrical mesh steel or plastic screen tube anchored into hollow concrete block masonry using an adhesive system.
2. Products and Manufacturers: Provide one of the following:
   a. HIT-HY 270 Hybrid Adhesive Anchor System, by Hilti Fastening Systems, Inc.
   b. Acrylic-Tie Adhesive, by Simpson Strong-Tie Company, Inc.
   c. Or approved equal.
3. Adhesive:
   a. Adhesive system shall use two-component adhesive mix.
   b. Hybrid adhesives shall comply with the following:
      1) ASTM D695 compressive yield strength greater than 7,200 psi on a seven-day cure.
   c. Adhesives shall have current ICC Evaluation Service Report for use in grout-filled concrete masonry, tested and assessed in accordance with ICC-ES AC 58 and ICC-ES AC 60.
4. Anchor:
   a. Provide stainless steel adhesive anchor rod complying with ASTM F593, AISI Type 316, Condition CW, with ASTM F594, AISI Type 316 stainless steel nuts. Provide ASTM A194/A194M, Grade 8S (Nitronic 60) stainless steel nuts where required.
5. Mesh Screen Tube (for hollow masonry applications):
   a. Provide with mesh size, length, and diameter as specified by adhesive anchor manufacturer.

D. Concrete Wedge Expansion Anchors:
   1. General:
      a. Concrete wedge expansion anchors shall consist of stud, wedge, nut, and washer.
   2. Products and Manufacturers: Provide one of the following:
      a. Kwik Bolt TZ Wedge Anchor, by Hilti Fastening Systems, Inc.
      b. Strong Bolt 2 Wedge Anchor, by Simpson Strong-Tie Company, Inc.
      c. Or approved equal.
   3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Provide concrete wedge expansion anchors suitable for use in cracked and uncracked concrete in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete wedge anchors in accordance with ACI 355.2 prequalification tests.
   4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
   5. Other Locations: Provide expansion anchors complete with nuts and washers, AISI Type 316 stainless steel anchor body, in accordance with ASTM A276 or ASTM A493.
   6. Concrete wedge expansion anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete with seismic recognition in seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

E. Grout-filled Masonry Wedge Expansion Anchors:
   1. General:
      a. Grout-filled masonry wedge expansion anchors shall each consist of stud, wedge, nut, and washer.
   2. Product and Manufacturers: Provide one of the following:
      a. Kwik-Bolt 3 Expansion Anchors, by Hilti Fastening Systems, Inc.
      b. Wedge-All Wedge Anchors, by Simpson Strong-Tie Company, Inc.
      c. Or approved equal.
   3. Anchors shall comply with physical requirements of FS A-A-1923A, Type 4. Anchors shall be non-bottom bearing type with single-piece steel expansion clip providing 360-degree contact with base material and shall not require oversized holes for installation.
   4. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
   5. Grout-filled masonry wedge expansion anchors shall have a current ICC Evaluation Service report for use in fully-grouted concrete masonry construction when tested and assessed in accordance with ICC-ES AC01.

F. Hollow Concrete Masonry Sleeve Expansion Anchors:
   1. General:
      a. Sleeve expansion anchors shall each consist of an externally threaded stud with full length expanding sleeve.

2. Products and Manufacturers: Provide one of the following:
   a. HLC Sleeve Anchors, by Hilti Fastening Systems, Inc.
   b. Dynabolt Sleeve Anchors, by ITW Red Head.
   c. Or approved equal.
3. Anchors shall comply with physical requirements of FS A-A-1922A. Anchors shall be non-bottom bearing type with single-piece steel expansion sleeve providing 360-degree contact with base material, and shall not require oversized holes for installation.
4. Interior Dry Non-corrosive Locations: Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633.
5. Other Locations: Provide expansion anchors complete with nuts and washers, Type 316 stainless steel, in accordance with ASTM A276 or ASTM A493.

G. Drop-in Expansion Anchors:
1. General:
   a. Drop-in expansion anchors shall each consist of an internally threaded, deformation-controlled expansion anchor with pre-assembled expander plug.
2. Products and Manufacturers: Provide one of the following:
   a. HDI Drop-In Anchors, by Hilti Fastening Systems, Inc.
   b. Drop-In Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or approved equal.
3. Provide carbon steel anchors complete with nuts and washers, zinc plated, in accordance with ASTM B633, complying with physical requirements of FS A-A-55614, Type I. Anchors shall be flush or shell type. Provide low-profile anchors for use in precast concrete planks.

H. Concrete Undercut Anchors:
1. General:
   a. Each concrete undercut anchor shall consist of threaded stud, thick-walled expansion sleeve, expander coupler, and nut and washer. Anchors shall be pre-set type or through-set type, as shown on the Drawings.
2. Products and Manufacturers: Provide one of the following:
   a. HDA Undercut Anchor, by Hilti Fastening Systems, Inc.
   b. DUC Ductile Undercut Anchor, by USP Structural Connectors.
   c. Or approved equal.
3. Provide concrete undercut expansion anchors in accordance with ACI 318 and ACI 350, Appendix D. Demonstrate suitability of cracked concrete undercut anchors in accordance with ACI 355.2 prequalification tests.
   a. Anchor shall comply with ductility requirements of ACI 350 or ACI 318 Appendix D, Section D.3.3.
4. Installed anchor shall exhibit form fit between bearing elements and the undercut in the concrete.

5. Interior Dry Non-Corrosive Locations: Provide carbon steel anchors, complete with nuts and washers, zinc plated, in accordance with ASTM B633.
6. Other Locations: Provide stainless steel anchors, complete with nuts and washers, manufactured of AISI Type 316 stainless steel or materials complying with ISO 3506-1 and having corrosion resistance equivalent to AISI Type 316 stainless steel.
7. Concrete undercut anchors shall have a current ICC Evaluation Service Report for use in both cracked and uncracked concrete for seismic recognition for seismic design Categories A through F when tested and assessed in accordance with ICC-ES AC193.

I. Concrete Inserts:
1. Manufacturers: Provide products of one of the following:
   a. Unistrut Corporation.
   b. Cooper B-Line, Inc.
   c. Anvil International, Inc.
   d. Or approved equal.
2. Spot Concrete Inserts:
   a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall comply with ANSI/MSS SP-58, malleable iron, Type 18. Spot inserts shall allow for lateral adjustment and have means for attachment to forms. Provide nuts compatible with insert and to suit threaded hanger rod sizes.
3. Continuous Concrete Inserts:
   a. Provide inserts recommended by insert manufacturer for required loading. Inserts shall be continuous type and shall be manufactured from minimum 12-gage cold-formed channel sections, complying with ASTM A1011/A1011M, stainless steel, Grade 33, complete with styrofoam inserts, end caps, and means for attaching to forms. Provide channel nuts compatible with insert suitable for threaded hanger rod sizes.
4. Provide inserts with plain finish.

J. Drive-In Expansion Anchors:
1. General:
   a. Drive-In expansion anchors shall each consist of stainless steel drive pin and expanding alloy body.
2. Products and Manufacturers: Provide one of the following:
   a. Metal HIT Anchor, by Hilti Fastening Systems, Inc.
   b. Zinc Nailon Anchor, by Simpson Strong-Tie Company, Inc.
   c. Or approved equal.
3. Provide Type 304 stainless steel drive pin with zinc alloy body. Anchor shall comply with physical requirements of FS A-A-1925A, Type 1.

K. Unless approved by ENGINEER, do not use power-actuated fasteners or other types of bolts and fasteners not specified in this Section.

L. Anti-Seizing Compound:
   1. Products and Manufacturers: Provide one of the following:
      a. Pure Nickel Never-Seez, by Bostik.
      b. Nickel-Graf, by Anti-Seize Technology.
      c. Or approved equal.
   2. Provide pure nickel anti-seizing compound.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials will be installed and advise ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Anchor Bolts:
   1. Provide anchor bolts as shown or indicated in the Contract Documents, or as required to secure structural element to the appropriate anchor surface.
   2. Locate and accurately set anchor bolts using templates or other devices as required, prior to placing concrete. Wet setting of anchor bolts is unacceptable.
   3. Protect threads and shank from damage during installation and subsequent construction operations.

B. Adhesive Anchors, Undercut Anchors, and Expansion Anchors – General:
   1. Prior to drilling, locate existing reinforcing steel in vicinity of proposed holes. If reinforcing conflicts with proposed hole location, obtain ENGINEER's approval of alternate hole locations to avoid drilling through or damaging existing reinforcing bars.

C. Adhesive Anchors:
   1. Comply with manufacturer's written installation instructions and the following.
   2. Drill holes to adhesive system manufacturer's recommended drill bit diameter to the specified depth. Drill holes in hammering and rotation mode with carbide-tipped drill bits that comply with the tolerances of ANSI B212.15. Core-drilled holes are unacceptable.
   3. Before setting adhesive anchor, hole shall be made free of dust and debris by method recommended by adhesive anchor system manufacturer. Hole

shall be brushed with adhesive system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles. Hole shall be dry as defined by adhesive system manufacturer.

4. Before injecting adhesive, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Prior to injecting adhesive into the drilled hole, dispense, to a location appropriate for such waste, an initial amount of adhesive from the mixing nozzle, until adhesive is uniform color.
6. Inject adhesive into hole through injection system-mixing nozzle and necessary extension tubes, placed to bottom of hole. Discharge end shall be withdrawn as adhesive is placed but kept immersed to prevent formation of air pockets. Fill hole to depth that ensures that excess material is expelled from hole during anchor placement.
7. Twist anchors during insertion into partially-filled hole to guarantee full wetting of rod surface with adhesive. Insert rod slowly to avoid developing air pockets.
8. Provide adequate curing in accordance to adhesive system manufacturer's requirements prior to continuing with adjoining Work that could place load on installed adhesive anchors. Do not begin adjoining Work until adhesive anchors are successfully tested or when allowed by ENGINEER.
9. Limitations:
    a. At time of anchor installation, concrete shall have compressive strength (f'c) of not less than 2,500 psi.
    b. At time of anchor installation, concrete shall have age of not less than 21 days.
    c. Installation Temperature: Comply with manufacturer's instructions for installation temperature requirements. Provide temporary protection and other measures, such as heated enclosures, necessary to ensure that base material temperature complies with anchor systems manufacturer's requirements during installation and curing of adhesive anchor system.
    d. Oversized Holes: Advise ENGINEER immediately if size of drilled hole is larger than recommended by anchor system manufacturer. Cost of corrective measures, including but not limited to redesign of anchors due to decreased anchor capacities, shall be paid by CONTRACTOR.
    e. Embedment depths shall be based on installation in normal-weight concrete with compressive strength of 2,500 psi when embedded in existing concrete, and 4,000 psi when embedded in new concrete.

D. Expansion Anchors:
1. Comply with expansion anchor manufacturer's written installation instructions and the following:
2. Drill holes using anchor system manufacturer's recommended drill bit diameter and to the specified depth. Drill holes in hammering and rotation

mode with carbide-tipped drill bits complying with tolerances of ANSI B212.15. Core drilled holes are unacceptable.

3. Before installing anchor, hole shall be made free of dust and debris by method recommended by anchor system manufacturer. Hole shall be brushed with anchor system manufacturer-approved brush and blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
4. Before installing anchor, obtain ENGINEER's concurrence that hole is dry and free of oil and other contaminants.
5. Protect threads from damage during anchor installation. Drive anchors not less than four threads below surface of the attachment. Set anchors to anchor manufacturer's recommended torque using a torque wrench.

E. Concrete Undercut Anchors:
1. Comply with undercut anchor manufacturer's written installation instructions and the following.
2. Protect threads from damage during anchor installation.
3. Drill hole to anchor manufacturer's specified depth and diameter using a drill bit matched to the specific anchor.
4. Before setting the undercut anchor, hole shall be free of dust and debris using method recommended by undercut anchor system manufacturer. Hole shall be blown clean with clean, dry, oil-free compressed air to remove all dust and loose particles.
5. Insert the anchor by hand until anchor reaches bottom of hole.
6. Set anchor in accordance with manufacturer's instructions using anchor manufacturer's specified setting tool.
7. Verify that the setting mark is visible on the threaded rod above the sleeve.
8. Anchor shall be set to manufacturer's recommended torque, using a torque wrench.

F. Concrete Inserts:
1. Comply with concrete insert manufacturer's installation instructions.
2. Inserts shall be flush with slab bottom surface.
3. Protect embedded items from damage during concrete placing. Ensure that embedded items are securely fastened to prevent movement during concrete placing, and ensure that embedded items do fill with concrete during concrete placing.
4. Inserts intended for piping greater than four-inch diameter shall be provided with hooked rods attached to concrete reinforcing.

G. Anti-Seizing Compound:
1. Provide anti-seizing compound in accordance with anti-seizing compound manufacturer's installation instructions, at locations indicated in Paragraph 2.1.B of this Section.

2. Do not use anti-seizing compound at locations where anchor bolt or adhesive anchor will contact potable water or water that will be treated to become potable.

3.3 CLEANING

A. After embedding concrete is placed, remove protection and clean bolts and inserts.

3.4 FIELD QUALITY CONTROL

1. Furnish services of independent testing laboratory to perform field quality tensile testing of production adhesive anchors at the Site, unless otherwise specified.
   a. Testing shall comply with ASTM E488.
   b. Test at least ten percent of all types of adhesive anchors. If one or more adhesive anchors fail the test, CONTRACTOR shall pay cost of testing, or at ENGINEER's option CONTRACTOR may arrange for testing paid by CONTRACTOR, for all adhesive anchors of same diameter and type installed on the same day as the failed anchor. If anchors installed on the same day as the failed anchor also fail the test, ENGINEER may require retesting of all anchors of the same diameter and type installed in the Work. CONTRACTOR shall be responsible for retesting costs.
   c. ENGINEER will direct which adhesive anchors are to be tested and indicate test load to be used
   d. Apply test loads with hydraulic ram.
   e. Displacement of post-installed anchors shall not exceed D/10, where D is nominal diameter of anchor being tested.
      1) Load each test anchor to failure.
      2) Testing shall comply with ASTM E488.
      3) Apply test loads with hydraulic ram.
   d. Anchors that fail to reach the specified test load shall be considered as not passing the test and shall be re-tested at no additional cost to OWNER.
   e. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.
3. Correct defective Work by removing and replacing or correcting, as directed by ENGINEER.
4. CONTRACTOR shall pay for all corrections and subsequent testing required to confirm competence in the installation of post-installed mechanical anchors.
5. Testing agency shall submit test results to CONTRACTOR and ENGINEER within 24 hours of completion of test.

B. Manufacturer's Services:
   1. Provide at the Site services of qualified adhesive manufacturer's representative during initial installation of adhesive anchor systems to train CONTRACTOR's personnel in proper installation procedures. Manufacturer's representative shall observe to confirm that installer demonstrates proper installation procedures for adhesive anchors and adhesive material.

+ + END OF SECTION + +

THIS PAGE INTENTIONALLY LEFT BLANK

SECTION 05 50 13

MISCELLANEOUS METAL FABRICATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish miscellaneous metal fabrications including surface preparation and shop priming.
   2. The Work also includes:
      a. Providing openings in miscellaneous metal fabrications to accommodate the Work under this and other Sections and attaching to miscellaneous metal fabrications all items such as sleeves, bands, studs, fasteners, and all items required for which provision is not specifically included under other Sections.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the Work to be installed with or attached to miscellaneous metal fabrications Work.
   2. Hot-dip Galvanizing: Coordinate with steel fabricator detailing for and fabrication of assemblies to be hot-dip galvanized, to minimize distortion during galvanizing process.

C. Related Sections:
   1. Section 03 00 05 Concrete
   2. Section 05 05 33, Anchor Systems.
   3. Section 09 91 00, Painting,

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI A14.3, Ladders – Fixed –Safety Requirements.
   2. ANSI Z359.1, Safety Requirements for Personal Fall Arrest Systems, Subsystems, and Components.
   3. ASTM A36/A36M, Specification for Carbon Structural Steel.
   4. ASTM A53/A53M, Specification for Pipe Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
   5. ASTM A123/A123M, Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   6. ASTM A153/A153M, Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

7. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet and Strip for Pressure Vessels and for General Applications.
8. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
9. ASTM A384/A384M-02 Standard Practice for Safeguarding Against Warpage and Distortion During Hot-Dip Galvanizing of Steel Assemblies.
10. ASTM A500, Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes.
11. ASTM A572/A572M, Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel.
12. ASTM A793, Specification for Rolled Floor Plate, Stainless Steel.
13. ASTM A992/A992M, Specification for Structural Steel Shapes.
14. ASTM B209, Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
15. ASTM B211, Specification for Aluminum and Aluminum-Alloy Bar, Rod and Wire.
16. ASTM B221, Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
17. ASTM B308/B308M, Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
18. ASTM B429, Specification for Aluminum-Alloy Extruded Structural Pipe and Tube.
19. ASTM B632/B632M, Specification for Aluminum-Alloy Rolled Tread Plate.
20. AWS D1.1/D1.1M, Structural Welding Code – Steel.
21. AWS D1.2/D1.2M, Structural Welding Code – Aluminum.
22. AWS D1.6, Structural Welding Code – Stainless Steel.
23. NAAMM, Metal Finishes Manual.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Welding:
      a. Qualify welding processes and welding operators in accordance with AWS D1.1/D1.1M, D1.2/D1.2M, or D1.6, as applicable.
      b. When requested by ENGINEER, provide certification that each welder employed on or to be employed for the Work have satisfactorily passed AWS qualification tests within previous 12 months. Ensure that all certifications are current.

B. Regulatory Requirements: Conform to the following:
   1. 29 CFR 1910, Occupational Health and Safety Standards.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:

1. Shop Drawings:
   a. Fabrication and erection details for assemblies of miscellaneous metal Work. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Include setting drawings and templates for locating and installing miscellaneous metal items and anchorage devices.
2. Product Data:
   a. Copies of manufacturer's specifications, load tables, dimension diagrams, anchor details, and installation instructions for products to be used in miscellaneous metal Work.

B. Informational Submittals: Submit the following:
1. Test and Evaluation Reports:
   a. Mill test report that indicate chemical and physical properties of each type of material, when requested by ENGINEER.
2. Qualifications Statements:
   a. Copies of welder's certifications, when requested by ENGINEER.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver products to Site to ensure uninterrupted progress of the Work. Deliver anchorage materials to be embedded in other construction in ample time to prevent delaying the Work.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Steel:
1. W-Shapes and WT-Shapes: ASTM A992/A992M.
2. S-Shapes and Channels: ASTM A572/A572M, Grade 50.
3. Hollow Structural Sections: ASTM A500, Grade B.
4. Angles, Plates, Bars: ASTM A36/A36M.
5. Steel Pipe: ASTM A53/A53M, Grade B.

B. Aluminum:
1. Aluminum Shapes: ASTM B308/B308M, Alloy 6061-T6, ASTM B 221, Alloy 6061-T6.
2. Aluminum Tubes and Pipes: ASTM B429, Alloy 6061-T6.
3. Aluminum Bars and Rod: ASTM B211, Alloy 6061-T6.
4. Aluminum Plates: ASTM B209, Alloy 6061-T6.

C. Stainless Steel:
   1. Plates and Sheets: ASTM A480/A 666, Type 316 stainless steel.
   2. Submerged or Intermittently Submerged: Type 316 stainless steel.
   3. Non-submerged: Type 316 stainless steel.

D. Stainless Steel Fasteners and Fittings: ASTM A 320/A 320M, Type 316 Stainless Steel.

E. Stainless Steel Type 316 Hardware: ASTM A 593/A 594.

2.2 MISCELLANEOUS METAL ITEMS

A. Shop Assembly:
   1. Pre-assemble items in the shop to the greatest extent possible to minimize field-splicing and field-assembly of units at the Site. Disassemble units only to extent necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

B. Steel Lintels:
   1. Provide loose structural steel lintels for openings and recesses in masonry walls and brick walls as specified or as shown.
   2. Weld adjoining members together to form a single unit, where shown or indicated.
   3. Provide not less than eight inches bearing at each side of openings, unless otherwise shown.
   4. Steel lintels to be installed in exterior walls shall be hot-dip galvanized and finish painted. Other steel lintels shall be painted.
   5. Surface preparation and painting shall conform to Section 09 91 00, Painting.
   6. Where lintels are not shown on the Drawings, provide lintels as specified in the following table. Provide other lintels where shown and of size indicated on the Drawings.

C. Shelf Angles:
   1. Provide structural steel shelf angles of sizes shown, for attachment to concrete or masonry construction. Provide slotted holes to receive 3/4-inch bolts, spaced not more than six inches from ends and not more than 2.0 feet on centers, unless otherwise shown.
      a. Provide galvanized shelf angles on outdoor construction.
   2. Provide wedge-type concrete inserts, complete with fasteners, for attachment of shelf angles to cast-in-place concrete.

D. Miscellaneous Framing and Supports:
   1. Provide miscellaneous metal framing and supports that are not part of structural steel framework and are required to complete the Work.

2. Fabricate miscellaneous units to sizes, shapes, and profiles shown on the Drawings or, if not shown, of required dimensions to receive adjacent grating, plates, tanks, doors, and other work to be retained by the framing.
3. Except as otherwise shown, fabricate from structural shapes, plates, and bars, of all-welded construction using mitered corners, welded brackets, and splice plates and minimum number of joints for field connection.
4. Cut, drill, and tap units to receive hardware and similar items to be anchored to the Work.
5. Furnish units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units are to be installed after concrete is placed.
   a. Except as otherwise shown, space anchors, 2.0 feet on centers, and provide units the equivalent of 1.25-inch by 1/4-inch by eight-inch strips.
   b. Galvanize exterior miscellaneous frames and supports.
   c. Where shown or indicated, galvanize miscellaneous frames and supports that are not to be installed outdoors.
6. Miscellaneous steel framing and supports shall be hot-dip galvanized and finish-painted, unless otherwise shown or indicated.

8. Surface preparation and painting of galvanized surface shall conform to Section 09 91 00, Painting

E. Fasteners and Hardware: Provide Type 316 stainless steel fasteners for aluminum fabrications and zinc-coated hardware for galvanized fabrications, unless otherwise shown or specified.

F. Anchors and Expansion Anchors: Refer to Section 05 05 33, Anchor Systems.

2.3 FINISHING

A. Surface Preparation and Shop Priming: Perform surface preparation and apply primer coat to miscellaneous metal fabrications in the shop. Conform to surface preparation and shop priming requirements in Section 09 91 00, Painting.

B. Galvanizing:
   1. Galvanizing of fabricated steel items shall comply with ASTM A123/A123M.
   2. Details of fabrication of steel items and assemblies to be hot-dip galvanized shall conform to recommendations of ASTM A384/A384M to minimize the potential for distortion.

C. Aluminum Finish: Provide an Architectural Class 1 anodized finish, AA-M32C22-A41, Clear, as specified in NAAMM Metal Finishes Manual.

2.4 SOURCE QUALITY CONTROL

A. Tests and Inspections:

1. Materials and fabrication procedures shall be subject to inspection and tests in the mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve CONTRACTOR of responsibility for providing materials and fabrication procedures complying with the Contract Documents.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine conditions under which the Work is to be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install miscellaneous metal fabrications accurately in location, alignment, and elevation, plumb, level, true, and free of rack, measured from established lines and levels. Brace temporarily or anchor temporarily in formwork where fabrications are to be built into concrete, masonry, or other construction.

B. Anchor securely as shown and as required for the intended use, using concealed anchors where possible.

C. Fit exposed connections accurately together to form tight, hairline joints. Field-weld steel connections that are not to be exposed joints and cannot be shop-welded because of shipping size limitations. Comply with AWS D1.1/D1.1M, D1.2/D1.2M and D1.6, as applicable to the material being welded. Grind steel joints smooth and touch-up shop paint coat. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.

D. Protection of Aluminum from Dissimilar Materials:
   1. Coat surfaces of aluminum that will contact dissimilar materials such as concrete, masonry, and steel, in accordance with Section 09 91 00, Painting.

+ + END OF SECTION + +

SECTION 07 92 00

JOINT SEALANTS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install joint sealants.
   2. Extent of each type of calking and sealant is shown or indicated and includes the following:
      a. Interior and exterior joints in equipment and construction systems not filled by another material, and that are not required to be open for operation.
      b. Joints specified to be recalked.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate installation of items to be installed with or before joint sealants.
   2. Coordinate final selection of joint sealants so that materials are compatible with all calking and sealant substrates specified.

C. Related Sections:
   1. Section 03 00 05, Concrete.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM C510, Test Method for Staining and Color Change of Single- or Multicomponent Joint Sealants.
   2. ASTM C661, Test Method for Indentation Hardness of Elastomeric-Type Sealants by Means of a Durometer.
   3. ASTM C793, Test Method for Effects of Accelerated Weathering on Elastomeric Joint Sealants.
   4. ASTM C794, Test Method for Adhesion-in-Peel of Elastomeric Joint Sealants.
   5. ASTM C920, Specification for Elastomeric Joint Sealants.
   6. ASTM C1021, Practice for Laboratories Engaged in Testing Building Sealants.
   7. ASTM C1087, Test method for Determining Compatibility of Liquid-Applied Sealants with Accessories Used in Structural Glazing Systems.
   8. ASTM C1193, Guide for Use of Joint Sealants.
   9. ASTM C1247, Practice for Durability of Sealants Exposed to Continuous Immersion in Liquids.
   10. BAAQMD Regulation 8, Rule 51.

11. FS TT-S-00227, Sealing Compound: Elastomeric Type, Multi-component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
12. FS TT-S-00230 Sealing Compound: Elastomeric Type, Single Component (for Calking, Sealing, and Glazing in Buildings and Other Structures).
13. NSF/ANSI Standard 61, Drinking Water System Components - Health Effects.
14. SCAQMD Rule 1168.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Installer:
      a. Engage a single installer, approved by product manufacturer, regularly engaged in calking and sealant installation and with successful experience in applying types of products required, and who employs only tradesmen with specific skill and successful experience in the type of Work required.
   2. Testing Laboratory:
      a. Furnish services of independent testing laboratory qualified according to ASTM C1021, for conducting testing required.

B. Component Supply and Compatibility:
   1. Obtain materials only from manufacturers who will, if required:
      a. Furnish at the Site services of a qualified technical representative to advise installer of proper procedures and precautions for using materials.
      b. Test joint sealants for compatibility with substrates for conformance with FS-TT-S-00227, and recommend remedial procedures as required.
   2. Before purchasing each sealant, investigate its compatibility with joint surfaces, joint fillers, and other materials in joint system. Provide products that are fully compatible with actual installation condition, verified by manufacturer's published data or certification, and as shown on approved Shop Drawings and other approved submittals.

C. Product Testing: Provide test results of laboratory pre-construction compatibility and adhesion testing, as specified in Article 3.1 of this Section, by qualified testing laboratory, based on testing of current sealant formulations within a 36-month period preceding the Notice to Proceed for the Work.
   1. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C920 and, where applicable, to other standard test methods.
   2. Test other joint sealants for compliance using specified post-construction field adhesion test.

D. Mock-ups:
   1. Prior to installing joint sealant Work but after ENGINEER's approval of Samples, provide Sample of each type of calking and sealant in areas selected by ENGINEER to show representative installation of calkings and sealants. Obtain ENGINEER's approval of visual qualities of mock-ups before starting calking and sealant Work. Retain and protect mock-ups during construction as

a standard for judging completed calking and sealant Work. Do not alter or destroy mock-ups until so allowed by ENGINEER.

2. Perform the following testing on calking and sealant mock-up, as specified in this Section: Post-construction field adhesion testing and water leak test.
3. Work that does not comply with test requirements on Sample areas will be considered defective.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of joint sealants installation, indication each specific surface where calking or sealants are to be provided and the material proposed for each application.
   2. Product Data:
      a. Copies of manufacturer's data sheets including color charts, specifications, recommendations, and installation instructions for each type of sealant, calking compound, and associated miscellaneous material required. Include manufacturer's published data, indicating that each product complies with the Contract Documents and is intended for the applications shown or indicated.
      b. Product test reports.
   3. Samples:
      a. Each type of actual cured material of each calking and sealant specified, in each of manufacturer's standard colors.
      b. Samples will be reviewed by ENGINEER for color and texture only. Compliance with other requirements is responsibility of CONTRACTOR.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certify that materials are suitable for intended use and materials meet or exceed requirements of the Contract Documents.
      b. Certification from manufacturer that products furnished are appropriate for surfaces and conditions to which they will be applied.
      c. Certify that applicator is approved by manufacturer.
   2. Field Quality Control Submittals:
      a. Results of tests on job mock-ups.
      b. Pre-construction and post-construction field test reports.
      c. Compatibility and adhesion test reports.
      d. Contractor's Field Test Report Logs:
         1) Indicate time present at the Site.
         2) Include observations and results of field tests, and document compliance with manufacturer's installation instructions and supplemental instructions provided to installers.
   3. Qualifications: Submit qualifications for:
      a. Installer.

C. Closeout Submittals: Submit the following:

1. Operation and Maintenance Data:
   a. Recommended inspection intervals.
   b. Instructions for repairing and replacing failed sealant joints.
2. Warranty: Submit written warranties as specified in this Section.

1.5 DELIVERY, STORAGE AND HANDLING

A. Product Storage and Handling Requirements, and the following:
1. Delivery of Products:
   a. Deliver products in calking and sealant manufacturer's original unopened, undamaged containers, indicating compliance with approved Shop Drawings and approved Sample color selections.
   b. Include the following information on label:
      1) Name of material and Supplier.
      2) Formula or Specification Section number, lot number, color and date of manufacture.
      3) Mixing instructions, shelf life, and curing time, when applicable.
2. Storage of Products:
   a. Do not store or expose materials to temperature above 90 degrees F or store in direct sunlight.
   b. Do not use materials that are outdated as indicated by shelf life.
   c. Store sealant tape in manner that will not deform tape.
   d. In cool or cold weather, store containers for sixteen hours before using in temperature of approximately 75 degrees F.
   e. When high temperatures prevail, store mixed sealants in a cool place.
3. Handling:
   a. Do not open containers or mix components until necessary preparatory Work and priming are complete.

1.6 JOB CONDITIONS

A. Environmental Conditions:
1. Do not install joint sealants under adverse weather conditions, or when temperatures are below or above manufacturer's recommended limitations for installation.
2. Proceed with the Work when forecasted weather conditions are favorable for proper cure and development of high-early bond strength.
3. Where joint width is affected by ambient temperature variations, install elastomeric sealants when temperatures are in the lower third of manufacturer's recommended installation temperature range, so that sealant will not be subjected to excessive elongation and bond stress at subsequent low temperatures.
4. When high temperatures prevail, avoid mixing sealants in direct sunlight.
5. Supplemental heat sources required to maintain both ambient and surface temperatures within the range recommended by manufacturer for material applications are not available at the Site.
6. Provide supplemental heat and energy sources, power, equipment, and operating, maintenance, and temperature monitoring personnel.

7. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas of calking, sealants, and painting Work, and areas where OWNER's personnel or construction personnel may work. Properly locate and vent such heat sources to outdoors so that joint sealants and other Work are unaffected by exhaust.

1.7 WARRANTY

A. Provide written warranty, signed by manufacturer and CONTRACTOR, agreeing to repair or replace sealants that fail to perform as air-tight and watertight joints; or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability; or appear to deteriorate in any other manner not clearly specified in approved Shop Drawings and other submittals, as an inherent quality of material for exposure indicated.
   1. Provide manufacturer warranty for period of one year from date of Substantial Completion of joint sealants Work.
   2. Provide installer warranty for period of two years from date of Substantial Completion of joint sealants Work.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. Provide elastomeric joint sealants for interior and exterior joint applications that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

B. Provide colors selected by ENGINEER from calking and sealant manufacturer's standard and custom color charts. "Or approved equal " manufacturers shall provide same generic products and colors as available from manufacturers specified.

2.2 MATERIALS

A. Exterior and Interior Vertical Joints; Non-submerged:
   1. Two-component Polyurethane Sealant:
      a. Products and Manufacturers: Provide one of the following:
         1) Sikaflex- 2c NS by Sika Corporation.
         2) Dymeric 240 FC by Tremco Sealant/Waterproofing Division of RPM International, Inc.
         3) Or approved equal.
      b. Polyurethane based, two-component elastomeric sealant complying with:
         1) FS TT-S-00227E: Type II (non-sag) Class A and ASTM C920, Type M, Grade NS, Class 25.
         2) Adhesion-in-Peel, FS TT-S-00227E and ASTM C794: (Minimum five pounds per linear inch with no adhesion failure): 10 pounds.
         3) Hardness (Standard Conditions), ASTM C661: 25 to 35 (Shore A).

4) Stain and color change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
6) Rheological Vertical Displacement at 120 degrees F, FS TT-S-00227E: No sag.
7) VOC Content: 100 g/L, maximum.

B. Exterior and Interior Horizontal Joints; Non-submerged:
1. Two-component Polyurethane Sealant:
a. Products and Manufacturers: Provide one of the following:
1) Sikaflex- 2c SL by Sika Corporation.
2) THC/900 by Tremco Sealant/Waterproofing Division of RPM International, Inc.
3) Or approved equal.
b. Polyurethane based, two-component elastomeric, self-leveling sealant complying with the following:
1) FS TT-S-00227E, Type I (self-leveling) Class A. and ASTM C920, Type M, Grade P, Class 25
2) Water Immersion Bond, FS TT-S-00227E: Elongation of 50 percent with no adhesive failure.
3) Hardness (Standard Conditions), ASTM C661: 35 to 45.
4) Stain and Color Change, FS TT-S-00227E and ASTM C510: No discoloration or stain.
5) Accelerated Aging, ASTM C793: No change in sealant characteristics after 250 hours in weatherometer.
6) VOC Content: 165 g/L, maximum.

C. Miscellaneous Materials:
1. Joint Cleaner: As recommended by calking and sealant manufacturer.
2. Joint Primer and Sealer: As recommended for compatibility with calking and sealant by calking and sealant manufacturer.
3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended for compatibility with calking and sealant by calking and sealant manufacturer, to be applied to sealant-contact surfaces where bond to substrate or joint filler must be avoided for proper performance of calking and sealant. Provide self-adhesive tape where applicable.
4. Sealant Backer Rod: Compressible rod stock polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable nonabsorptive material as recommended for compatibility with calking and sealant by calking and sealant manufacturer. Provide size and shape of rod that will control joint depth for sealant placement, break bond of sealant at bottom of joint, form optimum shape of sealant bead on back side, and provide highly-compressible backer to minimize possibility of sealant extrusion when joint is compressed.
5. Low-temperature Catalyst: As recommended by calking and sealant manufacturer.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine joint surfaces, substrates, backing, and anchorage of units forming sealant rabbet, and conditions under which calking and sealant Work will be performed, and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work and performance of sealants. Do not proceed with calking and sealant Work until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Protection: Do not allow joint sealants to overflow or spill onto adjoining surfaces, or to migrate into voids of adjoining surfaces including rough textured materials. Use masking tape or other precautionary devices to prevent staining of adjoining surfaces, by either the primer/sealer or calking and sealant materials.

B. Joint Surface Preparation:
   1. Clean joint surfaces immediately before installing sealant compound. Remove dirt, weakly adhering coatings, moisture and other substances that would interfere with bonds of sealant compound as recommended in sealant manufacturer's written instructions as shown on approved Shop Drawings.
   2. If necessary, clean porous materials by grinding, sandblasting, or mechanical abrading. Blow out joints with oil-free compressed air or by vacuuming joints prior to applying primer or sealant.
   3. Roughen joint surfaces on vitreous coated and similar non-porous materials, when sealant manufacturer's data indicates lower bond strength than for porous surfaces. Rub with fine abrasive cloth or steel wool to produce a dull sheen.
   4. Concrete Joint Preparation: Refer to Section 03 00 05, Concrete

C. Mixing:
   1. Comply with sealant manufacturer's written instructions for mixing multi-component sealants.
   2. Thoroughly mix components before use.
   3. Add entire contents of activator can to base container. Do not mix partial units.
   4. Mix contents for minimum of five minutes or as recommended by sealant manufacturer, until color and consistency are uniform.

3.3 INSTALLATION

A. Install joint sealants after adjacent areas have been cleaned and before joint has been cleaned and primed, to ensure calking and sealant joints will not be soiled. Replace calking and sealant joints soiled after installation.

B. Comply with sealant manufacturer's written instructions except where more stringent requirements are shown or indicated in the Contract Documents, and except where manufacturer's technical representative directs otherwise, only as acceptable to ENGINEER.

C. Prime or seal joint surfaces as shown on approved Shop Drawings and approved other submittals. Do not allow primer or sealer to spill or migrate onto adjoining surfaces. Allow primer to dry prior to applying sealants.

D. Apply masking tape before installing primer, in continuous strips in alignment with joint edge to produce sharp, clean interface with adjoining materials. Remove tape immediately after joints have been sealed and tooled as directed.

E. Do not install sealants without backer rods and bond breaker tape.

F. Roll back-up rod stock into joint to avoid lengthwise stretching. Do not twist, braid, puncture, or prime backer rods.

G. Employ only proven installation techniques that will ensure that sealants are 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 a vertical surface, fill joint to form a slight cove, so that joint will not trap moisture and dirt.

H. Install sealants to depths recommended by sealant manufacturer but within the following general limitations, measured at the center (thin) section of bead.
   1. For horizontal joints in sidewalks, pavements, and similar locations sealed with elastomeric sealants and subject to traffic and other abrasion and indentation exposures, fill joints to depth equal to 75 percent of joint width, but not more than 5/8-inch deep or less than 3/8-inch deep.
   2. For vertical joints subjected to normal movement and sealed with elastomeric sealants and not subject to traffic, fill joints to a depth equal to 50 percent of joint width, but not more than 1/2-inch deep or less than 1/4-inch deep.

I. Remove excess and spillage of compounds promptly as the Work progresses.

J. Cure calking and sealant compounds in compliance with manufacturer's instructions and recommendations, to obtain high-early bond strength, internal cohesive strength, and surface durability.

3.4 EXISTING JOINTS

A. Mechanically remove existing sealant and backer rod.

B. Clean joint surfaces of residual sealant and other contaminates capable of affecting sealant bond to joint surface.

C. Conduct laboratory pre-construction compatibility and adhesion testing on joint surfaces in accordance with Paragraph 3.1.B of this Section.

D. Allow joint surfaces to dry before installing new sealants.

3.5 FIELD QUALITY CONTROL

A. Post-construction Field Adhesion Testing: Before installing elastomeric sealants, field-test joint sealant adhesion to joint substrates as follows:
   1. Extent of Testing: Test completed elastomeric sealant joints as follows:
      a. Perform ten tests for the first 1,000 feet of joint length for each type of elastomeric sealant and joint substrate.
      b. Perform one test for each 1,000 feet of joint length thereafter, and minimum of one test per each floor per elevation.
      c. Test Method: Test joint sealants according to Method A, Field-applied Sealant Joint Hand Pull Tab, and Method D, Water Immersion in Appendix X1 of ASTM C1193. For joints with dissimilar substrates, verify adhesion to each substrate separately by extending cut along one side and verifying adhesion to opposite side. Repeat procedure for opposite side.
      d. Inspect joints for complete fill, absence of voids, and joint configuration complying with specified requirements. Record results in a log of field adhesion tests.
      e. Inspect tested joints and report on whether:
         1) Sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
         2) Sealants filled the joint cavities and are free of voids.
         3) Sealant dimensions and configurations comply with specified requirements.
      f. Record test results in a log of field adhesion tests. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
      g. Repair sealants pulled from test area by applying new sealants following same procedures used originally to seal joints. Ensure that original sealant surfaces are clean and that new sealant contacts original sealant.
      h. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other requirements will be satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.
      i. Do not proceed with installation of elastomeric sealants over joint surfaces that have been painted, lacquered, waterproofed, or treated with water repellent or other treatment or coating unless a laboratory test for durability (adhesion), in compliance with FS TT-S-00227, has successfully demonstrated that sealant bond is not impaired by the coating or treatment. If laboratory test has not been performed or shows bond interference, remove coating or treatment from joint surfaces before installing sealant.

B. Water Leak Testing: Field test for water leaks as follows:
   1. Flood the joint exposure with water directed from a 3/4-inch diameter garden hose, without nozzle, held perpendicular to wall face, two feet from joint and connected to water system with 30 psi minimum normal water pressure. Move stream of water along joint at an approximate rate of 20 feet per minute.
   2. Test approximately five percent of total joint system, in locations that are typical of every joint condition, and that can be inspected easily for leakage on opposite face. Conduct test in presence of ENGINEER, who will determine actual percentage of joints to be tested and actual period of exposure to water from hose, based on extent of observed leakage or lack of observed leakage.
   3. Where nature of observed leaks indicates potential of inadequate joint bond strength, ENGINEER may direct that additional testing be performed at a time when joints are fully cured, and before Substantial Completion.

3.6 ADJUSTING AND CLEANING

A. Where leaks and lack of adhesion are evident, replace sealant.

B. Clean adjacent surfaces of sealant and soiling resulting from the Work. Use solvent or cleaning agent recommended by sealant manufacturer. Leave all finish Work in neat, clean condition.

C. Protect sealants during construction so that they will be without deterioration, soiling, or damage at time of readiness for final payment of the Contract.

3.7 PROTECTION

A. During and after curing period, protect joint sealants from contact with contaminating substances and from damage resulting from construction operations or other causes, so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from original Work.

+ + END OF SECTION + +

SECTION 09 91 00

PAINTING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and apply paint systems.
      a. CONTRACTOR is responsible for surface preparation and painting of all new and existing interior and exterior items and surfaces throughout the Project areas included under this and other Sections.

   2. Extent of painting includes the Work specified below. Painting shown in schedules may not provide CONTRACTOR with complete indication of all painting Work. Refer to Article 2.2 of this Section where all surfaces of generic types specified are specified for preparation and painting according to their status, intended function, and location, using the painting system for that surface, function, and location as specified, unless specifically identified on the Drawings as a surface not to receive specified painting system.
      a. All new and specifically identified existing surfaces and items except where natural finish of material is specified as a corrosion-resistant material not requiring paint; or is specifically shown as indicated by written note, or specified as a surface not to be painted. Where items or surfaces are not specifically mentioned, paint them the same as adjacent similar materials or areas.
      b. Surface preparation and painting of all new and specifically identified existing items, both interior and exterior, and other surfaces, including items furnished by OWNER, are included in the Work, except as otherwise shown or specified.
      c. Removal of all substances, top coats, primers and all intermediate coats of paint and other protective or decorative coatings on those items and surfaces to remain that are identified to receive a painting system under this Section, to provide surfaces acceptable for application of painting specified.

B. Coordination:
   1. Review installation, removal, and demolition procedures under other Sections and coordinate them with the Work specified in this Section.

2. Coordinate painting of areas that will become inaccessible once equipment and similar fixed items have been installed.
3. Furnish information to ENGINEER on characteristics of finish materials proposed for use and ensure compatibility with prime coats used. Provide barrier coats over incompatible primers or remove and repaint as required. Notify ENGINEER in writing of anticipated problems using specified painting systems with surfaces primed by others. Reprime equipment primed in factory and other factory-primed items that are damaged or scratched.

C. Related Sections:
1. Section 07 92 00, Joint Sealants.

D. Work Not Included: The following Work is not included as painting Work, or are included under other Sections or in other contracts:
1. Shop Priming: Shop priming of structural metal, miscellaneous metal fabrications, other metal items and fabricated components such as shop-fabricated or factory-painted process equipment, plumbing equipment, heating and ventilating equipment, electrical equipment, and accessories shall conform to applicable requirements of this Section but are included under other Sections or in other contracts.
2. Pre-finished Items:
   a. Items furnished with such finishes as baked-on enamel, porcelain, and polyvinylidene fluoride shall only be touched up at Site by CONTRACTOR using manufacturer's recommended compatible field-applied touchup paint.
   b. Items furnished with finishes such as chrome plating or anodizing.
3. Concealed Surfaces: Non-metallic wall or ceiling surfaces in areas not exposed to view, and generally inaccessible areas, such as furred spaces, pipe chases, duct shafts, and elevator shafts.
4. Face brick, glazed structural tile, and prefaced, ground-faced or split-faced concrete unit masonry.
5. Exterior face of architectural precast concrete.
6. Corrosion-Resistant Metal Surfaces: Where the natural oxide of item forms a barrier to corrosion, whether factory- or Site-formed, including such materials as copper, bronze, muntz metal, terne metal, and stainless steel.
7. Operating Parts and Labels:
   a. Do not paint moving parts of operating units, mechanical and electrical parts such as valve and damper operators, linkages, sensing devices, interior of motors, and fan shafts.
   b. Do not paint over labels required by governing authorities having jurisdiction at Site, or equipment identification, performance rating, nameplates, and nomenclature plates.
   c. Cover moving parts and labels during the painting with protective masking. Remove all protective masking upon completion of Work.

Remove all paint, coatings, and splatter that comes in contact with such labels.

8. Structural and miscellaneous metals covered with concrete need not receive primers, intermediate, or finish coats of paint.
9. Existing structures, equipment, and other existing surfaces and items unless otherwise shown or specified.

E. Description of Colors and Finishes:
1. Color Selection:
   a. ENGINEER reserves the right to select non-standard colors for paint systems specified within ability of paint manufacturer to produce such non-standard colors. Provide such colors at no additional expense to OWNER.
2. Color Coding of Pipelines, Valves, Equipment, and Ducts:
   a. Color-coding of pipelines, valves, equipment and ducts shall comply with applicable standards of ANSI A13.1, ANSI Z535.1, CFR 1910.144, Recommended Standards for Water Works, and Recommended Standards for Wastewater Facilities. For piping and equipment not covered by the above standards, conform to OWNER's color standards.
   b. For equipment located on roofs and equipment that is exposed-to-view, color will be selected by ENGINEER.

1.2 REFERENCES

A. Referenced Standards: Standards referenced in this Section are:
1. ANSI A13.1, Scheme for Identification of Piping Systems.
2. ANSI Z535.1, Safety Color Code.
3. ASTM D16, Terminology for Paint, Related Coatings, Materials and Applications.
4. ASTM D2200, Pictoral Surface Preparation Standards for Painting Steel Surfaces.
5. ASTM D4262, Testing Method for pH of Chemically Cleaned or Etched Concrete Surfaces.
6. ASTM D4263, Test Method for Indicating Moisture in Concrete by the Plastic Sheet Method.
7. ASTM D4541, Test Methods for Pull-Off Strength of Coatings Using Portable Adhesion-Testers.
8. ASTM E329, Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
9. Great Lakes Upper Mississippi River Board of Public Health and Environmental Managers (GLUMRB) Recommended Standards for Water Works.
10. GLUMRB, Recommended Standards for Wastewater Facilities.
11. Ozone Transport Commission, (OTC), OTC Model Rule for Architectural and Industrial Maintenance Coatings.

12. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
13. SSPC VIS 1, Visual Standard for Abrasive Blast Cleaned Steel.
14. SSPC VIS 2, Method of Evaluating Degree of Rusting/Painted Steel Surfaces.
15. SSPC Volume 2, Systems and Specifications.

1.3 DEFINITIONS

A. Coating terms defined in ASTM D16 apply to this Section.

1.4 QUALITY ASSURANCE

A. Applicator Qualifications:
   1. Engage a single applicator regularly performing installation of painting systems, with documented skill and successful experience in installing types of products required and agrees to employ only tradesmen trained, skilled, and with successful experience in installing types of products specified.

B. Testing Agency Qualifications: Provide independent testing agency with experience and capability to satisfactorily conduct testing specified in accordance with ASTM E329. Testing agency shall be selected by OWNER and paid for by CONTRACTOR.

C. Source Quality Control:
   1. Obtain products from manufacturers that will provide services of a qualified manufacturer's representative at Site at commencement of painting Work to advise on products, mock-ups, installation, and finishing techniques, at completion of the Work to advise ENGINEER on acceptability of completed Work, and during course of Work as requested by ENGINEER.
   2. Submit "or equal" products, when proposed, with direct comparison to products specified, including information on durability, adhesion, color and gloss retention, percent solids, VOC's grams per liter, and recoatability after curing.
   3. "Or equal" manufacturers shall furnish same color selection as manufacturers specified, including intense chroma and custom pigmented colors in painting systems.
   4. Color Pigments: Provide pure, non-fading, applicable types to suit surfaces and services indicated. Comply with the following:
      a. Lead and Chromate: Lead and chromate content shall not exceed amount allowed by authorities having jurisdiction.
      b. Through CONTRACTOR, paint manufacturer shall notify ENGINEER of colors that are not suitable for long-term color retention in areas subject to hydrogen sulfide fume exposure.
      c. Manufacturer shall identify colors that meet requirements of authorities having jurisdiction at Site for use in locations subject to

contact with potable water or water that will be treated to become potable.

d. Comply with paint manufacturers' recommendations on preventing coating contact with levels of carbon dioxide and carbon monoxide that may cause yellowing during application and initial stages of curing of paint coatings.

D. Regulatory Requirements:

1. Comply with VOC content limits of Ozone Transport Commission (OTC), Model Rule for Architectural and Industrial Maintenance Coatings.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:

1. Product Data:

a. Copies of manufacturer's technical data sheets, including surface preparation, number of coats, dry film thickness, test performance data including paint analysis, VOC and chemical component content in comparison to maximum allowed by the Contact Documents, and application instructions for each product proposed for use

b. Submit proof of acceptability of proposed application techniques by paint manufacturer selected.

c. List each material and cross-reference to the specific painting system and application, including a list of site-specific surfaces to which painting system will be applied

d. Identify maximum exposure times allowable for each paint system component before next coat of paint can be applied. Submit proposed methods for preparing surfaces for subsequent coats if maximum exposure times are exceeded.

e. Information on curing times and environmental conditions that affect curing time of each paint system component and proposed methods for accommodating variations in curing time. Identify this information for each painting system in the Work.

f. Specification for spray equipment with cross-reference to paint manufacturer's recommended equipment requirements.

B. Informational Submittals: Submit the following:

1. Certificates:

a. Certificate from paint manufacturer stating that materials meet or exceed Contract Documents requirements.

b. CONTRACTOR shall provide notarized statement verifying that all painting systems are compatible with surfaces specified. All painting systems components shall be reviewed by an authorized technical representative of paint manufacturer for use as a compatible system. Verify that all painting systems are acceptable for exposures specified

and that paint manufacturer is in agreement that selected systems are proper, compatible, and are not in conflict with paint manufacturer's recommended specifications. Show by copy of transmittal form that a copy of letter has been transmitted to paint applicator.

2. Test Reports:
   a. Certified laboratory test reports for required performance and analysis testing in compliance with ASTM E329.
   b. Adhesion testing plan and procedures.
3. Manufacturer's Instructions: Provide paint manufacturer's storage, handling, and application instructions prior to commencing painting Work at Site.
4. Qualifications:
   a. Applicator.
   b. Testing laboratory

C. Closeout Submittals: Submit the following:
   1. Maintenance Manual: Upon completion of the painting Work, furnish ENGINEER five copies of detailed maintenance manual including the following information:
      a. Complete and updated product catalog of paint manufacturer's currently available products including complete technical information on each product. Identify product names and numbers of each product used in the painting Work.
      b. Name, address, e-mail address and telephone number of manufacturer, local distributor, applicator and technical representative.
      c. Detailed procedures for routine maintenance and cleaning.
      d. Detailed procedures for light repairs such as dents, scratches and staining.
   2. Statement of Application: Upon completion of the painting Work, submit a notarized statement to ENGINEER signed by CONTRACTOR and painting applicator stating that Work complies with requirements of the Contract Documents and that application methods, equipment, and environmental conditions were proper and adequate for conditions of installation and use.

1.6 DELIVERY, STORAGE AND HANDLING

A. Product Delivery Requirements: Deliver products to Site in original, new, and unopened packages and containers, accurately and legibly and accurately labeled with the following:
   1. Container contents, including name and generic description of product.
   2. Manufacturer's stock number and date of manufacture.
   3. Manufacturer's name.
   4. Contents by volume, for major pigment and vehicle constituents.
   5. Grams per liter of volatile organic compounds.
   6. Thinning instructions, where recommended.
   7. Application instructions.
   8. Color name and number.

B. Product Storage Requirements:
   1. Store acceptable materials at Site.
   2. Store in an environmentally controlled location as recommended in paint manufacturer's written product information. Keep area clean and accessible. Prevent freezing of products.
   3. Store products that are not in actual use in tightly covered containers.
   4. Comply with health and fire regulations of authorities having jurisdiction at Site.

C. Product Handling Requirements:
   1. Handle products in a manner that minimizes the potential for contamination, or incorrect product catalyzation.
   2. Do not open containers or mix components until necessary preparatory work has been completed and approved by ENGINEER and painting Work will start immediately.
   3. Maintain containers used in storing, mixing, and applying paint in a clean condition, free of foreign materials and residue.

1.7 SITE CONDITIONS

A. Site Facilities:
   1. Supplemental heat sources, as required to maintain both ambient and surface temperatures within range recommended by paint manufacturer for paint system applications, are not available at the Site.
   2. Provision of supplemental heat energy sources, power, equipment, and operating, maintenance, and temperature-monitoring personnel is CONTRACTOR's responsibility.
   3. Do not use heat sources that emit carbon dioxide or carbon monoxide into areas being painted. Properly locate and vent heat sources to exterior so that paint systems and personnel are unaffected by exhaust products.

B. Existing Conditions:
   1. Existing surfaces to receive painting Work shall have their surfaces prepared to meet requirements of painting systems specified. Prior to initiating painting Work, perform adhesion tests on existing surfaces to be painted. Perform testing per ASTM D4541 or other method acceptable to ENGINEER. Number and location of tests shall be sufficient to determine the condition of existing coatings and suitability of existing coatings to remain to provide an acceptable substrate for new coatings. Submit testing plan prior to testing and provide ENGINEER the adhesion test results.
   2. Provide abrasive blasting, scraping, or other abrading or surface film removal, or preparatory techniques accepted by ENGINEER.
   3. Before commencing painting in an area, surfaces to be painted shall be cleaned of dust using commercial vacuum cleaning equipment equipped

with high-efficiency particulate air (HEPA(filters and dust containment systems.

4. After painting operations have started in a given area, cleaning only with commercial vacuum cleaning equipment with high-efficiency particulate air (HEPA) filters and dust containment systems.

C. Environmental Requirements:
   1. Comply with manufacturer's published requirements.

D. Protection:
   1. Cover or otherwise protect finished Work of other trades and those surfaces not being painted concurrently and not to be painted.
   2. During surface preparation and painting, facility shall remain in operation. Use procedures that prevent contamination of process or cause or require facility shutdown.
   3. Coordinate and schedule surface preparation and painting to avoid exposing personnel to hazards associated with painting Work. Provide required personnel safety equipment per requirements of authorities having jurisdiction at Site.
   4. Submit protection procedures to be employed. Do not begin surface preparation and painting Work until ENGINEER accepts protection techniques proposed by CONTRACTOR.
   5. When working with flammable materials, provide fire extinguishers and post temporary signs warning against smoking and open flame.

PART 2 - PRODUCTS

2.1 PAINTING SYSTEM MANUFACTURERS

A. Products and Manufacturers: Where referenced under painting systems, provide painting systems manufactured by the following:
   1. Tnemec Company, Incorporated (TCI).
   2. The Carboline Company, part of StonCor Group, an RMP Company (TCC).
   3. Sherwin-Williams Company (SWC).
   4. Or approved equal.

2.2 PAINTING SYSTEMS

A. New and Existing Surfaces; Non-Submerged, Interior; Buried, Submerged and Intermittently Submerged, OTC Compliant; Interior and Exterior:
   1. Surface Preparation: Comply with manufacturer's published recommendations for material and surface condition.
   2. Filler, Surfacer and Patching Compound:
      a. Products: Provide one of the following:

1) Epoxy-based products, number of coats, and dry film thickness recommended in manufacturer's published data sheets for finish coats and surfaces specified.

3. Primer/Intermediate:
   a. Products: Provide one of the following:
      1) Epoxy-based products, number of coats, and dry film thickness recommended in manufacturer's published data sheets for finish coats and surfaces specified.
4. Finish for All Surfaces Except Wood; Semi-gloss:
   a. Generic Components:
      1) Minimum 62-percent volume solids, high-build, two-component, polyamide-catalyzed epoxy or polyamido-amine epoxy; 250 grams per gallon VOC, maximum.
   b. Products and Manufacturers: Provide products of one of the following:
      1) Series V69 Hi-Build Epoxoline (TCI); Carboguard 890 Series (TCC); Macropoxy HS (SWC)- two coats, 3.0 to 6.0 dry mils per coat, 107 to 201 square feet per gallon.

B. New and Existing Surfaces; Non-Submerged, OTC Compliant; Exterior:
1. Surface Preparation: Comply with manufacturer's published recommendations for material and surface condition.
2. Shop Primer:
   a. Products: Provide one of the following:
      1) Epoxy-based products, number of coats and dry film thickness recommended in manufacturer's published data sheets for finish coats and surfaces specified.
3. Intermediate:
   a. Products: Provide one of the following:
      1) Epoxy-based products, number of coats and dry film thickness recommended in manufacturer's published data sheets for finish coats and surfaces specified.
4. Finish, Metals: Semi-Gloss:
   a. Generic Components:
      1) Minimum 58-percent solids, aliphatic acrylic polyurethane; 340 grams per liter VOC, maximum.
   b. Products and Manufacturers: Provide products of one of the following:
      1) Series V73 Endura-Shield (TCI); Carbothane 133 VOC (TCC); Hi-Solids Polyurethane (SWC): Two coats, 2.0 to 5.0 dry mils per coat.
5. Finish for All Surfaces Other Than Metals; Semi-Gloss:
   a. Generic Components:
      1) Minimum 36-percent volume solids, flexible, high-build, single-component, modified waterborne acrylate, acrylic epoxy, or waterborne acrylic coating that can fill and bridge minor hairline cracks; 250 grams per liter VOC, maximum.
   b. Product and Manufacturer: Provide products of one of the following:

1) Series 156 Enviro-Crete (TCI); Carbocrylic 3359 (TCC); Epo-Plex Multi-Mil Low-Luster (SWC): One coat, 4.0 to 8.0 dry mils.

2.3 CALKING AND SEALANTS

A. Refer to Section 07 92 00, Joint Sealants.

2.4 INSTRUMENTS

A. Instruments:
   1. Provide one new dry-film thickness gauge for checking film thickness, one holiday detector to detect holidays or holes in the coating, and one set of visual standards to check surface preparation. Calibrate dry film thickness gauge at Site using Bureau of Standards standard shim blocks. After performing testing, furnish instruments and standards to OWNER.
   2. Products and Manufacturers: Provide the following:
      a. Film Thickness Testers: Model FM-III manufactured by Mikrotest, or approved equal.
      b. Holiday detector shall be Model M-1 as manufactured by Tinker & Rasor, or approved equal.
      c. Visual Standards: ASTM D2200, Swedish Standards, SSPC VIS 1.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine areas and conditions under which painting Work is to be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of Work. Do not proceed with Work until unsatisfactory conditions have been corrected in a manner acceptable to ENGINEER.

B. Do not paint over existing paint where there is no assurance that existing paint will provide an acceptable surface for long-term adherence and durability of painting systems specified, or where paint manufacturer requires removal of all existing paint to recommend use of specified painting system.

3.2 SURFACE PREPARATION

A. General:
   2. Comply with paint manufacturer's published recommendations for products, surface condition, and surface preparation.

3.3 PROTECTION OF PROPERTY AND STRUCTURES

A. Protect property and structures adjacent to the Work from waste residues resulting from cleaning, surface preparation, and painting Work.

B. Use shrouding, vacuum blasting, or other acceptable methods for cleaning and surface preparation of exterior surfaces.

C. During blast cleaning and surface preparation of interior and exterior surfaces, control exhausting of dust and grit using shrouding, negative-pressure containment/dust collection systems, or other means to protect adjacent property and structures and prevent dust and grit from escaping. Similarly, control removal and temporarily store residues to protect adjacent property and structures.

D. For painting of exterior surfaces, use rollers, shrouding, or other acceptable methods as required to protect adjacent property and structures from wind-blown paint residues.

E. Submit proposed procedures for cleaning, surface preparation, and paint application that describe in detail methods to be used to protect adjacent property and structures from residues. Do not proceed with cleaning, surface preparation, or painting until proposed procedures are accepted by ENGINEER.

3.4 MATERIALS PREPARATION

A. General: Mix and prepare painting products in strict accordance with paint manufacturer's product data sheets.

3.5 APPLICATION

A. General:
   1. Apply paint systems by brush, roller, or airless spray per paint manufacturer's recommendations and in compliance with Paint Application Specifications No. 1 in SSPC Volume 2, where applicable, and in strict accordance with paint manufacturer's product data sheets.
   2. Surfaces of items not normally exposed-to-view do not require same color as other components of system of which they are a part, but require same painting system specified for exposed surfaces of system.
   3. Paint interior surfaces of ducts, where visible through registers or grilles, with a flat, non-specular black paint before final installation of registers or grilles.
   4. Paint backs of access panels and removable or hinged covers to match exposed surfaces.
   5. Omit field-applied primer on metal surfaces that have been primed in the shop. Touch-up paint to shop-primed coats and pre-finished items only when approved by ENGINEER using compatible primers and paint manufacturer’s recommended compatible field-applied finishes.

6. Welds shall be stripe-coated with intermediate or finish coat of paint after application of prime coat.

B. Minimum/Maximum Paint Film Thickness: Comply with manufacturer's published recommendations for coating type and surface.

C. Scheduling Surface Preparation and Painting: Comply with manufacturer's published recommendations for coating type and surface.

D. Prime Coats: Recoat primed and sealed walls and ceilings where there is evidence of suction spots or unsealed areas in first coat, to result in a finish coat with no burn-through or other defects caused by insufficient sealing.

E. Pigmented (Opaque) Finishes: Completely cover to provide an opaque, smooth surface of uniform finish, color, appearance, and coverage.

F. Brush Application:
   1. Brush-out and work all brush coats onto the surfaces in an even film. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections are unacceptable. Neatly draw all glass and color break lines.
   2. Brush-apply all primer or first coats, unless otherwise allowed to use mechanical applicators.

G. Mechanical Applicators:
   1. Use mechanical methods for applying paint when allowed by applicable ordinances, paint manufacturer, and approved by ENGINEER.
   2. Limit roller applications, if approved by ENGINEER, to interior wall finishes for second and third coats. Apply each roller coat to provide equivalent hiding as brush-applied coats.
   3. Where spray application is used, apply each coat to provide equivalent hiding of brush-applied coats. Do not double back with spray equipment for purpose of building up film thickness of two coats in one pass.

H. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint Work not in compliance with specified requirements as required by ENGINEER.

3.6 FIELD QUALITY CONTROL

A. Notify ENGINEER after completing each coat of paint. After inspection and checking of film thickness, holidays, and imperfections, and after acceptance by ENGINEER, proceed with succeeding coat. Provide testing instruments specified in Article 2.4 of this Section for testing by CONTRACTOR. Testing instruments shall become property of OWNER.

1. ENGINEER will witness all testing and shall be notified of scheduled testing at least twenty-four hours in advance.
2. Apply additional coats, if required, to produce specified film thickness and to correct holidays and to completely fill all surface air holes.

B. Record time, location, number of coats, dry film thickness, holidays, and other imperfections and submit results to ENGINEER.

3.7 PROTECTION

A. Provide "Wet Paint" signs as required to protect newly painted finishes. After completing painting Work, remove temporary protective wrappings provided for protection of the Work.

3.8 ADJUSTMENT AND CLEAN-UP

A. Correct damage to work of other trades by cleaning, repairing or replacing, and repainting, as acceptable to ENGINEER.

B. During progress of the Work, remove from Site all discarded paint products, rubbish, cans, and rags at end of each workday.

C. Upon completion of painting, clean paint-spattered surfaces. Remove spattered paint by proper methods of washing and scraping, using care not to scratch or otherwise damage finished surfaces.

D. At completion of Work of other trades, touch-up and restore all damaged or defaced painted surfaces as determined by ENGINEER.

+ + END OF SECTION + +

SECTION 10 14 00

SIGNAGE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, tools, equipment, and incidentals as shown, specified, and required to furnish and install signage.
      a. CONTRACTOR shall be responsible for all signage furnished under this Section for the entire Project in accordance with the Contract Documents.
   2. Extent of signage is shown and specified.
   3. Types of products required include the following:
      d. Pipe markers, tags, and equipment nameplates.
      j. Stainless steel fasteners, supports, very-high-bond high-performance mounting tape, primers and other accessories.

B. Coordination:
   1. Coordinate adhesives and fasteners with mounting surfaces. Review other Sections to ensure compatibility of signage mounting accessories with various surfaces on which signage will be installed.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before signage Work.

C. Related Sections:
   1. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. AA DSA-45, Designation System for Aluminum Finishes.
   2. ASME A13.1 Scheme for the Identification of Piping Systems.
   3. ANSI/ICC A117.1, Accessible and Usable Buildings and Facilities.
   4. ANSI Z535.1, Marking Physical Hazards Safety Color Code.
   5. ANSI Z535.2, Environmental and Facility Safety Signs.
   6. ANSI Z535.3, Criteria for Safety Symbols.
   7. ASTM B26/B26M, Specification for Aluminum-Alloy Sand Castings.
   8. ASTM B584, Specification for Copper Alloy Sand Castings for General Applications.
   9. ASTM E527, Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS).

10. CDA, Properties of Cast Copper Alloys.
11. NFPA 704, System for the Identification of the Hazards of Materials for Emergency Response.
12. UL 924, Safety of Emergency Lighting and Power Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Signage Manufacturers:
      a. Engage firms specializing in producing types of products specified, in compliance with the Contract Documents, with documented record of successful in-service performance, and that possess sufficient production capacity to avoid delaying the Work.
      b. Submit to ENGINEER name and experience record of manufacturers.

B. Component Supply and Compatibility:
   1. Obtain each separate type of signage from a single Supplier and from a single manufacturer.

C. Regulatory Requirements: Comply with applicable requirements of the following:
   1. OSHA, 29 CFR Part 1910.1200, Hazard Communication Standard.
   2. OSHA, 29 CFR Part 1910, Subpart Z, Toxic and Hazardous Substances.
   3. OSHA, 29 CFR Part 1910.144, Safety Color Code for Marking Physical Hazards.
   4. OSHA, 29 CFR Part 1910. 145, Specification for Accident Prevention Signs and Tags.
   5. United States Access Board, Americans with Disabilities Act (ADA) and Architectural Barriers Act (ABA) Accessibility Guidelines.
   6. Americans with Disabilities Act (ADA), Public Law 101-36, 28 CFR Part 36, Appendix A, Accessibility Guidelines for Buildings and Facilities (ADAAG), relative to characters and symbols contrast only.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of all signage required for the Work, indicating signage type location, and other information to demonstrate compliance with the Contract Documents.
      b. Fabrication and erection information for each type of signage
      c. Valve schedule for small-diameter valves, in accordance with this Section.
      d Mounting and Installation Data:
         1) Drawings of and information on anchorages and accessory items.
         2) Submit location template drawings for items supported or anchored to permanent construction.

3) Coordinate mounting position, method, and proposed mounting accessories and fasteners with actual Project conditions. Indicate required mounting accessories on plan drawings showing locations of required exit signs based on measurements taken at the Site. Show final location and identify type of mounting surface for each exit sign. Coordinate location of exit signs for non-interference with other Work and as required by authorities having jurisdiction.

2. Product Data:
   a. Copies of manufacturer's technical data, including catalog information and specifications, for each product specified.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. Templates for anchorages to be installed in concrete or masonry.
      b. Manufacturer's instructions and recommendations for support and foundations of signs installed outdoors.

C. Closeout Submittals: Submit the following:
   1. Warranty Documentation:
      a. General and special warranties required under this Section.

D. Maintenance Material Submittals: Submit the following:
   1. Extra Stock Materials:
      a. Furnish extra stock materials from the same manufactured lot as the materials installed.
      b. Submit documentation of actual quantities of signage installed for the Project and calculations indicating the required quantity of extra stock materials.
      c. Furnish the following spare parts and accessories:
         1) For every 20 of each type (snap-on, strap-on, adhesive type) of pipe markers installed:
            a) One complete mounting assembly.
         2) For every 20 equipment nameplates installed:
            a) One complete nameplate mounting assembly.
         3) For every 20 valve tags and pipe tags installed:
            a) One stainless steel cable and splice.

1.5 WARRANTY

A. General Warranty: The special warranty specified for each type of sign in this Article shall not deprive OWNER of other rights or remedies OWNER may otherwise have under the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by CONTRACTOR under the Contract Documents. The obligations of CONTRACTOR under the Contract Documents shall not be limited in any way by the provisions of the specified special warranty.

B. Special Warranty on Products:
   1. Provide each signage manufacturer's written warranty, running to the benefit of OWNER, agreeing to correct, or at option of OWNER, remove or replace materials specified in this Section found to be defective during a period of five years after the date of Substantial Completion.
   2. Special warranty shall cover defective Work that includes, but is not limited to, the following:
      a. Deterioration of metal and polymer finishes beyond normal weathering.
      b. Deterioration of embedded graphic image colors and sign lamination.

PART 2 – PRODUCTS

2.1 SYSTEM PERFORMANCE

A. General:
   1. Details shown or indicated for signage, such as alpha-numeric and text type representation, letter spacing, designs of borders, and other graphic features, are generic and intended only to establish text, general positions, and symbols.
   2. Colors shall be brilliant, distinctive shades, matching the safety colors specified in ANSI Z535.1 and OSHA 1910.144.
   4. Accident prevention signs and tags shall comply with OSHA 1910.145.
   5. Health, safety, and warning signs shall comply with ANSI Z535.1, ANSI Z535.2, ANSI Z535.3, OSHA 1910.144, and 1910.145, unless otherwise shown or indicated. Colors shall be as indicated in Table 1 of ANSI Z535.1. In addition to text, safety symbol pictograms shall be incorporated into each sign.

2.2 PHOTO-LUMNINESCENT EXIT SIGNS

A. Products and Manufacturers: Provide one of the following:
   1. Series 90.8924 Photoluminescent Exit Signs by EverGlow NA, Inc.
   2. Series 2002 by Active Safety Corporation.
   3. Or approved equal.

B. Photo-luminescent Exit Signs:
   1. Provide photo-luminescent exit signs with single- and double-face dimensions of nine inches by 14.25 inches by 3/4-inch deep.
   2. Sign housing shall consist of an AA-A42 color anodized extruded aluminum frame and legend protected by a temper-resistant polycarbonate shield.
   3. Size, graphics, and background colors of sign legend shall comply with Laws and Regulations.
   4. Sign Letters and Directional Arrows. Furnish signs with photo-luminescent luminous letters and directional arrows.

5. Signs shall comply with UL 924 and be constructed for 15-year service life each.
6. Rated Viewing Distance: 75 feet.
7. Provide manufacturer's standard universal mounting brackets, extended wall and ceiling mounting brackets, pendant mounting brackets, and recessed mounting brackets as required by mounting surface and exiting conditions, or as shown.

2.3 PANEL SIGNS – ROOM IDENTIFICATION, INFORMATION, ENTRY, AND DIRECTIONAL

A. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast MP and FG ADA System and Custom Design ADA Series, by Best Sign Systems, Inc.
   2. Blast Etched Fiberglass and Blast Etched Melamine Signs, by **Visigraph** Corporation.
   3. Or approved equal.

B. Panel Signs – Room Identification, Information, Entry, and Directional:
   1. Product Description: Provide unframed signs, surface-etched, 1/32-inch raised tactile lettering and pictograms, sandblasted on an opaque sheet.
   2. Materials:
      a. Interior Signs: Three-ply, self-extinguishing melamine plastic.
      b. Exterior Signs: One-piece fiberglass.
   3. Size and Thickness: 0.125-inch thick; eight inches by eight inches with 1/2-inch radiused corners.
   4. Graphics and Text: White, Standard Helvetica Medium characters and matching arrow type-face; upper and lower case letters, one-inch high capitals and, in addition, Grade 2 Braille alphabet for room designation, directional, entry, and information signs.

   5. Colors and Contrast: Background of signs shall be eggshell, matte, or other non-glare finish. Characters and symbols shall contrast by at least 70 percent with their background as determined by ADA formula in ADAAG Appendix A4.30.5.

2.4 PANEL SIGNS – HEALTH, SAFETY, WARNING, FLOOR LOADING, AND FIRE EXTINGUISHER LOCATION

A. Product Description: Provide rigid fiberglass reinforced plastic signs with fade-resistant embedded graphics.

B. Products and Manufacturers: Provide one of the following:
   1. Graphic Blast Word and Picture Series, by Best Sign Systems, Inc.
   2. Blast Etched Fiberglass Signs, by Visigraph Corporation.
   3. Or equal.

C. General:
   1. Size and Thickness: 0.125-inch thick; 10 inches by 14 inches, unless otherwise shown or indicated.
   2. Graphics and Text: Standard Helvetica Medium characters and matching arrow type-face; upper and lower case, one-inch high capitals.
   3. Exposure: As recommended by sign manufacturer for both indoor and outdoor use and with an upper service temperature limit of 190degrees F. Average durability for outdoor use shall be 15 years.

D. Safety Instruction Signs: Standard color of sign background shall be white; panel shall be green with white letters and numbers. Letters and numbers used against white background shall be black.

E. Caution Signs: Standard color of sign background shall be yellow; panel shall be black with yellow letters and numbers.

F. Danger Signs: Standard color of sign background shall be white; panel shall be black with red insert with white letters and numbers. Letters and numbers used against white background shall be black.

G. Warning Signs: Standard color of sign background shall be orange; panel shall be black with orange insert with black letters and numbers. Letters and numbers used against orange background shall be black.

H. No Smoking Signs: Standard color of sign background shall be white. Letters and numbers used against white background shall be red.

I. Biohazard Signs: Standard color of sign background shall be white; panel shall be black with white letters. Sign shall include red international biohazard pictogram on white background.

J. Floor Loading Signs: Standard color of sign background shall be white; panel shall be blue with white letters and numbers. Letters and numbers used against white background shall be black.

K. Fire Extinguisher Location Signs (surface-mounted units only): Standard color of sign background shall be red with white letters and numbers. Each sign shall include international fire extinguisher pictogram and directional arrow indicating location of fire extinguisher.

L. Auxiliary Products:
   1. Mounting Brackets: Provide sign manufacturer's standard mounting brackets for installing projected or double-sided signs.

2.5 PIPE MARKERS

A. Description:
   1. Provide pipe markers for each pipeline provided under the Contract, and for other piping indicated to receive pipe markers.

B. Products and Manufacturers: Provide one of the following:
   1. Custom High Performance Pipe Markers (B-689), and SnapOn and StrapOn Pipe Markers (B-915), by Brady Worldwide, Inc., Signmark Division.
   2. Custom Ultra-Mark High Performance Pipe Markers, by Seton Identification Products, a Tricor Direct Company.
   3. Or equal.

C. Pipe Markers:
   1. Lettering of Titles/Legend and Color Field Size:
      a. Letter size and color field length shall be as indicated in Table 10 14 00-A of this Section:

TABLE 10 14 00-A, PIPE MARKERS: SIZE OF TEXT AND COLOR FIELD

Outside Diameter of Pipeline or Covering* (inches)	Size of Text (Legend Characters)	Minimum Length of Color Field**
3/4 to 1.25	1/2-inch	8 inches
1.5 to 1-7/8	3/4-inch	8 inches
2 to 5-7/8	1.25-inch	12 inches
6 to 9-7/8	2.5-inch	24 inches
10 and Larger	3.5-inch	32 inches
*Outside diameter includes pipe diameter plus insulation and jacketing. **Length of sign and color field shall be as required to accommodate required legend, and shall not be less than minimum length indicated unless required otherwise by space constraints.		

      b. Text and symbols shall be Standard Helvetica Medium, all upper case. Pipe markers shall include text with separate arrow signs indicating direction of flow of pipeline contents. Pipe markers with arrows shall be located as specified in Part 3 of this Section.
      c. Pipe markers indicating pipeline contents shall identify pipeline contents by complete name, as indicated in Table 10 14 00-B of this Section. Obtain from ENGINEER interpretation of required pipe marker text for pipelines provided under the Project that are not listed in Table 10 14 00-B of this Section.
   2. Pipe Marker Materials:
      a. General: The following are applicable to all types of pipe markers furnished under this Section:

1) Provide pipe markers with ultraviolet light-resistant, sealed, subsurface color graphics, recommended by sign manufacturer, suitable for both indoor and outdoor use.
2) Pipe markers shall be resistant to abrasion, chemical reagents, and physical agitation such as washdowns and wind.
3) Provide manufacturer's full selection of standard and custom sizes and graphics.
4) Where manufacturer has established minimum order quantities for custom units provide minimum order quantities at no additional cost to OWNER.

b. Materials: Provide the following at CONTRACTOR's option, suitable for outside diameter of the associated pipe and pipe covering:
1) Adhesive, Wrap-Around Pipe Markers: Adhesive pipe markers shall be coiled construction, 0.006-inch total thickness, PVF over laminated polyester, with peel-off backing. Suitable for for service temperature ranging from -40 degrees F to 230 degrees F.
2) Snap-on Pipe Markers: Snap-on pipe markers shall be cylindrically coiled, printed plastic sheets. Pipe marker total thickness for pipe and pipe covering from 3/4-inch to 2-3/8-inch outside diameter shall be not less than 0.020-inch. Pipe marker total thickness for pipe and pipe covering from 2.5-inch through six-inch ourside diameter shall be not less than 0.030-inch. Suitable for service temperature ranging from -40 degrees F to 180 degrees F.
3) Strap-on Pipe Markers: Provide strap-on pipe markers where pipe diameter is large enough to preclude overlap of pipe marker material around the circumference of the pipe. Strap-on pipe markers shall be flat, printed plastic sheets, not less than 0.020-inch total thickness, constructed to be attached to the pipe with bands. Suitable for service temperature ranging from -40 degrees F to 180 degrees F. Provide each pipe marker with two 1/4-inch wide band straps of nylon, plastic, or stainless steel, lengths as required by circumference of pipe and pipe covering. Provide manufacturer's recommended banding tools for banding.

3. Legend for Pipe Markers: Pipe markers shall have the text or abbreviations in the color combinations indicated in Table 10 14 00-B of this Section to identify the pipeline service hazard. Pipe marker colors shall comply with ASME A13.1, unless otherewise indicated.

TABLE 10 14 00-B,
SCHEDULE OF PIPE MARKERS*

Pipeline Legend	Lettering/Text Color	Background Color
WATER		
Domestic Hot Water	Black	Yellow
Engine Cooling Water	White	Green
Plant Water	White	Green

TABLE 10 14 00-B, SCHEDULE OF PIPE MARKERS*		
Pipeline Legend	**Lettering/Text Color**	**Background Color**
PROCESS		
Sludge	Black	Orange

2.6 EQUIPMENT NAMEPLATES

A. Description:
   1. Provide equipment nameplate for each equipment item furnished under the Contract, and for other equipment items indicated to receive nameplates. Equipment nameplates specified in this Article are in addition to equipment manufacturer's standard nameplate with manufacturer name, model number, serial number, and similar information.
   2. Install equipment nameplates as indicated in Part 3 of this Section. Mechanically fasten equipment nameplates to the associated equipment item.

B. Products and Manufacturers: Provide one of the following:
   1. Stainless Steel (HEET) Tags (B-748) custom engraved, by Brady Worldwide, Inc.
   2. Custom Engraved Stainless Steel Nameplates, by Seton Identification Products, a Tricor Direct Company
   3. Or equal.

C. Equipment Nameplates:
   1. Material: Type 304 or Type 316 stainless steel, 26-gage, with rounded corners. Suitable for temperatures ranging from -40 to 89 degrees C.
   2. Provide each equipment nameplate with not less than two holes, each approximately 3/16-inch diameter, for mechanically fastening nameplate to the associated equipment. Provide appropriate stainless steel fasteners.
   3. Nameplate Size:
      a. Size shall be as required for required text, and shall be not less than one-inch by four inches.
   4. Text Engraved on Nameplates:
      a. Text Size: Equipment nameplate titles shall have text as large as possible to fit on nameplate; text shall be not less than 1/2-inch high. All text on a given nameplate shall be one size.
      b. Text and symbols shall be Standard Helvetica Medium, all upper-case.
      c. Left-justify multiple lines of text
      d. Where more than one item of the same type of equipment is furnished, consecutively number each associated equipment nameplates as shown or indicated; for example "Pump No. 1", "Pump No. 2", "Pump No. 3", and so on.
   5. Legend for Nameplates:

a. Nameplates for equipment, including operating stands for valves and gates, shall be in accordance with the required text and colors indicated in Table 10 14 00-C.
b. Obtain interpretation from ENGINEER for equipment not included in Table 10 14 00-C.

TABLE 10 14 00-C, SCHEDULE OF EQUIPMENT NAMEPLATES*			
Legend		**Color**	
First Line	**Second Line**	**Lettering/Text**	**Background**
Rock Trap	FOG- RTP-001		
Grinder	FOG- GRD-001		
Unloading/Mixing Pump No. 1	FOG- PMP-011		
Unloading/Mixing Pump No. 2	FOG- PMP-012		
FOG Receiving Tank	FOG- TNK-001		
Activated Carbon Drum	FOG- ACD-001		
Metering Pump No. 1	FOG- PMP-021		
Metering Pump No. 2	FOG- PMP-022		
Flow Meter	FOG- FMT-001		

D. Operating Stands for Valves and Gates:
1. Nameplate material, size, and text requirements are the same as indicated above for other equipment nameplates.
2. Operating stands for valves and gates shall carry the respective legends “V. No. ___” or “S.G. No. ___,” with the appropriate equipment number to be indicated by ENGINEER.
3. Background and text color of nameplates for valve and gate operators shall be the same colors specified above for other equipment nameplates.

2.7 VALVE AND PIPELINE TAGS

A. Products and Manufacturers: Provide one of the following:
1. Custom Engraved Stainless Steel Valve Tags, by Brady Worldwide, Inc.
2. Custom Stainless Steel Valve Tags, by Seton Identification Products, a Tricor Direct Company
3. Or equal.

B. Metal Tags:
   1. For each valve and for pipelines smaller than 3/4-inch outside diameter, provide permanently-legible, round metal tags, each two-inch diameter, Type 304 or Type 316 stainless steel, with engraved lettering filled with black enamel. Provide tags with 3/16-inch diameter hole located that does not interfere with legend.
   2. Legend for Valve Tags:
      a. Based on information provided on the Drawings, submit to ENGINEER not less than 14 days before system startup, a valve schedule indicating all required valves.
      b. For each valve, the valve schedule shall indicate: location, valve type, valve number, words to identify valve's function, type of operator, and normal operating position.
      c. Information presented in the valve schedules shall be coded on tags in a system provided by or acceptable to OWNER. Each valve shall be coded and identified by ENGINEER utilizing a combination of up to twelve letters and numbers.
   3. Legend for Small Pipeline Tags: Comply with requirements for pipe markers relative to legend. Where legend is not indicated, obtain interpretation from ENGINEER.
   4. Miscellaneous Valve and Small Pipeline Tag Accessories:
      a. Stainless Steel Wire: Nylon-coated; 0.048-inch outside diameter.
      b. Clamps: Brass.
      c. Lead Seals: Monel; four ply, 0.014-inch by 10 inches long; for attaching tags.
      d. Hand Sealing Press: As recommended by tag manufacturer for crimping lead seals.

2.15 FABRICATION

A. Shop Assembly:
   1. Fabricate and preassemble items in the shop to the greatest extent possible.
   2. Disassemble units only to extent necessary for shipping and handling limitations.
   3. Clearly mark units for reassembly and coordinated installation.

2.16 SOURCE QUALITY CONTROL

A. Fabrication Tolerances:
   1. Produce smooth, even, level sign panel surfaces, constructed to remain flat under installed conditions within tolerance of plus or minus 1/16-inch measured diagonally across each sign.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine substrates and conditions under which signage will be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Location:
      a. Install signage and appurtenances at the locations shown or indicated. When locations are not shown or indicated, install signage at locations directed by ENGINEER.
      b. Provide exit signs at locations shown or indicated. Surface-mount signs above each point of egress, unless otherwise shown or indicated.
      c. Lightly mark and locate position of each sign. Obtain ENGINEER's acceptance of marked locations before mounting.
   2. Installation – General:
      a. Install signs level, plumb, and at proper height.
      b. Signage shall be securely mounted with concealed, very-high-bond acrylic foam tape, specified adhesives, or mechanical fasteners where specified. Attach signs to surfaces in accordance with sign manufacturer's instructions, unless otherwise shown or indicated.
      c. Provide very-high-bond acrylic foam tape on back of signage using a full perimeter of specified tape. Leave no gaps in tape perimeter at back of signage; peel off second release liner and press onto surfaces.
   3. Repair or replace damaged units.

B. Panel Signs – Room Identification, Directional, and Information Signs:
   1. Where permanent identification is provided for rooms and spaces, install signs on the wall adjacent to the latch side of the door.
   2. Where there is no wall space on the latch side of the door, including at double leaf doors, install signs on the nearest adjacent wall.
   3. Mounting height shall be in accordance with ADA-ABA Accessibility Guidelines in areas accessible to disabled people. For other areas install signs with five feethes from the finished floor to centerline of sign. Mount such signage so that a person may approach within three inches of the sign without encountering protruding objects or, when reading sign, be forced to stand within the swing of a door.

C. Pipe Markers, Equipment Nameplates, and Pipe and Valve Tags:
   1. Location of Pipe Markers and Pipe Tags:

a. Provide pipe markers with text (pipeline contents or service) and adjacent arrow indicating the direction of flow of pipeline contents on each piping system provided under the Project and other piping systems shown or indicated as to receive pipe markers.
b. Locations: Provide pipe markers at each of the following locations:
   1) At intervals of not more than 30 linear feet apart
   2) Directly adjacent to each side of each penetration by the pipeline of the following: wall, floor, ceiling, roof.
   3) Adjacent to each change in flow direction.
   4) On each branch where pipes connect together including but not limited to tees, wyes, and crosses.
   5) Adjacent to each side of each valve (including but not limited to check valves, isolation valves, control valves, and other valves), strainer cleanouts, and each equipment item along the pipeline.
   6) Comply with ASME A13.1.
c. Provide flow-direction arrows at intervals not greater than 15 linear feet. Where flow may be bi-directional, provide arrows adjacent to each other to indicate both directions.
d. Pipe marker locations will be determined by ENGINEER, but in general place pipe markers where personnel view of label is unobstructed. When pipeline is overhead, install label on the two lower quarters of the pipe or pipe covering. Pipe markers shall be clearly visible from personnel operating positions, especially operating positions adjacent to valves and equipment.
e. Provide pipe tags, where specified, at locations as specified for pipe markers.

2. Location of Valve Tags and Valve Nameplates:
   a. Valve nampeplates and valve signs for large valves shall be located on or adjacent to the valve.
   b. For smaller valves, attach tags to valve bonnet or valve flange bolts.
   c. For valves to receive equipment nameplates, as specified in this Section, install nameplate as requied for other equipment nameplates.
   d. Do not attach tags, nameplates, or signs to valve handwheels or other valve actuators.
3. Equipment Nameplates:
   a. Locate nameplates on equipment bases and on structures at readily-visible elevation in such positions relative to the equipment and structures as to prevent damage to nameplate.
   b. Position nameplace for ease of reading by operations and maintenance personnel.

D. Panel Signs – Right-To-Know Signs, Labels, and Tags:
1. Locate tags at intervals of not more than 20 feet center-to-center along chemical pipelines and fill pipelines and on each side of locations where pipelines emerge from penetrations with other materials.

2. Install tank signs on each tank shown or indicated to receive signage at quarter-points on tank circumference, five feet above finished floor.

3.3 PROTECTION AND CLEANING

A. After installation, clean soiled signage surfaces in accordance with manufacturer's written instructions.

B. Protect signage from damage until completion of the Work.

+ + END OF SECTION + +

SECTION 26 05 05

GENERAL PROVISIONS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, incidentals, testing, troubleshooting, and training as shown, specified, and required to provide complete and operable electrical work.
   2. Obtain written permission from OWNER prior to de-energization of any electrical power on the plant site.

B. Coordination:
   1. Review installation procedures and schedules under other Specification Sections and coordinate with other trades the installation of electrical items that will be installed with or within formwork, walls, partitions, ceilings, and panels.

C. General:
   1. Interpretation of Drawings:
      a. Dimensions shown on the Drawings that are related to equipment are based on the equipment of one manufacturer. Conform the dimensions of the equipment furnished to the space allocated for that equipment.
      b. The Drawings show the principal elements of the electrical Work. They are not intended as detailed working drawings for the electrical Work, but as a complement to the Specifications to clarify the principal features of the electrical systems.
      c. It is the intent of the Drawings and Specifications that all equipment and devices, furnished and installed under this Contract, be properly connected and interconnected with other equipment and devices so as to render the installations complete for successful operation, regardless of whether all the connections and interconnections are specifically mentioned in the Specifications or shown on the Drawings.
      d. It is the intent of the Drawings and Specifications that similar products be provided by the same manufacturer for uniformity on the Project.

D. Area Classifications:
   1. Dry Locations: Materials, equipment, and incidentals in these locations shall meet NEC and NEMA requirements for dry locations. Conduit systems shall be as specified in Section 26 05 33.13, Rigid Conduit. Enclosures, pullboxes, and terminal boxes shall be NEMA 12, unless noted otherwise.
   2. Wet/Corrosive Locations: Materials, equipment, and incidentals in these locations shall meet NEC and NEMA requirements for wet locations.

Conduit systems shall be as specified in Section 26 05 33.13, Rigid Conduit. Enclosures, pull boxes, and terminal boxes shall be NEMA 4X Type 316 Stainless Steel, unless noted otherwise.

E. Area Classification Table:

DRY LOCATIONS:
Electrical Rooms
WET / CORROSIVE LOCATIONS:
All outdoor locations (above and below grade)

1.2 QUALITY ASSURANCE

A. Qualifications:
1. CONTRACTOR shall have a master electrician in his/her employment with a license that was issued by the Texas Department of Licensing and Regulation (TDLR). Name and license number of licensee shall be verifiable on the TDLR website.
2. CONTRACTOR shall have a minimum of five years continuous experience in the following:
   a. Low voltage (600V and below) electrical distribution.
3. Provide a list of three projects of size and scope similar to this project with name and telephone number of client contact if requested by the OWNER or ENGINEER.
4. CONTRACTOR shall have a journeyman electrician on the project site at all times while any electrical work is taking place. This includes unloading of equipment and materials. Journeyman license shall be issued by the Texas Department of Licensing and Regulation (TDLR). Name and license shall be verifiable on the TDLR website.
5. Work performed in this project shall conform with the latest applicable provisions and requirements of the following:
   a. NFPA 70 - National Electrical Code (NEC).
   b. National Electrical Safety Code (NESC).
   c. NFPA 70E - Standard for Electrical Safety in the Workplace.

B. Component Supply and Compatibility:
1. Materials and equipment similar to each other shall be from the same manufacturer for uniformity.

C. Regulatory Requirements:
1. Permits: Refer to the General Conditions, Supplementary Conditions, and other parts of the Contract Documents for responsibilities relative to obtaining and paying for permits, licenses, and inspection fees.

D. Existing Conditions:
   1. CONTRACTOR shall visit project site and make themselves aware of all existing conditions prior to submitting his/her bid.

1.3 SUBMITTALS

A. General:
   1. Submit Shop Drawings and other CONTRACTOR submittals for each Specification Section in accordance with the requirements listed in Section 01 33 00, Submittal Procedures.
   2. To the extent practical, submit Shop Drawings and other CONTRACTOR submittals for each Specification Section into the smallest number of submittals possible. Do not furnish partial submittals.
   3. Review of equipment submittals does not relieve CONTRACTOR of responsibility for providing complete and successfully operating systems.

B. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Internal wiring diagram and drawings indicating all connections to components and numbered terminals for external connections.
      b. Dimensioned plan, section, elevations, and panel layouts showing means for mounting, conduit connection, and grounding.
      c. List of components including manufacturer’s name and catalog number (or part number) for each.
      d. Point-to point interconnection wiring diagrams.
   2. Product Data:
      a. Manufacturer's name and product designation or catalog number.
      b. Electrical ratings.
      c. Manufacturer’s technical data and specifications.
      d. Manufacturer’s indication of compliance with applicable reference standards.
      e. Painting and coating systems proposed.
   3. Test Procedures: Proposed testing procedures and testing limitations for source quality control testing and field quality control testing.

C. Informational Submittals: Submit the following:
   1. Manufacturer’s Instructions:
      a. Installation data and instructions.
      b. Instructions for handling, starting-up, and troubleshooting.
   2. Field Quality Control Submittals:
      a. Report documenting results of required field testing.
   3. Qualifications:
      a. Electrical Contractor.

D. Closeout Submittals: Submit the following:
   1. Record Documentation:
      a. System Record Drawings: Include the following:

1) One-line wiring diagram of the electrical distribution system.
2) Actual, in-place conduit and cable layouts with schedule of conduit sizes and number, and size of conductors.
3) Layouts of the power and lighting arrangements and the grounding system.
4) Control schematic diagrams, with terminal numbers and control devices identified, for all equipment.

PART 2 – PRODUCTS

A. Refer to individual Division 26 equipment specifications.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which Work will be performed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install materials and equipment in accordance with the Contract Documents, Laws and Regulations, approved (and accepted, as applicable) Shop Drawings and other CONTRACTOR submittals, and manufacturer's recommendations.
   2. Provide tools and equipment required to trace circuits necessary for proper execution of the Work.
   3. Define and identify all wiring, circuit terminations, and equipment to be modified to ensure proper interface of components. The Contract Price includes all costs associated with field services specified for a complete and functional system.

B. Staging, Sequencing, and Coordination with Existing Facilities:
   1. Schedule, sequence, and install materials and equipment in accordance with Section 01 14 16, Coordination with Owner's Operations
   2. Perform the Work in a manner that will not interfere with the existing equipment and facilities or cause interruption of the functions of the Site, unless specified otherwise or otherwise allowed by OWNER.
   3. When operation of existing facilities and Site is disrupted due to CONTRACTOR's operations, comply with Section 01 14 16, Coordination with Owner's Operations, unless otherwise allowed by OWNER.
   4. Where the Work ties in with existing installations, take precautions and provide safeguards in connecting the Work to existing operating circuits to prevent

interruption to existing circuits. Connection of Work to existing circuits shall be performed in the presence of OWNER and ENGINEER.

5. Interruptions of existing circuits, not addressed in Section 01 14 16, Coordination with Owner's Operations, shall be coordinated with the OWNER who will determine the length of time a circuit may be de-energized to maintain the OWNER's processes in dependable and safe operation.

3.3 FIELD QUALITY CONTROL

A. Field Quality Control – General:
   1. Perform field quality control for electrical Work in accordance with the Contract Documents.

B. Site Tests:
   1. Prior to requesting certificate of Substantial Completion, demonstrate to ENGINEER that electrical systems and electrically-operated equipment installed or modified under the Contract operates in accordance with the Contract Documents and operates as required
   2. Perform the following operational tests on electrical systems:
      a. Operate power circuits to verify proper operation and connection to electrical systems materials and equipment, including mechanical key-interlocks for circuit breakers.
      b. Operate control circuits, including pushbuttons, indicating lights, and similar devices, to verify proper connection and function. Operate all devices, such as pressure switches, flow switches, and similar devices, to verify that shutdowns and control sequences operate as required.
      c. Operate lighting systems and receptacle devices to verify proper operation and connections.
   3. Prepare and submit report on the equipment demonstration and operating field quality control tests. Report shall include complete information on the tests performed and results. Report shall state all tested equipment / circuits have passed the tests and are ready to be placed into operation. The reports shall be signed and dated by the responsible testing supervisor.

C. Manufacturer's Services:
   1. Furnish qualified, factory-trained representative(s) of equipment manufacturers at the Site for the services indicated in the Contract Documents.

D. Field Adjustments:
   1. Protective device settings shall be adjusted at the Site by factory-trained representative(s) of the equipment manufacturer, in accordance with the final settings determined by the power system study.

+ + END OF SECTION + +

[THIS PAGE IS LEFT BLANK INTENTIONALLY]

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install low-voltage conductors and cabling as shown on the Drawings.

B. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ASTM B3 - Specification for Soft or Annealed Copper Wire.
   3. ASTM B8 - Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   4. ASTM D3485 - Specification for Smooth-Wall Coilable Polyethylene (PE) Conduit (Duct) for Preassembled Wire and Cable.
   5. ASTM F2160 - Solid Wall High Density Polyethylene (HDPE) Conduit Based on Controlled Outside Diameter (OD).
   6. NEMA TC 7 - Smooth Wall Coilable Electrical Polyethylene Conduit.
   7. UL 44 - Thermoset-Insulated Wires and Cables.
   8. UL 1277 - Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 300, Wiring Methods.
   2. NEC Article 310, Conductors for General Wiring.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer’s literature, specifications, and engineering data for low volt cable proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Insulated Cable in Raceways:
   1. Material: Single tinned copper conductor complying with ASTM B3 and ASTM B8 with flame-retardant, moisture- and heat-resistant insulation rated for 90 degrees C in dry or wet locations, listed by UL as Type XHHW/XHHW-2 complying with UL 44.
   2. Wire Sizes: Not smaller than No. 12 AWG for power and lighting and No. 14 AWG for 120-volt control circuits.
   3. Stranding: All conductors shall be stranded.
   4. Manufacturers: Provide products of one of the following:
      a. Southwire.
      b. General Cable.
      c. Encore Wire Corporation.
      d. Or equal.

B. VFD Cable:
   1. Application: Use between low voltage (less than 600V) VFDs and their associated motors.
   2. Manufacturers: Provide products of one of the following:
      a. Southwire.
      b. ServiceWire Co.
      c. General Cable.
      d. Belden.
      e. Or equal.
   3. Description: Three tinned copper conductors insulated with 2000V XLPE insulation with three symmetrically placed ground wires cabled together and covered with 5 mil copper tape shield, wrapped with 50% overlap. PVC jacket covering tape shield. Grounding cable terminations shall be made in accordance with the manufacturer's instructions.
   4. Compliances:
      a. UL 1277 Type TC-ER, 2000V.
      b. UL File # E57179.
      c. UL Type RHH or RHW-2 conductors per UL 44.
      d. IEEE 383.
      e. IEEE 1202.
   5. Wire sizes: 12 AWG to 500 kcmil. Provide size shown on conduit schedule.
   6. Stranding: Stranded only.

C. Cable Connectors, Solderless Type:
   1. Products and Manufacturers: Provide products of one of the following:
      a. T&B Sta-Kon.

b. Burndy Hylug.
c. Or equal.

2. For wire sizes No. 4 AWG and above, use either compression type or bolted type with silver-plated contact faces.
3. For wire sizes, up to and including No. 6 AWG, use compression type. Alarm and control wire shall be terminated using forked type connectors at terminal boards.
4. For wire sizes No. 250 KCMIL and larger, use connectors with at least two cable clamping elements or compression indents and provision for at least two bolts for joining to apparatus terminal.
5. Properly size connectors to fit fastening device and wire size. Connectors shall be rated for 90 degree C, 600 volts.
6. Provide insulated mechanical connectors for wiring terminations within motor junction boxes as manufactured by Ilsco, or equal.

D. Cable Splices:
1. Products and Manufacturers:
a. Compression-Type Splices: Provide one of the following:
1) Burndy Hylink.
2) T&B Color-Keyed Compression Connectors.
3) Or equal.
b. Spring Connectors: Provide one of the following:
1) Buchanan B-Cap.
2) T&B Wire Connector.
3) Or equal.
2. For wire sizes No. 10 AWG and smaller, splices may be made up with pre-insulated spring connectors.
3. For wet locations, splices shall be waterproof. Compression type splices shall be waterproofed by sealant-filled, thick wall, heat shrinkable, thermosetting tubing or by pouring thermosetting resin into mold that surrounds the joined conductor. Spring connector splices shall be waterproofed with sealant filler.
4. Splices shall be suitably sized for cable, rated 90 degrees C, and 600 volts.

E. Wire and Cable Markers:
1. Provide wire and cable markers in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install cables complete with proper terminations at both ends. Check and correct for proper phase sequence and proper motor rotation. Use corrosion resistant, electrical contact grease for all wiring terminations, as manufactured by Sanchem NO-OX-ID or equal.

B. Pulling:
   1. Use insulating types of pulling compounds containing no mineral oil.
   2. Pulling tension shall be within limits recommended by wire and cable manufacturer.
   3. Use dynamometer where mechanical means are used.
   4. Cut off section subject to mechanical means.

C. Bending Radius: Limit to minimum of eight times cable overall diameter.

D. Slack: Provide maximum slack at all terminal points.

E. Splices:
   1. Splices are permitted for control wiring circuits only.
   2. Where possible, install cable continuous, without splice, from termination to termination.
   3. Where required, splice as shown and also where required for cable installation. Splices below grade, in manholes, handholes, and wet locations shall be waterproof and shall be approved by the OWNER/ENGINEER.
   4. Splices are not allowed in conduits.

F. Identification:
   1. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
   2. Identify power conductors by circuit number and phase at each terminal or splice location.
   3. Identify control and status wiring using numeral tagging system.

G. Color-code power cables as follows:
   1. No. 8 AWG and Smaller: Provide colored conductors.
   2. No. 6 AWG and Larger: Apply general purpose, flame retardant tape at each end, wrapped in overlapping turns to cover an area of at least two inches.
   3. Colors: Match color scheme in use at the Site. If the Site does not have an existing color scheme, use the following colors:

System	Conductor	Color
All Systems	Equipment Grounding	Green
240/120 Volts Single-Phase, Three-Wire	Grounded Neutral One Hot Leg Other Hot Leg	White Black Red
208Y/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	White Black Red Blue
240/120 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A	White Black

System	Conductor	Color
Delta, Center Tap Ground on Single-Phase	High (wild) Leg Phase C	Orange Blue
480Y/277 Volts Three-Phase, Four-Wire	Grounded Neutral Phase A Phase B Phase C	Gray Brown Orange Yellow

3.2 FIELD QUALITY CONTROL

A. Cable testing shall be performed in accordance with NETA ATS recommendations. Refer to Section 26 01 26, Electrical Testing, for complete requirements.

+ + END OF SECTION + +

[THIS PAGE LEFT BLANK INTENTIONALLY]

SECTION 26 05 23

INSTRUMENTATION CABLE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install instrumentation and communication cables.
   2. Types of cables include the following:
      a. Shielded instrumentation cables.

B. Related Sections:
   1. Section 26 05 33.13, Rigid Conduits.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. UL 13 - Power-Limited Circuit Cables.
   2. UL 1581 - Electrical Wires, Cables and Flexible Cords.
   3. UL VW-1 - Vertical Wire Flame Test.
   4. UL 910 - Safety Test for Flame-Propagation and Smoke-Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. NEC 725, Class 1, Class 2, and Class 3 Remote-Control, Signaling and Power-Limited Circuits.
   2. NEC 800, Communications Circuits.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data: Manufacturer's technical information for instrumentation cables and communications cables proposed.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals: Written report of results of field quality control testing specified in this Section.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Single Shielded Pair Instrument Cables:
   1. Manufacturers: Provide products of one of the following:
      a. Belden Company.
      b. Okonite Company.
      c. Dekoron Wire and Cable Company.
      d. Or equal.
   2. Tinned copper, XLPE-insulated, stranded conductors, not less than no. 16 AWG, twisted pair, with overall shield, stranded tinned no. 18 AWG copper drain wire and overall PVC or CPE jacket. Rated for not less than 600 volts and complying with UL 1581. Temperature rated 90 degrees C in dry locations and 75 degrees C in wet locations.
   3. Shielded pair cable uses abbreviation "TSP" on the Drawings.

B. Cable Terminals:
   1. Manufacturers: Provide products of one of the following:
      a. T&B Sta-Kon.
      b. Burndy Insulug.
      c. Or equal.
   2. Fork type copper compression terminals with nylon insulation for termination of cable at terminal blocks.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. General:
   1. Install cables complete with proper terminations at both ends.
   2. Install in conduit separate from power cables, unless shown or indicated otherwise.
   3. Ground shield on shielded cables at one end only and as recommended by instrument manufacturer.

4. Identify conductors in accordance with Section 26 05 53, Identification for Electrical Systems.
5. Install and terminate Supplier-furnished cable in accordance with equipment manufacturer requirements and cable manufacturer's recommendations.
6. Install in accordance with Laws and Regulations, including NEC.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. Test shielded instrumentation cable shields with ohmmeter for continuity along full length of cables, and for shield continuity to ground.
   2. Connect shielded instrumentation cables to calibrated 4 to 20 mA dc signal transmitter and receiver. Test at 4 and 20 mA transmitter settings.
   3. Replace with new cables the full length of cables that fail test.
   4. Test equipment shall be provided by CONTRACTOR.
   5. For testing of communications cables, test equipment used shall comply with the following:
      a. Equipment shall consist of a "master" and a "remote" unit.
      b. Test of all aspects of cables shall be automatic and initiated with a single command. Test over entire frequency range. Test unit shall be capable of accepting cable identification tag for reporting. Test unit shall return "pass/fail" status for cables and, if "fail", shall indicate reason for failure.
      c. Test unit shall be capable of storing all test results internally and printing the results later.
      d. For unshielded twisted pair cables, test unit shall be specifically designed and manufactured to certify cabling relative to Category 6 compliant.

+ + END OF SECTION + +

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install complete grounding for electrical systems, structures, and equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS - Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. ASTM B8 - Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft.
   3. UL 467 - Grounding and Bonding Equipment.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NEC Article 250, Grounding.
   2. UL Standard #467, Electrical Grounding and Bonding Equipment.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for grounding materials proposed for use.
   2. Listing of grounding connector types identifying where they are to be used.
   3. Layouts of each structure ground grid.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Tinned Bare Copper Ground Cable:
   1. Material: Soft drawn tinned bare copper stranded cable conforming with ASTM B8 and B189. Provide size as shown on the Drawings, but in no case less than No. 4 AWG.
   2. Manufacturer: Provide ground cable of one of the following:

a. Cable Corporation.
b. General Cable Corporation.
c. Or equal.

B. Ground Rods:
1. Material: Copper clad steel rod, 3/4-inch diameter, 10 feet long.
2. Manufacturer: Provide ground rods by one of the following:
a. Erico.
b. T&B Blackburn Company.
c. Or equal.

C. Grounding Connectors:
1. Material: Compression connectors shall be heavy duty copper. Bolted connectors to be copper alloy castings, designed specifically for the items to be connected, and assembled with Durium or silicone bronze bolts, nuts and washers. Welded connections to be by exothermic process utilizing molds, cartridges and hardware designed specifically for the connection to be made.
2. Product and Manufacturer: Provide grounding connectors of one of the following:
a. Pressure Connectors:
1) Burndy Hyground Corporation.
b. Welded Connections:
1) Cadweld by Erico Products, Incorporated.

PART 3 – EXECUTION

3.1 STRUCTURE GROUND SYSTEM

A. Provide complete grounding system as shown on Drawings and as specified herein.

B. Ground the neutral on the secondary of dry transformers per the following:
1. Provide a 3/4 inch x 10 foot ground rod through a 1 inch diameter cored hole in the concrete floor at the location of each dry transformer.
2. Connect the transformer neutral to the ground rod with a #4/0 ground cable.
3. Extend a #4/0 ground cable to the closest accessible cold water pipe that extends below the concrete floor and attach cable to pipe with a ground clamp.
4. Extend a #4/0 ground cable to the closest accessible steel building column and attach cable to column with an exothermic weld.
5. Bond the secondary of the dry transformer secondary neutral to the transformer ground bus and enclosure in accordance with the NEC.

C. Do not ground neutrals at points other than those stated above.

D. Weld all buried connections.

3.2 EQUIPMENT GROUNDING AND BONDING

A. Bond all electrical equipment in compliance with the National Electrical Code.

B. Connect ground conductors to conduit with copper clamps, straps or with grounding bushings.

C. Connect to piping with ground clamps. Use tinned copper bonding jumpers on gasketed joints.

D. Connect to equipment by means of lug compressed on cable end. Bolt lug to equipment frame using holes or terminals provided on equipment specifically for grounding. Do not use anchor bolts. Where grounding provisions are not included, drill suitable holes in locations designated by ENGINEER.

E. Connect to motors by bolting directly to motor frames, not to sole plates or supporting structures.

F. Connect to service water piping by means of copper clamps. Use tinned copper bonding jumpers on gasketed joints.

G. Scrape bolted surfaces clean and coat with a conductive oxide- resistant compound.

3.3 TESTING

A. Ground system testing shall be performed in accordance with NETA ATS recommendations. Refer to Section 26 01 26, Electrical Testing, for complete requirements.

+ + END OF SECTION + +

[THIS PAGE LEFT BLANK INTENTIONALLY]

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install hangers and supports for electrical systemns.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   3. Section 26 05 33.13, Rigid Conduits.

1.2 REFERENCES

A. Standards referenced in this section are:
   1. ASTM A123/A123M - Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
   2. ASTM A1011/A1011M - 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.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Detail dimensions.
   2. Bills of Materials.
   3. Manufacturer’s name, product designation, and catalog number.

B. Product Data:
   1. Copies of manufacturer’s specifications including material, dimensional and weight data, and load capacity for each supporting system component proposed.
   2. Pictorial views and corresponding identifying text of each component proposed for installation.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. B-Line.
   2. Kindorf.
   3. Unistrut.
   4. Or equal.

2.2 MATERIALS

A. Strut, Fittings, and Accessories:
   1. Unless otherwise shown or indicated, strut shall be 1-5/8 inches by 1-5/8 inches. Double struts shall be two pieces of the same strut, welded back-to-back at the factory.
   2. Provide 12-gauge Type 316 stainless steel at all locations.
   3. Provide 316 stainless steel plates, fittings, fasteners, etc

B. Hanger (all thread) Rods:
   1. Provide 316 stainless steel minimum 3/8-inch diameter.

C. Beam Clamps for Attaching Threaded Rods or Bolts to Beam Flanges for Hanging Struts or Conduit Hangers:
   1. Provide 316 stainless steel beam clamps with 316 stainless steel bolts and other fasterners.

D. Concrete Anchor Bolts:
   1. Provide 316 stainless steel minimum 3/8-inch diameter.

2.2 MANUFACTURERS

A. Provide products of one of the following:
   1. B-Line.
   2. Superstrut.
   3. Unistrut.
   3. Or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install supporting systems with all necessary channels, fittings, brackets, and related hardware for mounting and supporting equipment. Include anchor bolts, concrete anchor bolts and associated hardware for proper support of equipment. Use anti-seize compound on all threaded connections used for mechanical fastening.

B. Equipment and devices shall be installed on supporting systems as shown on the Drawings, specified, or required.

C. Install supporting devices level, parallel, and perpendicular to building walls and floors, such that the support system is installed in a neat and professional manner.

D. Holes in suspended ceilings for support rods and other equipment shall be made adjacent to bars where possible to facilitate removal of ceiling panels.

E. Installation of supporting systems shall be coordinated with equipment, cabinets, consoles, panels, enclosures, boxes, conduit, cable tray, wireway, busway, cablebus, piping, ductwork, lighting fixtures, and other systems and equipment, and located clear of interferences and access ways.

F. Mounting of Conduit:
   1. A minimum of 1/4-inch space shall be provided between conduit surfaces and abutting or near surfaces except struts, cable trays, steel beams, and columns.
   2. Conduit shall be fastened to struts, cable trays, steel beams, and columns using specified clamps and straps as shown, specified, and required.

G. Install conduit supports and fasteners per Section, 26 33 13.33, Rigid Conduits.

H. Mounting of Cabinets, Consoles, Panels, Enclosures, and Boxes:
   1. Freestanding: Unless otherwise specified or shown on the Drawings, floor mounted equipment, cabinets, consoles, panels, enclosures, and boxes shall be installed on 4-inch high concrete equipment base with a 45 degree chamfered edge. The base shall extend two inches beyond outside dimensions of equipment, all sides.
   2. Wall Mounted:
      a. A minimum 1/4-inch space shall be provided between cabinets, consoles, panels, enclosures, or boxes and the surface on which they are mounted. Non-metallic or stainless steel spacers shall be provided as required.
      b. Equipment, enclosures, panels, and boxes shall not be mounted directly to beams or columns. Struts shall first be mounted to beams or columns using beam clamps and equipment, enclosures, panels, and boxes shall be mounted to the struts.
   3. Electrical Rack:
      a. Where equipment, cabinets, consoles, panels, enclosures, or boxes cannot be wall mounted, provide an independent stand rack.
      b. Rack shall consist of struts, plates, brackets, connection fittings, braces, accessories, and hardware assembled in a rigid framework suitable for mounting of intended equipment.

c. Rack shall be equipped with brackets and bases for rigidly mounting the framework to the ceiling or floor, or equipped with beam clamps, angle plates, washers, and bolts for fastening to beam flanges.

d. When the equipment, cabinets, consoles, panels, enclosures, and boxes weigh more than 100 pounds:

1) The main vertical supports of floor stand rack assemblies shall be back-to-back struts.

2) Bracing, clamping and anchoring of each rack shall be sufficient to ensure rigidity of the rack with the intended equipment, enclosures, conduit, cable tray, busway, cablebus, or wireway installed. Racks shall not be deflected more than 1/8-inch by a 100 pound force applied at any point on the rack in any direction.

I. Drilling into beams or columns is not allowed except as authorized by ENGINEER.

J. Field Cutting:

1. Cut edges of strut and hanger rod shall have corners rounded, edges beveled and burrs removed. If field cutting the strut is required, use only clean, sharp, dedicated tools. Oil, shavings, and other residue of cuttings shall be removed prior to installation.

+ + END OF SECTION + +

SECTION 26 05 33.13

RIGID CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install conduit and fittings to form complete, coordinated, and grounded raceway systems.
   2. When specific, detailed conduit routings for various systems within buildings and other areas are not be shown on the Drawings, CONTRACTOR shall establish routings based on single-line, riser, and interconnection diagrams and other information on the Drawings. CONTRACTOR shall provide for the proper installation of conduits in each system.

B. Coordination:
   1. Conduit runs shown are diagrammatic. Coordinate conduit installation with piping, ductwork, light fixtures, and other systems and equipment and locate to avoid interferences.

C. Provide conduit types as follows:
   1. Schedule 80 PVC conduit: Underground duct banks, embedded in concrete floors/slabs of buildings, conduit turn-up/stub-up locations.
   2. Rigid Aluminum Conduit: Aboveground outdoor locations, aboveground indoor locations (exposed).
   3. PVC Coated Rigid Aluminum Conduit: Exposed conduits routed in corrosive chemical areas.

D. Related Sections:
   1. Section 26 05 29, Hangers and Supports for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI C80.5 - Standard for Rigid Electrical Aluminum Conduit.
   2. ANSI/NEMA FB1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable.
   3. NEMA TC2 - Electrical Polyvinyl Chloride (PVC) Conduit.
   4. NEMA TC3 - Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.

5. NEMA TC14 - Reinforced Thermosetting Resin Conduit (RTRC) and Fittings.
6. UL 6A - Electrical Rigid Metal Conduit – Aluminum.
7. UL 514B - Conduit, Tubing, and Cable Fittings.
8. UL 651 - Safety Schedule 40 and 80 Rigid PVC Conduit and Fittings.
9. UL 886 - Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the following:
   1. NEC Article 344, Rigid Metal Conduit.
   2. NEC Article 352, Rigid Nonmetallic Conduit.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. When requested by the ENGINEER, provide assembly details of conduit racks and other conduit support systems.
      b. When requested by the ENGINEER, provide layout drawings showing proposed routing of exposed conduits, conduits embedded in structural concrete, and conduits directly buried in the ground. Drawings shall show locations of pull and junction boxes and penetrations in walls and floors. Shop Drawings of embedded conduits shall include cross-sections showing thickness of concrete slabs and locations of conduits relative to reinforcing steel, water stops, and other features of the slab.
   2. Product Data:
      a. Manufacturer's catalog cuts and product data for conduit, fittings, and appurtenances.

B. Informational Submittals: Submit the following:
   1. Manufacturer's Instructions:
      a. When requested by ENGINEER, provide copies of manufacturer's recommendations for handling and installing products.
   2. Site Quality Control Submittals:
      a. When requested by ENGINEER, provide copies of results of specified Site quality control testing.
   3. Installer Qualifications:
      a. Provide documentation that installer has completed a training course in the installation of PVC coated conduit and has minimum 5 years of related field experience.

C. Closeout Submittals: Submit the following:
   1. Record Drawings:

a. Show actual routing of exposed and concealed conduit runs in record documents in accordance with Section 01 78 39, Project Record Documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Rigid Aluminum Conduit, Elbows, and Couplings:
   1. Material: Rigid, heavy-wall aluminum, smooth interior, tapered threads and carefully reamed ends; 3/4-inch NPS minimum size.
   2. Manufacturers: Provide products of one of the following:
      a. Allied Tube and Conduit.
      b. Wheatland Tube Company.
      c. Or approved equal.

B. PVC-coated Rigid Aluminum Conduit, Elbows, and Couplings:
   1. Material: Rigid, heavy-wall aluminum, smooth urethane interior coating, tapered threads, carefully reamed ends, 3/4-inch NPS minimum size with factory exterior coating of 40-mil thick PVC.
   2. Color: Color of coating shall be the same on all conduit and fittings.
   3. Manufacturers: Provide products of one of the following:
      a. Robroy Industries.
      b. Perma-Cote Industries.
      c. OCAL, Inc.
      d. Or equal.

C. Rigid Aluminum Conduit Fittings, and Conduit Bodies:
   1. Material and Construction: Cast aluminum bodies and covers consistent with conduit material. Units shall be threaded type with five full threads. Conform to ANSI/NEMA FB1 and be listed by UL. Provide conduit bodies stamped with permissible conductor combinations. Provide a conduit body rated for the conductor combination at the location where the unit will be installed. Conduit bodies shall be gasketed and watertight at all installation locations.
   2. Rigid aluminum conduit fittings shall be of the threaded type only. Provide threaded couplings between each section of rigid aluminum conduit. Each rigid aluminum conduit that terminates into a box, enclosure, etc shall terminate into an aluminum threaded hub fitting. Threaded hub fittings shall have insulated throats and shall be Myers Scru-Tite or equal. Locknut terminations of rigid aluminum conduits will not be allowed.
   3. Manufacturers: Provide products of one of the following:
      a. Crouse-Hinds Company.
      b. Appleton Electric Company.
      c. Or approved equal.

D. Rigid Nonmetallic Conduit and Fittings:
   1. PVC Plastic Conduit:
      a. Manufacturers: Provide products of one of the following:
         1) Cantex.
         2) Carlon.
         3) Certainteed.
         3) Or approved equal.
      b. Material: Schedule 80 PVC, rated for 90 degrees C, conforming to NEMA TC3 and UL 514B and 651.
      c. Fittings: Form elbows, bodies, terminations, expansions, and fasteners of same material and manufacturer as base conduit. Provide cement by same manufacturer as base conduit.

E. Conduit Hubs:
   1. Manufacturers: Provide products one of the following.
      a. Myers Electrical Products Company.
      b. Or approved equal.
   2. Material: Threaded conduit hub, vibration-proof, weatherproof, with captive O-ring seal, zinc metal with insulated throat and bonding screw.
   3. Use: Provide for all conduit terminations to boxes, cabinets, and other enclosures in areas designated as wet locations.

F. Conduit Bushings and Locknuts:
   1. Manufacturers: Provide products one of the following:
      a. O-Z/Gedney.
      b. Appleton Electric Company.
      c. Or approved equal.
   2. Insulated Bushings: Malleable iron body with plastic liner. Threaded type with 316 stainless steel clamping screw. Provide with bronze grounding lug, as required.
   3. Locknuts: 316 stainless steel for sizes 3/4-inch through two-inch diameter and malleable iron for sizes 2.5-inch through four-inch diameter.
   4. Use: Provide for all conduit terminations to boxes, cabinets and other enclosures except threaded type in areas designated as dusty locations.

G. Thruwall Seals:
   1. For new construction through exterior subsurface walls and exterior concrete walls.
      a. Manufacturer: Provide one of the following:
         1) Type WSK and WSCS by O-Z/Gedney.
         2) Or approved equal.
   2. For new construction passing through concrete floors and floor slabs.
      a. Manufacturer: Provide one of the following:
         1) Type FSK and FSCS floor seals by O-Z/Gedney.
         2) Or approved equal.
   3. For conduits passing through new exterior masonry block walls or through core-drilled holes in existing exterior subsurface walls, exterior concrete

walls, floor slabs, and roof slabs, and for conduits passing through existing interior concrete walls or floors and interior masonry block walls.

a. Manufacturer: Provide one of the following:
   1) Type CSMI sealing bushing at the inside of the structure and Type CSMC sealing bushing at the outside of the structure by O-Z/Gedney.
   2) Or approved equal.

H. Expansion/Deflection Couplings:
   1. Copper-free aluminum with stainless steel clamps and tinned copper braid bonding jumper complying with UL 514B.
   2. Design Features:
      a. Axial expansion or contraction up to 3/4-inch.
      b. Angular misalignment up to 30 degrees in any direction.
      c. Parallel misalignment up to 3/4-inch.
   3. Manufacturer: Provide one of the following:
      a. Type XD by Crouse Hinds Company.
      b. Or approved equal.

I. Expansion Fittings:
   1. Copper-free aluminum with stainless steel clamps and tinned copper braid bonding jumper complying with UL 514B.
   2. Design Features:
      a. Eight-inch total movement.
   3. Manufacturer: Provide one of the following:
      a. Type XJG by Crouse Hinds Company.
      b. Or approved equal.

2.2 ACCESSORIES

A. Fasteners: Provide 316 stainless steel fasteners only.

B. Duct Sealing Compound
   1. Soft, fibrous, slightly tacky, non-hardening sealing compound.
   2. Remains workable at all temperatures.
   3. Manufacturer:
      a. Type DUX by O-Z/Gedney.
      b. Or approved equal.

2.3 IDENTIFICATION

A. Conduit Labels:
   1. Provide conduit tags in accordance with Section 26 05 53, Identification for Electrical Systems.

B. Warning Tape:
   1. Provide warning tape in accordance with Section 26 05 53, Identification for Electrical Systems.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be performed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with installation until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Provide threaded fittings and connections only for couplings, terminations, etc. Set screw type fittings will not be permitted for rigid aluminum conduit. Provide oxidation inhibitor, Noalox, Penetrox or equal coating on all threaded connections.

B. Install conduits in conformance with Laws and Regulations.

C. Supports:
   1. Rigidly support conduits by clamps, hangers, or Unistrut-type channels. Conduit supports and accessories shall be in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.
   2. Support single conduits by means of one-hole pipe clamps in combination with one-screw back plates, to raise conduits from the support surface. Support multiple runs of conduits on trapeze type hangers.

D. Fastenings: Fasten raceway systems rigidly and neatly to supporting structures using specified materials.

E. Exposed Conduit:
   1. Install parallel or perpendicular to structural members or walls.
   2. Where possible, run in groups. Provide conduit racks of suitable width, length, and height, arranged to suit field conditions. Provide support every ten feet, minimum.
   3. Install on structural members in protected locations.
   4. Locate clear of interferences.
   5. Provide six inches of clearance from hot fluid lines and 1/4-inch from walls.
   6. Install vertical runs plumb. Unsecured drop length shall not exceed 12 feet.

F. Conduit Embedded in Structural Concrete:
   1. Run embedded conduit in structural concrete in center of slabs and walls and above waterstops. Conduit connections shall be made watertight.
   2. Before placing concrete, arrange for observation of conduit installation by RPR or ENGINEER and make necessary conduit location measurements and provide required information on record documents.

3. Confirm that concrete thickness is sufficient for embedding the quantity of conduits intended. Unless specifically shown or indicated otherwise, embedded conduits shall be in accordance with the following criteria:
   a. Minimum concrete thickness shall be as follows:
      1) For concrete 16 inches thick and less, minimum concrete thickness shall be 11.5 inches plus the depth of largest conduit assembly. Conduit assembly depth shall be from the top of uppermost conduit to bottom of lowest conduit.
      2) For concrete greater than 16 inches thick, minimum concrete thickness shall be 13.5 inches plus depth of largest conduit assembly.
      3) For concrete at foundation slabs, provide an one inch additional to minimum concrete thicknesses specified.
   b. Conduit spacing shall be as follows:
      1) Two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of larger conduit
      2) When conduits cross at a point, conduits may be in direct contact and angle of cross shall be 45 degrees or greater. Conduits may also cross within the vertical spacing of multi-conduit layer assembly.
      3) When conduits cross structural expansion joint, two adjacent conduits shall be separated by center-to-center distance of three times the outer diameter of conduit fitting of the larger conduit

G. Underground Conduits:
   1. Install individual, underground conduits minimum of 20 inches below grade, unless otherwise shown or indicated.
   2. Perform excavation, bedding, backfilling, and surface restoration, including pavement replacement where required, in accordance with Division 31.
   3. Install warning tape 12 inches below finished grade over buried conduits.

H. Empty Conduits:
   1. Install nylon pull string in each empty conduit and cap conduits not terminating in boxes with permanent fittings designed for the purpose. Pull string shall have minimum tensile strength of 240 lbs.

I. Field Bends: No indentations. Diameter of conduit shall not vary more than 15 percent at bends.

J. Joints:
   1. Apply conductive compound to joints before assembly.
   2. Make up joints tight and ground thoroughly.
   3. Use standard tapered pipe threads for conduit and fittings.
   4. Cut conduit ends square and ream to prevent damaging wire and cable.
   5. Use full threaded couplings. Split couplings are not allowed.
   6. Use strap wrenches and vises to install conduit. Replace conduit with wrench marks.

K. Terminations:
   1. Install insulated bushings on conduits entering boxes or cabinets, except when threaded hubs are used.
   2. Provide locknuts on both inside and outside of enclosure, except when threaded hubs are used.
   3. Use of bushings in lieu of locknuts is not allowed.
   4. Install conduit hubs on conduits entering boxes or cabinets in wet and corrosive areas.

L. Moisture Protection:
   1. Plug or cap conduit ends at time of installation to prevent entrance of moisture and foreign materials.
   2. Underground and embedded conduit connections shall be watertight.
   3. Thruwall Seals and Conduit Sealing Bushings: Install for conduits passing through concrete slabs, floors, walls, or concrete block walls.
   4. Drainage: Conduit runs shall be fully drainable. Where possible install conduit runs to drain to one end and away from building. Avoid pockets or depressions in conduit runs.
   5. Seal conduit openings within control and instrumentation panels and distribution equipment with duct sealing compound to provide watertight seal.
   6. Dissimilar Metals:
      a. Prevent occurrence of electrolytic action between dissimilar metals.
      b. Do not use copper products in connection with aluminum, and do not use aluminum in locations subject to drainage of copper compounds on bare aluminum.
      c. Back paint aluminum in contact with masonry or concrete with two coats of bituminous paint.

M. Core drill for individual conduits passing through existing concrete slabs and walls. Notify ENGINEER in writing in advance of core drilling. Prior to core drilling, drill sufficient number of small exploratory holes to establish that the area to be core drilled is free of existing embedded conduits. Seal spaces around conduit as indicated in Paragraph 3.2.K.3 of this Section.

N. Non-metallic Conduit:
   1. Install in accordance with manufacturer’s recommendations.
   2. Provide manufacturer’s recommended adhesives or sealants for watertight connections.
   3. Provide expansion fittings for expansion and contraction to compensate for temperature variations. Fittings shall be watertight and suitable for direct burial.
   4. Transition to PVC-coated rigid aluminum conduit before making turn up to enclosures.

O. PVC-coated Rigid Aluminum Conduit:

1. Install in accordance with manufacturer's recommendations.
2. Install with manufacturer's installation tools to avoid damage to PVC coating.
3. Repair damaged PVC coating with manufacturer's recommended touch-up compound.

P. Identify conduits, including spares, in accordance with Section 26 05 53, Identification for Electrical Systems.

Q. Seal fittings: Use oversized fittings with reducing bushings when necessary to maintain cable fill requirements of the conduit system.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
1. Test conduits by pulling through each conduit a cylindrical mandrel with length not less than two pipe inside diameters, having an outside diameter equal to 90 percent of conduits inside diameter.
2. Maintain a record, by number, of all conduits successfully tested.
3. Repair or replace conduits that do not successfully pass testing, and re-test.

+ + END OF SECTION + +

[THIS PAGE IS LEFT BLANK INTENTIONALLY]

SECTION 26 05 33.16

FLEXIBLE CONDUITS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install flexible metallic conduit and fittings.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEC Article 351 - Liquid-Tight Flexible Metal Conduit.
   2. UL Standard No. 360 - Liquid-Tight Flexible Steel Conduit.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature and technical information for flexible conduit and fittings proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Flexible Conduit:
   1. Material: Flexible aluminum core with smooth, abrasion resistant, liquid-tight, polyvinyl chloride cover. Continuous copper ground built in for sizes 3/4-inch through 2 inch. Material shall be UL listed.
   2. Product and Manufacturer: Provide one of the following:
      a. Anaconda Sealtite EFL.
      b. Or approved equal.

B. Flexible Conduit Fittings:
   1. Material and Construction: Aluminum with standard finish. Fittings shall adapt the conduit to standard threaded connections, shall have an inside diameter not less than that of the corresponding standard conduit size and shall be UL listed.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install at motors, transformers, field instruments, and equipment subject to vibration or require movement for maintenance purposes. Provide necessary reducer where equipment furnished cannot accept 3/4-inch diameter flexible conduit. Limit flexible conduit length to three feet maximum.

B. Install in conformance with manufacturer's requirements.

+ + END OF SECTION + +

SECTION 26 05 33.33

PULL, JUNCTION AND TERMINAL BOXES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pull, junction, and terminal boxes.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.

1.2 QUALITY ASSURANCE

A. Reference Standards:
   1. NEC Article 370 - Outlet, Switch and Junction Boxes, and Fittings.
   2. UL Standard No. 50 - Electrical Cabinets and Boxes.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for pull and junction boxes proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Pull, Junction and Terminal Boxes:
   1. General:
      a. Boxes shall be rated at not less than NEMA 12. Boxes shall be appropriate for each location in accordance with NEMA requirements and as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.
   2. Material and Construction.
      a. Welded steel sheets of USS gauge.
      b. Oil-resistant gasket.
      c. Lift-off hinges and quick-release latches.

d. Boxes with any dimension 24 inches and smaller shall be 14 gauge. Boxes with any dimension larger than 24 inches shall be 12 gauge, except use 10 gauge on boxes with any dimension of 36 inches or more.

2. Manufacturer: Provide boxes manufactured by one of the following:
   a. Hoffman Engineering.
   b. Appleton.
   c. Crouse-Hinds.
   d. Or approved equal.

B. Terminal Blocks:
   1. Material and Construction:
      a. NEMA rated nylon modular terminal blocks.
      b. 600 volt rated.
      c. Control and alarm circuit terminals shall be screwed type with permanently affixed numeric identifiers beside each connection.
      d. Power terminals shall be copper and rated for the circuit ampacity.
   2. Manufacturer: Provide terminal blocks of one of the following:
      a. Allen-Bradley Company, Bulletin, 1492.
      b. Or approved equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Mount boxes so that sufficient access and working space is provided and maintain clearance of not less than 1/4-inch from walls.

B. Securely fasten boxes to walls or other structural surfaces on which boxes are mounted. Provide independent supports that comply with Section 26 05 29, Hangers and Supports for Electrical Systems, where boxes will not be mounted on walls or other structural surface.

C. Install pull boxes where shown or indicated, and provide pull boxes where one or more of the following conditions exist:
   1. Conduit runs containing more than three 90-degree bends.
   2. Conduit runs exceeding 200 feet in length.

D. Provide removable, flame-retardant, insulating cable supports in boxes with any

dimension exceeding three feet.

E. Field-apply PVC touch-up to scratched PVC boxes damaged during installation. Touch-up work shall be in accordance with manufacturer's recommendations and instructions.

F. Size junction, pull, and terminal boxes in accordance with NEC Article 314 and other Laws and Regulations.

G. Provide terminal blocks in boxes where shown and where cable terminations or splices are required.

+ + END OF SECTION + +

[THIS PAGE LEFT BLANK INTENTIONALLY]

SECTION 26 05 43.13

UNDERGROUND DUCT BANKS FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install the underground duct bank system shown on the Drawings.

B. Coordination:
   1. Proposed duct bank routing shown on the Drawings is diagrammatic. CONTRACTOR shall field verify the routing of all underground duct banks prior to installation and modify routing as necessary to avoid piping and underground utilities at no additional cost to the OWNER. Alternate routing paths shall be submitted to the ENGINEER for approval.
   2. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before underground duct bank Work.

C. Related Sections:
   1. Section 31 23 05, Excavation and Fill.
   2. Section 03 30 00, Cast-in-Place Concrete.
   3. Section 26 05 26, Grounding and Bonding for Electrical Systems.
   4. Section 26 05 53, Identification for Electrical Systems.
   5. Section 26 05 33.13, Rigid Conduits.

1.2 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Layouts showing proposed routing of duct banks and locations of manholes, handholes, and areas of reinforcement.
      b. Typical cross sections for each duct bank.
      c. Duct bank spacer specifications.

B. Closeout Submittals: Submit the following:
   1. Record Drawings:
      a. Indicate actual routing of underground duct bank sections on record documents.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Raceways: Provide Schedule 80 PVC conduit for underground raceways. Provide PVC coated rigid aluminum conduit for all conduit turn ups. All conduit and fittings shall be provided in accordance with Section 26 05 33.13, Rigid Conduits. Minimum underground raceway size shall be 2 inches.

B. Backfill: Provide backfill, including select backfill, in accordance with Section 31 23 05, Excavation and Fill. Clean adjacent road surfaces after backfilling and provide dust control measures.

C. Conduit Spacers: Conduit spacers shall be nonmetallic, interlocking type to maintain spacing between conduits. Provide spacers suitable for all conduit types used in multiple sizes. Spacers shall be located in maximum four foot intervals and provide minimum two inch clearance between conduits.

D. Duct Sealing Compound:
   1. Products and Manufacturers: Provide one of the following:
      a. O-Z/Gedney, Type DUX.
      b. Or approved equal.

E. Handholes: Precast concrete construction with AASHTO H-20 load rating. Raceway entrances shall be sized accordingly and located to suit the duct bank installation. Provide minimum interior dimensions of 3’ x 3’ x 3’ with 6” diameter sump in handhole floor.
   1. Accessories:
      a. Cover: Diamond pattern, aluminum spring assisted cover with heavy duty 316 stainless steel hinges bolted to frame and cover with 316 stainless steel hardware. Provide cover with locking provisions and lifting handles that store flush with covers when not in use.
      b. Frame: Extruded aluminum rated for AASHTO H-20 loading.
      c. Identification: Marked “ELECTRICAL” in raised two-inch letters.
   2. Manufacturer:
      a. Old Castle.
      b. Or Equal.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are

corrected.

3.2 INSTALLATION

A. Excavation and Backfilling:
   1. Provide excavation and backfilling for duct bank installation in accordance with Section 31 23 05, Excavation and Fill.
   2. Do not backfill with material containing large rock, paving materials, cinders, large or sharply angular substances, corrosive material, or other materials that can prevent adequate compaction of backfill or that can damage or contribute to corrosion of raceways and cables.

B. Duct Bank Layout:
   1. Top of duct bank shall be a minimum of 24 inches below grade, unless otherwise indicated on the Drawings.
   2. Slope duct bank runs for drainage toward manholes and away from buildings with slope of approximately three inches vertical per 100 feet of run.

C. Duct Bank Assembly:
   1. Assemble duct banks using non-magnetic saddles, spacers, and separators. Position separators to provide minimum three-inch clearance from outer surfaces of each conduit.
   2. Make bends with sweeps of not less than four-foot radius or five-degree angle couplings.

D. Conduit Transitions:
   1. Conduit installations shall be watertight throughout entire length of duct bank.
   2. Transition from non-metallic to metallic conduit where duct banks enter structure walls and slabs.
   3. Terminate conduits in insulated grounding bushings.
   4. Continue routing of conduits within buildings in accordance with Section 26 05 33.13, Rigid Conduits, and as shown or indicated in the Contract Documents.
   5. Provide expansion and deflection fittings in accordance with Division 26.
   6. Plug and seal all empty spare conduits entering structures and manholes. Conduits in use entering structures shall be sealed watertight with duct sealing compound.

E. Connections to Structures:
   1. Duct bank penetrations through structure walls shall be watertight.

F. Grounding:

1. Provide bare stranded copper duct bank ground cable in each duct bank envelope. Ground connection shall be electrically continuous throughout entire duct bank system.
2. Connect ground cable to all building grounding grids and equipment ground buses. Connect ground cable to all metallic conduit extensions of underground duct bank system.
3. Provide ground clamp and bonding of each metallic conduit extension to maintain continuity of ground system.
4. Terminate ground cable at last manhole or handhole for outlying structures.

G. Detectable Underground Warning Tape:
1. Provide detectable underground warning tape over the full length of each underground duct bank. Tape shall comply with Section 26 05 53, Identification for Electrical Systems.
2. Install warning tape approximately 12 inches below grade.
3. Provide multiple tape sections across the width of each duct bank. Locate center of a warning tape above each edge of duct bank, and at intervals across top width of duct bank so that clear space between tapes does not exceed six inches.

H. Installation at Existing Roadways:
1. Sawcut existing concrete pavement to minimize excavation needed for routing duct banks across roadways. Restore concrete pavement to its previous condition upon completion of the duct bank installation.

I. Reusing Existing Raceways:
1. Pull rag swab through raceway to remove water and clean prior to installing new cable.
2. Repeat swabbing until all foreign material is removed.
3. Pull mandrel through raceway to remove obstructions if necessary.

+ + END OF SECTION + +

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals shown, specified, and required to furnish and install identification for electrical apparatus and electrical Work.

B. Related Sections:
   1. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
   2. Section 26 05 23, Instrumentation and Communication Cable.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the latest applicable provisions and requirements of the following:
   1. NEC Article 110 - Requirements for Electrical Installation.
   2. NEC Article 210 - Branch Circuits.
   3. NEC Article 215 - Feeders.
   4. 40 CFR 1910.145 (OSHA) – Specification for Accident Prevention Signs and Tags.
   5. NFPA 70E - Electrical Safety in the Workplace.

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Provide a complete description and listing of proposed electrical identification and electrical identification devices on Shop Drawings for associated equipment or systems.
   2. Conduit and wire identification numbering system and equipment signage.

B. Product Data:
   1. Manufacturer's cut sheets, specifications, dimensions and technical data for all products proposed under this Section.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Engraved Identification Devices (Nameplates and Legend Plates):
   1. Nameplates:
      a. Laminated thermoset plastic, 1/16-inch thick, engraved condensed block black lettering on white background, square corners, and beveled front edges, or match existing.
      b. Size: As required.
      c. Letter Size: Minimum 3/16-inch.
      d. Nameplates one-inch or less in height shall have one mounting hole at each end. Nameplates greater than one-inch in height shall have mounting holes in the four corners.
      e. For outdoors, provide engraved aluminum nameplates with black lettering as described above.
   2. Legend Plates:
      a. Legend plates for pushbuttons, pilot lights, selector switches, and other panel-mounted devices shall be large size with dimensions of approximately 2-7/16 inches wide by 2-13/32 inches tall (Allen Bradley large automotive size), plastic, custom engraved with black letters on white background.
         1) Provide standard-size legend plates where devices are mounted on motor control centers and spacing of devices precludes using automotive-size legend plates.
      b. Lettering size and line weight shall be the same for all legend plates on the same panel or enclosure. Maximum size shall be 1/4-inch and minimum size shall be 1/8-inch.

B. Safety Signs and Voltage Markers:
   1. Low voltage safety signs shall be pressure sensitive vinyl conforming to 40 CFR 1910.145, 5 inches by 3.5 inches in size, and shall read, “DANGER - 480 VOLTS”.
      a. Products and Manufacturers:
         1) B-302-86060 by Brady.
         2) Or equal.
   2. Low voltage markers shall be either pressure sensitive vinyl or vinyl cloth with black lettering on orange background and shall read, “120 VOLTS”, “208 VOLTS”, “120/208 VOLTS”, or “240 VOLTS” as required.
      a. Products and Manufacturers:
         1) CV442xx by Brady.
         2) Or equal.

C. Voltage System Identification Directories:
   1. General:

a. Directories shall be laminated thermoset plastic, 1/16-inch thick, engraved block black letters on white background, square corners, and beveled front edges.
b. Directories shall identify all voltage systems within building or structure.
c. Directories shall list the colors that identify ungrounded and grounded conductors of each system.
d. Colors shall be in accordance with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
e. Example Directory Text:

Voltage System Identification		
System	**A, B, C**	**Neutral**
277/480	Brown, Orange, Yellow	Gray
120/208	Black, Blue, Red	White

2. Large directories for rooms shall have text height not less than 1/2-inch.
3. Small directories for equipment shall have text height of not less than 1/4-inch.

D. Conduit Labels:
1. Provide the following for conduit identification:
a. Round stainless steel conduit tags manufactured for the purpose stamped with conduit identification information.
b. Stainless steel band manufactured for the purpose encircling the conduit and passing through an opening in the conduit tag. Tags shall be banded at both ends.

E. Wire Identification:
1. Heat Shrinkable Wire and Cable Labeling System:
a. Products and Manufacturers: Provide one of the following:
1) B-341 PS-xxx-2W by Brady.
2) Or equal.
b. White heat-shrinkable irradiated polyolefin shrink-on sleeves. Labels shall be thermal printed. Labels shall be not less than two inches wide.
2. Wrap-Around Wire and Cable Labeling System:
a. Products and Manufacturers: Provide one of the following:
1) THT-XX-427 by Brady.
2) Or equal.
b. Self-laminating white/transparent self extinguishing vinyl strips. Length shall be sufficient to provide at least 2.5 wraps. Labels shall be thermally printed and not less than two inches wide.

F. Detectable Underground Warning Tape:
1. Products and Manufacturers: Provide one of the following:

a. Indentoline by Brady.
b. Or equal.

2. Material: Polyethylene or polyester with detectable metal core and polyester underlaminate.
3. Width: Two inches.
4. Color and Labeling: Yellow or red with permanently imprinted black letters: "CAUTION – Buried Electric Line", repeated continuously over full length of tape.

G. Thermal Printing System:
1. Utilize thermal transfer process to provide non-smearing labels and markers.
2. Wire and Cable Markers:
a. Portable, Products and Manufacturers: Provide one of the following:
1) TLS2200 by Brady.
2) Or equal.
b. Desktop, Products and Manufacturers: Provide one of the following:
1) 200M by Brady.
2) Or equal.
3. Cable Markers:
a. Portable, Products and Manufacturers: Provide one of the following:
1) Handimark by Brady.
2) Or equal.
b. Desktop, Products and Manufacturers: Provide one of the following:
1) Labelizer PLUS by Brady.
2) Or equal.

2.2 FABRICATION

A. Engraved Identification Devices (Nameplates and Legend Plates):
1. Nameplate and legend plate text is preliminary and subject to change pending final review and approval of nomenclature by ENGINEER after start-up and testing.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Provide electrical identification in accordance with manufacturer recommendations and as required for proper identification of equipment.

B. Engraved Identification Devices (Nameplates and Legend Plates):
1. Unless otherwise indicated in the Contract Documents, attach permanent nameplates with permanent adhesive and with 3/16-inch diameter, round head, stainless steel machine screws into drilled and tapped holes.

2. Provide nameplate with 1.5-inch high letters to identify each console, cabinet, panel, or enclosure as shown or indicated.
3. Provide nameplates for field-mounted motor starters, disconnect switches, manual starter switches, pushbutton stations, and similar equipment operating components, which shall describe motor or equipment function and circuit number.
4. Provide nameplates with 1/2-inch high letters to identify each junction and terminal box shown or indicated.
5. At motor control centers provide nameplates for each main and feeder circuit and for all indicating lights, displays, and instrument on enclosure doors.
   a. Provide nameplate with 1.5-inch high letters giving switchgear designation, voltage rating, ampere rating, short circuit rating, manufacturer's name, general order number, and item number.
   b. Identify individual door for each compartment with nameplate giving item designation and circuit number.
6. Push Buttons:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
   c. Provide red buttons for stop function.
   d. Provide black buttons for other functions.
7. Pilot Lights:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
   c. Shall have lens colors as shown or indicated. Where no color is indicated, provide the following lens colors:

Color	**Legend**
Red	Running, Open
Green	Stopped, Closed
Amber	Alarm
Blue	Power
White	Status

8. Selector Switches:
   a. Provide legend plates for identification of functions.
   b. Provide nameplates for identification of controlled equipment.
9. Panel Mounted Instruments:
   a. Provide nameplates for identification of function.
10. Interiors of Cabinets, Consoles, Panels, Terminal Boxes, and Other Enclosures:
   a. Provide nameplates for identification.
   b. Provide each item inside cabinet, console, panel, terminal box, or enclosure with laminated plastic nameplate as shown on approved

Shop Drawings and CONTRACTOR"s other submittals. Install nameplates with adhesive.

c. Interior items requiring nameplates include:
   1) Terminal blocks and strips.
   2) Bus bars.
   3) Relays.
   4) Rear of face-mounted items.
   5) Rear of door-mounted items.
   6) Interior mounted items that require identification when mounted externally.

d. Circuit Breaker Directory:
   1) Provide engraved laminated plastic directory listing function and load controlled for each circuit breaker within panel used for power distribution.

11. Re-label existing equipment whose designation have changed.

C. Safety Signs and Voltage Markers:
1. Provide safety signs and voltage markers on and around electrical equipment as shown or indicated.
   a. Install rigid safety signs using stainless steel fasteners.
   b. Clean surfaces before applying pressure-sensitive signs and markers.
2. Install low voltage safety signs on equipment doors that provide access to uninsulated 480-volt conductors, including terminal devices.
3. Install low voltage markers on each terminal box, safety disconnect switch, and panelboard installed, modified, or relocated as part of the Work and containing 120/208 volt conductors.

D. Voltage System Identification Directories
1. Provide voltage system identification directories as required by NEC Article 210 and NEC Article 215.
2. For panelboards and other branch circuit or feeder distribution equipment provide voltage system identification directory mounted on equipment.
   a. Directories shall be affixed using epoxy glue. Screws or bolts shall not penetrate equipment enclosures.
   b. Directories shall be readily visible and not obscure labels and other markings on equipment.

E. Conduit Labels:
1. Conduits shall be provided with conduit labels unless otherwise specified.
2. Flexible conduit shall not be labeled.
3. Exposed single conduit runs of less than 25 feet between local disconnect switches and their associated equipment will not be labeled.
4. Conduit labels shall convey the following information:

a. Conduit Number: Alphanumeric as shown on the Drawings, as assigned by CONTRACTOR for unlabeled conduits, and per approved submittals.

5. Conduit labels shall be installed at the following locations:
   a. Where conduit enters or exits walls, ceilings, floors, or slabs.
   b. Where conduit enters or exits boxes, cabinets, consoles, panels, or enclosures, except pull boxes and conduit bodies used for pull boxes.
   c. At maximum intervals of 50 feet along the length of the conduit.
6. Conduit labels shall be oriented to be readable.

F. Wire and Cable Identification:
1. Color-coding of insulated conductors shall comply with Section 26 05 19, Low Voltage Electrical Power Conductors and Cables.
2. Use heat-shrinkable wire labels where wire or cable is terminated. Use wrap-around labels where wire or cable is to be labeled but is not terminated.
3. Do not provide labels for the following:
   a. Bare (uninsulated) conductors, unless otherwise shown or indicated as labeled.
4. Provide wire and cable labels for the following:
   a. New, rerouted, or revised wire or cable.
   b. Insulated conductors.
   d. Wire and cable terminations:
      1) Wire labels shall be applied between 1/2-inch and one inch of completed termination
      2) Apply cable labels between 1/2-inch and one inch of cable breakout into individual conductors.
         a) Label individual conductors in a cable after breakout as specified for wires.
   e. Wire or cable exiting cabinets, consoles, panels, terminal boxes, and enclosures.
      1) Label wires or cables within two inches of entrance to conduit.
   f. Wire or cable in junction boxes and pull boxes
      1) Label wires or cables within two inches of entrance to conduit.
   g. Wire and cable installed in cable tray.
      1) Wire and cable shall have labels at maximum intervals of 20 feet.
   h. Wire and cable installed without termination in electrical manholes.
      1) Wire and cable shall have wrap-around labels applied within one foot of exiting manhole.
5. Wire and Cable Identification System:
   a. Wire and cable labels shall be imprinted with an identifying designator.
      1) Wire and cable extending between two devices or items and that does not undergo a change of function shall be identified by a single unique designator as specified below.

b. Field Wiring:
   1) Wire or cable designator shall consist of:
      a) Three left-most characters shall consist of the Contract number under which wiring or cable was installed.
      b) Fourth character from the left shall be an asterisk (*), a plus sign (+) or a hyphen (-). Do not use other punctuation symbols in a wire designator.
      c) Remaining characters shall be alphanumeric and make wire designator unique.
      d) Numbering shall reflect actual designations used in the Work and shall be documented in record documents.

c. Cabinet, Console, Panel, and Enclosure Wiring, Internal:
   1) New Cabinets, Consoles, Panels, and Enclosures:
      a) Wire and cable inside cabinets, consoles, panels, and enclosures shall have designators as specified in Section 40 61 13, Process Control Systems General Provisions.

6. Modified Cabinets, Consoles, Panels, and Enclosures:
   a. New or rerouted wire or cable in existing cabinets, consoles, panels, and enclosures shall be labeled as shown on the Drawings or be assigned a ten-character designator equivalent to field wire designator.

G. Terminal Strip Labeling:
   1. Label panel side of terminal to match panel wire number.
   2. Label field side of terminal to match field wire number. Terminal number shall not include the Contract number.

+ + END OF SECTION + +

SECTION 26 08 00

ELECTRICAL ACCEPTANCE TESTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as required to test, inspect, and calibrate all electrical equipment and materials provided for the electrical system.
   2. CONTRACTOR shall provide the services of an independent electrical testing firm to perform acceptance testing as specified herein. Testing firm shall be International Electric Testing Association Standards (NETA) certified and shall have a minimum of five years' experience in providing acceptance testing for similar installations.
   3. The intent of electrical acceptance testing is to confirm that all electrical equipment is operational within industry standards and manufacturer's tolerances and has been installed as intended by the ENGINEER.

B. Related Sections:
   1. Division 26, Electrical.

1.2 REFERENCES

A. Electrical testing shall be performed in accordance with the following:
   1. International Electrical Testing Association ANSI/NETA ATS - Standard for Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. Manufacturer requirements and instructions.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Testing Plans, Procedures, and Testing Limitations:
      a. Proposed test methods and procedures that detail the type, schedule and duration of each test.
      b. Testing plans shall identify tools required, construction power required, and any safety concerns.
      c. Sample testing forms.
      d. Submit testing plans for approval a minimum of 30 days in advance of date of testing.

B. Informational Submittals: Submit the following:

1. Certified Test Reports:
   a. Cable field insulation resistance test results.
   b. Grounding system resistance test results.
   c. Equipment field test reports.
2. Qualifications Statements:
   a. Independent testing firm.

PART 2 – PRODUCTS

2.1 TESTING EQUIPMENT

A. The testing firm shall have a calibration program that ensures that all applicable testing instruments are maintained within rated accuracy. The accuracy shall be directly traceable to National Institute of Standards and Technology (NIST) Standards. A calibration label shall be visible on all test equipment indicating the date of calibration, name of calibrating firm/technician, and required recalibration date.

PART 3 – EXECUTION

3.1 TESTING REQUIREMENTS

A. Low Voltage Electrical Power Conductors and Cables:
   1. Perform insulation resistance testing for all power circuits in accordance with NETA ATS and manufacturer instructions. Cables must withstand the high test voltage without breakdown and shall exhibit steady or decreasing leakage current during testing.
   2. Testing shall be performed after cables are permanently installed to demonstrate that the circuit and equipment are connected properly and will perform satisfactorily. Disconnect any equipment that may be damaged during testing.
   3. Insulation resistance for each conductor shall not be less than value recommended by the cable manufacturer. Cables not meeting recommended values or that fail when tested under full load conditions shall be replaced with a new cable for the entire length.

B. Ground Testing:
   1. Perform a fall-of-potential test on the grounding system installation in accordance with NETA ATS using an electrical ground resistance tester. The grounding system maximum resistance shall not exceed 5 ohms under normally dry conditions when measured by the resistance tester. Resistance values above 5 ohms shall be brought to the ENGINEER'S attention.

2. Provide additional ground rods as required to attain a resistance to ground of less than five ohms for each grounding system. Add grounding additive when installing additional ground rods to increase their effectiveness.
3. Test all grounded cables and metal parts for continuity of connection.

C. Motor control centers (MCCs):
1. Test and inspect MCCs in accordance with NETA ATS and manufacturer instructions. Make the following minimum tests and checks before energizing modified equipment:
   a. Inspect the equipment for physical damage and loose/damaged components.
   b. Inspect unit compartment doors for alignment and missing hardware.
   c. Test ground connections for continuity and resistance.
   d. Verify that all wiring has been properly terminated, supported, and clear of energized parts.
   e. Megger bus bar, phase-to-phase, and phase-to-ground after disconnecting devices sensitive to megger voltage.
2. In the event of an equipment fault, notify the OWNER immediately. After the cause of the fault has been identified and corrected, a joint inspection of the equipment shall be conducted by the CONTRACTOR, ENGINEER, and the equipment manufacturer's factory service technician. Repair or replace the equipment as directed by the ENGINEER prior to placing the equipment back into service.

3.2 SYSTEM FUNCTIONAL TESTING

A. CONTRACTOR shall perform functional testing on each system to ensure satisfactory operation. Perform functional testing upon satisfactory completion of electrical acceptance testing. Functional testing shall include field adjustment of protective relays and circuit breakers as recommended by the findings of the power system study.

+ + END OF SECTION + +

[THIS PAGE LEFT BLANK INTENTIONALLY]

SECTION 26 24 19

MOTOR CONTROL CENTER MODIFICATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to modify existing motor control centers as shown on the Drawings and as specified herein.

B. Coordination:
   1. Obtain motor nameplate data on equipment being furnished for properly sizing circuit breakers, starters and overloads.
   2. Obtain data on motor space heater and other accessories for properly sizing control power transformers.

C. Related Sections:
   1. Section 26 05 53, Identification for Electrical Systems.

1.2 QUALITY ASSURANCE

A. Where possible, circuit breakers and other components shall be the product of the original manufacturer of the motor control center in which they are being installed.

B. Motor control centers shall be modified and tested in accordance with the latest revision of UL 845 – Motor Control Centers. Motor control centers shall maintain the UL listing of the equipment after all modifications.

C. Modifications shall be made by a CONTRACTOR specializing in this type of work and, upon ENGINEER's request, documentation shall be submitted for qualification approval.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Components list and nameplate schedule.
      b. Unit control schematics and elementary wiring diagrams showing numbered terminal points.
      c. Three-line diagrams.
      d. Time current curves for protective devices.

2. Product Data:
   a. Technical specifications with assembly and component ratings.
   b. Equipment datasheets.

PART 2 – PRODUCTS

2.1 CONSTRUCTION

A. General:
   1. Furnish new devices and components for motor control center modifications. No existing parts shall be re-used unless noted otherwise.
   2. Voltage Rating: Devices and components shall be rated 600 volts.
   3. Interrupting Capacity Rating: Devices and components shall be rated for 65 kA RMS symmetrical amperes regardless of the ratings of the existing MCC bus bracing, devices and components.
   4. New devices installed in existing motor control centers shall be designed for continuous operation at rated current in a 40 degree C ambient temperature. Installation shall conform to manufacturer's recommended clearances and ventilation practices to prevent overheating and to maintain UL listing.

B. Enclosure:
   1. Provide sheet metal cubicles and doors to match existing equipment enclosure as required. Cubicles shall be supplied by the original equipment manufacturer where possible. Where existing units are obsolete, cubicles may be supplied by a third party vendor.
   2. Provide individual, flange formed, pan type door with concealed hinges and quarter turn latches for each device compartment as required. Doors shall be removable. Door removal shall not be required to withdraw starter units or feeder tap devices.
   3. Provide individual, isolated unit compartments for fixed mounted devices such as circuit breakers, cable lugs, metering, and control devices.
   4. Provide provisions for padlocking unit disconnect handles in the OFF position with up to three padlocks.
   5. Provide mechanical interlock with bypass to prevent opening unit door with disconnect in the ON position, or moving disconnect to the ON position while the unit door is open.

C. Wiring and device identification:
   1. Identify compartment doors, devices, and field wiring in accordance with Section 26 05 53, Identification for Electrical Systems.
   2. Identify all internal control conductors with permanent type wire markers. Each wire shall be identified by a unique number attached to wire at each termination point.
   3. Identify all internal control devices with permanent type markers. Each device shall be identified by a unique number attached to each device.
   4. Numbering system for each wire and control device shall be identified on the

wiring diagrams and shall reflect the actual designations used in the Work.

2.2 COMPONENTS

A. Full Voltage Non-Reversing (FVNR) combination motor starters:
   1. NEMA 1 minimum motor starter size. Starter units shall be draw out type in NEMA size 1 and 2 and draw out type after disconnecting power leads only in NEMA size 3 and 4.
   2. Units shall be NEMA rated and include a magnetic contactor, with encapsulated magnet coils. Wound coils are unacceptable. All control shall be 120 volts AC unless noted otherwise. Starters shall be furnished with motor circuit protectors as recommended by the manufacturer. Provide the motor control circuit for each combination starter as contained in the Drawings.

B. Motor Control Unit Auxiliary Items:
   1. Overload Relays: Provide an overload relay for each motor starter. Overload relays shall be in accordance with the following:
      a. Thermal Overload Relays: Relays shall be thermal, bimetallic type, direct or current sensing. Relays shall include ambient compensation and be equipped with separate heater elements sized for full-load amperes and service factor of actual motors furnished.
      b. Each overload relay shall be manual reset type and shall include provisions for resetting by an insulating button on front of starter unit door.
      c. Each overload relay shall include a normally open auxiliary contact for remote alarm purposes.
   2. Individual control power transformers for all starters, capacity as required for all control circuit devices, 100VA minimum, Class A insulation, two primary fuses, 120VAC secondary, one secondary fuse, and the other secondary leg grounded.
   3. Motor horsepower shown are preliminary. Circuit breaker trips and starter overload heaters to be coordinated with the actual equipment installed.
   4. Auxiliary contacts, relays, timers as required for specified control functions and those shown on Drawings.
   5. All starter devices, including spare contacts, wired to numbered terminal blocks.
   6. Terminal blocks for field connections to unit compartments shall be plug-in/pull apart type. Terminals shall be fully accessible from the front. Terminals shall be mounted near the front of vertical wireway.
   7. Relays shall have the following characteristics:
      a. 120VAC coils.
      b. Contacts rated for 5A minimum @ 120VAC.
      c. Clear plastic case.
      d. Test pushbutton and neon or LED indicating lamp.
      e. Mounting socket with hold down clip.
      f. Potter and Brumfield KUP or approved equal.

8. Timers shall have the following characteristics:
   a. 120VAC.
   b. Contacts rated for 3A minimum @ 120VAC.
   c. Mounting socket.
   d. Adjustment dial calibrated in seconds or minutes.
   e. Potter and Brumfield or approved equal.
9. Elapsed time meter shall have the following characteristics:
   a. 120VAC.
   b. Electromechanical with 6 digits minimum and non-resettable.

C. Branch circuit breakers:
1. Thermal magnetic type, molded case circuit breakers shall be 600 volt rated with number of poles as indicated on the Drawings and labeled in accordance with UL Standard 489. Circuit breakers shall be fully rated to meet the specified equipment short circuit rating. Provide independently adjustable magnetic trips on 225A frame breakers and larger.

D. Surge Protective Device (SPD):
1. Surge protective device rated for 200 kA surge current capacity rating. Unit shall be provided in accordance with UL 1449 and have internal fuse protection. Provide a 30A/2P circuit breaker disconnect for connection to power bus. Provide low impedance cable system for connection from power bus to circuit breaker and from circuit breaker to SPD. SPD shall be provided with a transient counter with display for indicating number of surges detected, LED indicators for device status, and auxiliary form C contacts for remote alarm annunciation.

E. Pilot Devices:
1. Operator Devices: Industrial, heavy duty, 30.5 mm round, oil-tight construction with clearly-marked legend plates.
2. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
3. Selector Switches: Rotary type with round or oval handles. Positioning device to securely hold switch in selected position for maintained type and for spring return from both left and right to maintained position.
4. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
5. Indicating Lights: 120VAC, LED push-to-test type. LED lamp and lens color shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

F. Control Wiring:
1. Stranded, tinned copper, Type MTW or SIS, rated 600 volts. Wiring shall have red insulation with wire numbers on both ends of conductors corresponding to the numbers used on manufacturer drawings for the MCCs. Terminate wire with crimp type insulated spade terminals or non-insulated ring terminals. Armor or enclose control wires in grounded metal troughs where they pass through primary compartments.

2.5 SURFACE PREPARATION AND SHOP COATINGS

A. All metal parts of the motor control center assembly shall be cleaned of all weld spatter and other foreign material and given a phosphatized chemical pre-treatment with two coats of primer to inhibit rust.

B. Surfaces shall be finish painted with one coat of polyurethane enamel to match color of the existing motor control center assembly.

C. Unpainted non-current carrying parts shall receive a protective zinc plating to prevent corrosion.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Modifications to existing motor control centers shall be made in accordance with manufacturer's instructions and recommendations. Provide all hardware necessary for installation.

B. Field installed interior wiring shall be neatly grouped by circuit and bound by plastic tie wraps. Support grouped circuits so that circuit terminations are not stressed.

C. Touch up damaged paint finishes.

D. Cable connections to existing bus shall be made with two hole NEMA lugs. Remove bus bar sections for shop drilling. Verify adequate torque for all connections.

3.2 SITE TESTING

A. Site testing shall be performed in accordance with NETA ATS and manufacturer recommendations. Refer to Section 26 01 26, Electrical Testing, for complete requirements.

3.3 ADJUSTMENT

A. Inspect the installation for compliance with the manufacturer's recommended installation practices and report any deviations to the ENGINEER.

B. Test all operational features of the installed equipment to the satisfaction of the OWNER.

3.4 CLEANING

A. Remove all foreign objects and debris from inside and around the motor control center. Remove dirt, dust, or concrete spatter from the interior and exterior of the equipment using brushes, vacuum cleaner, or clean, lint-free rags. Do not use compressed air for cleaning of equipment.

+ + END OF SECTION + +

SECTION 26 28 16.33

DISCONNECT SWITCHES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install disconnect switches.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 QUALITY ASSURANCE

A. Reference Standards: Comply with applicable provisions and recommendations of the following except where otherwise shown or specified:
   1. NFPA 70 - National Electrical Code (NEC).
   2. UL Standard 98 - Enclosed Switches.
   3. NEMA KS-1 - Enclosed Switches.
   4. NEMA 250 - Enclosures for Electrical Equipment (1,000 Volts Maximum).

1.3 SUBMITTALS

A. Shop Drawings: Submit for approval the following:
   1. Manufacturer's technical information for disconnect switches proposed for use.
   2. Listing of the switches to be furnished with an identification of their location, rating and NEMA enclosure type.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Single Throw Switches:
   1. Type: Heavy-duty, single throw, quick- make, quick-break mechanism, visible blades in the OFF position and safety handle (lockable in the OFF position). Provide voltage rating, current rating and number of poles as required for each motor or equipment circuit being disconnected.
   2. Switch blades and jaws shall be tin-plated copper construction. Silver-plated switch blades are not acceptable.
   3. Switches shall bear a UL label.

4. Where disconnect switch is used ahead of air conditioning equipment, provide fuse class and maximum ampere rating per the recommendation of the air conditioning equipment manufacturer.
5. Where fusible disconnect switches are indicated provide fuses per the following:
   a. Fuse class shall be Class J for ampere ratings up to 600 amperes and Class L for ampere ratings greater than 600 amperes.
   b. Fuse ampere rating shall be as recommended by the manufacturer of the equipment served.
6. Where indicated on the Drawings, provide an early-break type auxiliary contact to provide a control signal before power is disconnected from the source.

B. Enclosures:
   1. NEMA rating shall be as required for area classifications specified in Section 26 05 05, General Provisions for Electrical Systems.

C. Identification:
   1. Identify all switches in accordance with Sections 26 05 05, General Provisions for Electrical Systems and 26 05 53, Identification for Electrical Systems.

D. Manufacturer: Provide disconnect switches of one of the following:
   1. Eaton.
   2. General Electric.
   3. Schneider Electric/Square D.
   4. Or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Mount equipment so that sufficient access and working space is provided for ready and safe operation and maintenance.

B. Securely fasten equipment to walls or other structural surfaces on which they are mounted. Provide rack mounting when the Drawings indicate that rack mounting is to be provided or when no wall or structural surface is available to mount the disconnect switch.

C. Install in conformance with National Electrical Code.

D. Provide suitable 1/4-inch spacers to prevent mounting enclosure directly against walls.

+ + END OF SECTION + +

SECTION 26 29 23

LOW-VOLTAGE VARIABLE FREQUENCY DRIVES

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, services, and incidentals as shown, specified, and required to furnish and install low-voltage variable frequency drives, complete and operational.
   2. Variable frequency drives (VFDs) included in this Section are associated with the following equipment:
      a. Metering Pump PMP-021.
      b. Metering Pump PMP-022.

B. Related Sections:
   1 Section 05 05 33, Anchor Systems.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. IEEE 519 - Recommended Practices and Requirements for Harmonic Control in Electrical Power Systems.
   2. ISO 9000 - Quality Management Systems, Fundamentals and Vocabulary.
   3. ISO 9001 - Quality Management Systems, Requirements.
   4. ISO 9002 - Quality Systems, Model for Quality Assurance in Production, Installation and Servicing.
   5. NEMA ICS 2 - Controllers, Contactors and Overload Relays Rated 600 Volts.
   6. NEMA ICS 7 - Industrial Control and Systems Adjustable Speed Drives.
   7. NEMA MG 1 - Motor and Generators.
   8. NFPA 70 - National Electrical Code (NEC).
   9. NFPA 70E - Electrical Safety in the Workplace.
   10. UL 489 - Molded-Case Circuit Breakers, Molded-Case Switches and Circuit Breaker Enclosures.
   11. UL 508 - Industrial Control Equipment.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:

a. VFD manufacturer shall have not less than ten years of experience designing and regularly manufacturing and servicing substantially similar equipment to that required and, upon ENGINEER's request, shall submit documentation of not less than five installations in satisfactory operation for not less than five years each.
b. Manufacturer shall be certified under ISO 9000, ISO 9001, or ISO 9002 for materials and equipment specified.
c. For all required factory tests, VFD manufacturer shall use a factory test facility that has calibrated its testing apparatus in the previous twelve months, and is staffed by qualified, experienced technicians.

B. Component Supply and Compatibility:
1. Each variable frequency drive shall be fully compatible with associated driven equipment and motors. Variable frequency drives shall be matched to specific load requirements for each system. Operation of variable frequency drive shall not overstress motor insulation.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Manufacturer's literature, illustrations, specifications, and engineering data that indicate performance, dimensions, materials, size, and weight.
2. Fabrication, assembly, and installation drawings.
3. Schematic and wiring diagrams.
4. Complete list of components and catalog identification.
5. Description of Supplier's quality assurance program.
6. Complete functional description of system operation.
7. VFD Heat Dissipation System:
a. Complete information on VFD heat rejection/cooling system, including fan dimensions, output in standard cubic feet per minute, fan design discharge pressure, and fan manufacturer's literature and specifications, and fan curves.
b. VFD heat loss at full load.
8. Product Data:
a. Manufacturer's equipment datasheets and technical information.
9. Testing Plans:
a. Not less than thirty days prior to source quality control testing, submit descriptions of proposed shop testing methods, procedures, apparatus, and limitations.
b. Not less than thirty days prior to source quality control testing, submit descriptions of proposed field testing methods, procedures, apparatus, and limitations.

B. Informational Submittals: Submit the following:
1. Certificates:

a. Certification letters from VFD manufacturer and motor manufacturer that the approved driven equipment has been reviewed and that VFD units and motors are compatible and shall be provided in accordance with the Contract Documents and requirements of the driven equipment.

2. Source Quality Control Submittals:
   a. Within five days of completing source quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
3. Field Quality Control Submittals:
   a. Within five days of completing field quality control tests and inspections, submit test results with indication of whether all criteria of the Contract Documents for the specified equipment were met.
4. Manufacturer Reports:
   a. Within five days of each visit to the Site by manufacturer's representative, submit written report of reason for visit, problems encountered, solutions implemented, and remaining work.
5. Qualifications Statements:
   a. Manufacturer, when requested by ENGINEER.

C. Closeout Submittals: Submit the following:
1. Operation and Maintenance Data:
   a. Submit complete installation, operation and maintenance manuals including test reports, maintenance data and schedules, description of operation, list of recommended spare parts, and spare parts ordering information.
   b. Manuals shall include record drawings of control schematics, including point-to-point wiring diagrams.
   c. Include a listing of all programmable drive parameters and their settings at Substantial Completion. Submit parameters as both printed pages in the operations and maintenance manual and in electronic format on compact disc that can be directly uploaded to the drive in event of drive replacement or repair.
   c. Comply with Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
1. Packing:
   a. Inspect prior to packing to ensure that assemblies and components are complete and undamaged.
   b. Protect mating connections.
   d. Cover all openings into enclosures with-vapor inhibiting, water-repellent material.
   e. Indoor containers shall be bolted to skids.
2. Upon delivery, check materials and equipment for evidence of water that

may have entered equipment during transit.

3. Handling:
   a. Lift, roll or jack variable frequency drive equipment into locations shown.
   b. Variable frequency drives shall be equipped for handling required for installation. Handle equipment in accordance with manufacturer's requirements.

B. Storage and Protection:
   1. Store variable frequency drive equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

1.6 WARRANTY

A. The manufacturer shall provide a single warranty against faults and defects in material and workmanship for a period of 24 months of operation from the date of successful commissioning. Warranty shall provide for free replacement or repair of parts during that time period including all necessary labor. Warranty shall be administered by the manufacturer or its authorized service representative. A warranty statement including these features shall be provided with submittals and executed versions included as part of the operational and maintenance data.

PART 2 – PRODUCTS

2.1 VARIABLE FREQUENCY DRIVE

A. General:
   1. VFD shall be a six-pulse diode rectifier, suitable for operation on a 480 VAC, three phase power supply. VFD shall produce a variable AC voltage/frequency output to vary speed of driven equipment.
   2. The VFD shall be provide continuous operation over the normal system 30 to 100 percent speed range. VFD shall be capable of sustained operation at 1/10 speed to facilitate checkout and maintenance of driven equipment.
   3. VFDs shall be UL listed and designed, built, and tested in accordance with UL 489, NEMA ICS 2, NEMA ICS 7, and UL 508.
   4. VFDs shall meet all requirements of the most current edition of IEEE 519 for total harmonic voltage and current distortion and as indicated in this Section. Individual or simultaneous operation of the VFDs shall not add more than three percent total harmonic voltage distortion while operating. Maximum allowable total harmonic current distortion limits for each VFD shall not exceed five percent as calculated and measured at the point of common coupling. The point of common coupling for all harmonic calculations and field measurements for both voltage and current distortion

shall be defined as the nearest upstream motor control center or switchgear as applicable.

5. VFD switching frequency shall be adjustable and allow operation at 5,000 Hertz or less. Controller technology shall include a switching scheme that reduces the dv/dt of output supply.
6. Provide VFD with a three-percent DC bus reactor or input line reactor.
7. VFD's solid state converter input section switching devices shall have 1600 volt PIV rating.
8. Overload rating of 150 percent for one minute.
9. Able to withstand output terminal line-to-line short circuits without component failure.

B. Ratings:

1. Nominal voltage: 480 VAC (±10 percent) three phase, three wire. Include an under-voltage feature to allow trip-free operation down to 35 percent undervoltage.
2. Withstand/Interrupting Rating: Equal to or greater than the short circuit withstand and interrupting rating of the upstream overcurrent protection device.
3. Nominal frequency: 60 Hertz (± 3 Hertz)
4. Volts per hertz ratio (V/Hz): Adjustable from 3 to 60 Hertz.
5. Frequency accuracy: ±0.5 percent at 25 degrees C.
6. Input power factor: 0.95 minimum from 70-100 percent operating speed.
7. Efficiency: Minimum 96 percent at full speed and full load.
8. Ambient temperature: 0 to 40 degrees C.
9. Operational humidity: Up to 90 percent non-condensing.
10. Altitude: 1000 feet above sea level.
11. Overload capacity shall be one minute at 150 percent of continuous rated nameplate current. The inverter shall be designed to not be internally shutdown within the 150 percent overload operating range.
12. Acceleration time: 1 to 3600 seconds adjustable.
13. Dynamic braking: 12 percent standard.
14. Ramp to stop: 1 to 3600 seconds adjustable.
15. Nominal horsepower for driven equipment is indicated on the Drawings. The VFD shall be supplied with the necessary current ratings to properly operate the connected load. Coordinate with the approved manufacturer of the equipment / motor for required operating currents.
16. Provide all electronic circuit boards with conformal coating for protection of components from corrosion, humidity, heat, and airborne dirt and dust.

C. Features:

1. Controller shall have the following features:
   a. Digital keypad and display module shall provide parameter setting, adjustments, and monitoring of control functions and faults. Display messages shall be in English.

b. Independent acceleration/deceleration rates shall provide two to 600 seconds minimum. When called to stop, motor shall decelerate to minimum speed before stopping.
c. Power loss feature shall allow five cycle ride through capability for input supply interruptions.
d. Time delay automatic restart shall allow restart after controller fault conditions with programmable attempts.
e. Coasting motor restart shall allow controller to restart into a spinning motor without damage or tripping. If the motor is spinning in reverse, the VFD shall engage the motor in the reverse direction, bring the motor to a controlled stop and then accelerate the motor to the preset speed.
f. An undervoltage condition of less than 30 milliseconds (ms) duration shall not affect drive operation. The VFD shall be able to operate at 85 percent full load current without any disturbances in output power delivered to the load. If the main power source falls below 85 percent of rated voltage, the VFD shall decelerate the load in an attempt to "ride through" the undervoltage condition. The manufacturer shall provide an option which allows control power to be maintained for 100 ms in the event of a power failure. If the power failure exceeds this, the VFD shall automatically restart upon restoration of full rated voltage.

D. Drive Protection:
1. VFD shall have protective functions as follows:
a. Input line metal oxide varistor transient protection.
b. Electronic overcurrent instantaneous trip protection and inverse time overload protection with thermal memory retention.
c. Short circuit trip (hall-effect current transformer).
d. DC bus overvoltage trip.
e. DC bus fuses.
f. High temperature trip protection.
g. Overcurrent trip protection. Current limit circuitry shall automatically phase back voltage and frequency to decrease current to 110 percent of the drive rated capacity. This shall be programmable based on motor full load amps.
h. Input line overvoltage and undervoltage trip protection with automatic restart on voltage recovery.
i. Momentary power failure trip (greater than 100 ms) with automatic restart.
j. The VFD shall be able to withstand phase-to-phase and phase-to-ground shorts without damage to the drive unit.
k. Ground fault trip protection.
l. Fault trip conditions, except short time or momentary line voltage loss or line voltage momentary dip, shall lock out the VFD control.

Resetting of control after fault trip shall be manual by a door-mounted pushbutton.

m. Auto restart shall be a standard feature of the drive as follows:
   1) Auto restart shall be enabled or disabled by programming or jumper selection.
   2) On auto restart selection, the microprocessor shall determine, in the event of a fault, if a restart should be attempted. A restart shall be attempted under the following conditions:
      a) Undervoltage (UP): Every time as soon as voltage returns to a safe level. Fault relay shall not be activated.
      b) Input Overvoltage (OPS): Every time as soon as voltage returns to a safe level. Fault relay shall be activated for the duration of the high voltage condition.
      c) Overcurrent (OC): Five attempts in 30 seconds. After the fifth overcurrent event, the drive shall trip out and latch the fault relay.

n. A restart shall not be attempted for any other type of fault and the drive shall trip out immediately, activate the fault relay, and display fault information on the display until the drive is reset by pressing the reset button or removing control power.

2.2 MANUFACTURERS

A. Provide variable frequency drives manufactured by one of the following:
   1. ABB.
   2. Danfoss.
   3. Eaton.

2.3 CONTROLS AND AUXILIARY DEVICES

A. General:
   1. Variable frequency drive control shall include status indicators, controller keypad, and system fault condition displays and operating controls. Provide status indicators and operating controls associated with drive control on front door of enclosure.
   2. Equip each variable frequency drive control system with relays, switches, fuses, indicating lights, and components required for a complete, functional system and as shown on the Drawings.
   3. Control arrangement shall be such that variable frequency drive internal electronic supply voltage is isolated from field wiring.

B. Wiring and Device Identification:
   1. Provide control wiring and device identification for each variable frequency drive:

a. Identify all control conductors with permanent type wire markers. Each wire shall be identified by a unique number and shall be attached to wire at each termination point.
b. Identify each control device with permanent type marker. Each device shall be identified by a unique number and shall be attached to each device.
c. Numbering system for each wire and control device shall be identified on wiring diagrams and shall reflect actual designations used in the Work.

2.4 ENCLOSURE

A. Provide each VFD and associated components within a wall-mounted, front-access, NEMA 1, filtered and gasketed enclosure. Enclosure shall house all components required for the associated variable frequency drive and shall be UL listed.

B. Enclosure shall provide adequate cooling for components within and include positive ventilation.

C. Enclosures shall include a main circuit breaker provided in accordance with UL 489 with an associated circuit breaker disconnect switch. The disconnect switch handle shall be suitable for padlocking in the “open” position and shall be through-the-door type with handle height not exceeding six feet. Operation of switch shall remove the service supply from all internal components. Power devices shall be suitable for interrupting capacity of 65,000 RMS symmetrical amperes. Include current limiting semi-conductor fuses where required for protection of solid state components.

D. Enclosure door shall include an operator interface for access to the controller’s digital keypad/display and shall contain equipment operator devices and nameplates as specified herein. Operator devices shall be industrial, heavy duty type, 30.5 mm round, oil-tight NEMA 4X construction with clearly marked legend plates as manufactured by the approved VFD manufacturer. Indicating lights shall be 120VAC, LED push-to-test type. LED lamp and lens color shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

E. Provide control and timing relays as manufactured by the approved VFD manufacturer with relay contacts rated for 10A at 120VAC/24VDC. Provide phenolic type terminal blocks suitably labeled for all internal and remote wiring requirements, plus twenty percent spare.

F. Provide enclosure with nameplates for identification of equipment and operating functions. Nameplates shall be in accordance with Section 26 05 53, Identification for Electrical Systems.

2.6 SOURCE QUALITY CONTROL

A. Tests:
   1. Perform factory tests on each variable frequency drive prior to shipping. Tests shall consist of simulating expected load to be driven by operating load through speed ranges specified for driven equipment, for minimum of two hours per drive unit.
   2. Provide factory control and alarm tests on each drive unit by simulating each control signal and each alarm function to verify proper and correct drive unit action.
   3. Perform specified tests in addition to standard factory tests typically performed.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment in accordance with manufacturer's recommendations and instructions and in conformance the Contract Documents.

B. Install equipment with sufficient access and working space provided for ready and safe operation and maintenance.

C. For installations against masonry walls, provide an insulation board, 1/4-inch minimum thickness, between equipment and wall for corrosion protection. Trim board neatly within outline of equipment.

D. Install all terminations, lugs, and required appurtenances necessary to properly terminate power supplies.

E. Install control wiring terminations and appurtenances necessary to complete installing control and monitoring devices.

F. Immediately prior to Substantial Completion, replace all enclosure filters and frames provided under this Contract with new filters and frames, except expanded metal filter types. Immediately prior to Substantial Completion, clean expanded metal filters.

3.3 FIELD QUALITY CONTROL

A. Site Tests:
   1. After installation, inspect, adjust, and test each variable frequency drive at the Site. Testing and inspection shall be in accordance with manufacturer's recommendations and be performed by manufacturer's factory-trained representative. Through CONTRACTOR, manufacturer's factory-trained representative shall inform OWNER and ENGINEER when equipment is correctly installed and ready to be energized. Do not energize equipment without permission of OWNER.
   2. Perform the following equipment inspection and testing and provide reports documenting procedures and results.
      a. Verify all device settings and drive adjustments.
      b. Inspect all mechanical and electrical interlocks and controls for proper operation.
      c. Test each drive through specified speed ranges and loads for a minimum of two hours per drive unit.
      d. Test each drive by using actual control signal for remote and local operation.
      e. Test each drive alarm function.
      f. Perform other tests recommended by equipment manufacturer.

B. Manufacturer Services:
   1. Manufacturer's factory-trained representative shall check and approve the installed equipment before initial operation. Manufacturer shall calibrate, set and program variable frequency drives provided. Services by manufacturer's representative under this paragraph shall be at least one (1) eight-hour day at the Site.
   2. Manufacturer's factory-trained representative shall adjust the system to final settings as specified in this Section.
   3. Representative shall revisit the Site as often as necessary until all deficiencies are corrected, prior to readiness for final payment.
   4. Provide services of manufacturer's factory-trained representatives to correct defective Work within 72 hours of notification by OWNER during the correction period specified in the General Conditions as may be amended by the Supplementary Conditions.
   5. Replacement parts or equipment provided during the correction period shall be equal to or better than original.
   6. Training: Provide services of qualified factory trained specialists from manufacturer to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction, and other qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.

+ + END OF SECTION + +

SECTION 26 29 33

CONTROL STATIONS

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install pushbuttons, selector switches, indicating lights and other operator devices as specified herein and shown on the Drawings.
   2. Field mounted operator devices shall be installed in an enclosure specifically manufactured for operator devices and shall be provided with the applicable NEMA rating.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 29, Hangers and Supports for Electrical Systems.
   3. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. NEMA ICS 2, Controllers, Contactors and Overload Relays Rated 600 Volts.
   2. NEMA ICS 5, Industrial Control and Systems: Control-Circuits and Pilot Devices.
   3. NEMA ICS 6, Industrial Control and Systems Enclosures.
   4. NEMA 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
   5. UL 508, Industrial Control Equipment.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Obtain all control stations furnished under this Section from a single manufacturer.
   2. Components shall be suitable for the specified application and shall be integrated into the overall assembly by control station manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Listing of control stations to be furnished with their location, rating,

and NEMA enclosure type.

b. Wiring diagrams, device layout, bill of material and dimensional information including internal and external elevations.

2. Product Data:
   a. Manufacturer's technical information and specifications for control stations proposed for use.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Control Stations:
   1. Manufacturers: Provide products of one of the following:
      a. Eaton.
      b. Schneider Electric/Square D Company.
      c. Or equal.
   2. Operator Devices: Industrial, heavy duty, 30.5 mm round, oil-tight construction with clearly-marked legend plates. NEMA 4X construction.
   3. Emergency Stop or Lockout Stop: Lockout stop pushbuttons shall be two-position, push-pull type with maintained contact and mushroom head. Provide control stations with padlocking attachment and legend plate reading "PUSH-TO-STOP".
   4. Pushbuttons: Momentary or maintained types, NEMA A600 contact rating.
   5. Selector Switches: Rotary type with round or oval handles. Positioning device to securely hold switch in selected position for maintained type and for spring return from both left and right to maintained position.
   6. Potentiometer: Wire-wound, precision, single turn type with stainless steel shaft and skirted round knob. Provide resistance-to-current converters as required for application.
      a. Resistance tolerance: + 5 percent.
      b. Resistance Range: As required by application.
      c. Dielectric Strength: 1000 VAC for 60 seconds.
      d. Working Voltage: 500V max.
      e. Power Rating: 2W minimum.
   7. Control stations shall comply with NEMA ICS 2, NEMA ICS 5, and UL 508, and shall bear the UL label.
   8. Indicating Lights: 120VAC, LED push-to-test type. LED lamp and lens color shall be in accordance with Section 26 05 53, Identification for Electrical Systems.
   9. Enclosures: NEMA 4X Type 316 stainless steel.
   10. Identification: Identify enclosures in accordance with Section 26 05 53, Identification for Electrical Systems. Devices shall include front-mounted nameplates identifying function and equipment controlled, if not readily apparent.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work will be installed and notify ENGINEER in writing of conditions detrimental to proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions are corrected.

3.2 INSTALLATION

A. Install equipment as shown and provide sufficient access and working space for safe operation and maintenance.

B. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide independent supports where no wall or other surface exists, in accordance with Section 26 05 29, Hangers and Supports for Electrical Systems.

+ + END OF SECTION + +

[THIS PAGE LEFT BLANK INTENTIONALLY]

SECTION 26 50 00

LIGHTING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install lighting fixtures and associated controls as shown on the Drawings.

B. Related Sections:
   1. Section 26 05 05, General Provisions for Electrical Systems.
   2. Section 26 05 53, Identification for Electrical Systems.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. IECC - International Energy Conservation Code.
   2. NFPA 70 - National Electrical Code (NEC).
   3. UL 924 - Standard for Emergency Lighting and Power Equipment.
   3. UL 8750 - Standard for Light Emitting Diode (LED) Equipment for Use in Lighting Products.

1.3 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Schedule of light fixtures to be furnished, indicating fixture type and location.
      b. Light pole foundation details and anchoring requirements.
   2. Product Data:
      a. Manufacturer’s technical information, specifications, standard wiring diagrams, and datasheets for lighting fixtures proposed.
      b. Fixture construction details and overall dimensions.
      c. Photometric data for each fixture proposed.
      d. Complete listing of fixture ratings.

1.4 QUALITY ASSURANCE

A. Qualifications:

1. Manufacturer: Shall have not less than five years' experience in manufacturing similar lighting fixtures of the type required for the Project. When requested by ENGINEER, submit list of installations in satisfactory operation for compliance.
2. All lighting fixtures shall be UL or ETL labeled and conform to applicable standards.

1.5 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery:
1. Upon delivery, inspect equipment for evidence of water that may have entered equipment during transit.

B. Storage:
1. Store lighting fixtures, controls, related materials and equipment in clean, dry location with controls for uniform temperature and humidity. Protect materials and equipment with coverings and maintain environmental controls.
2. Store materials and equipment for easy access for inspection and identification. Keep materials and equipment off ground, using pallets, platforms, or other supports. Protect materials and equipment from corrosion and deterioration.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General: Lighting fixtures shall be provided per mounting requirements and ratings indicated on the Drawings.

B. Construction: All lighting fixtures shall be high-efficiency, LED type and provided as a complete assembly consisting of luminaire housing, LED array, electronic driver (power supply) and integral dimming controls. Electronic driver shall provide minimum 80% efficiency at full load. Provide integral surge protection against outside noise and interference in accordance with ANSI/IEEE C64.41.

C. Ratings:
1. Input Voltage: 120VAC (±10%), 50/60Hz.
2. Efficiency: 80% minimum.
3. Minimum lifespan: 50,000 hours at 70% lumen maintenance (L70).
4. Color rendering index (CRI): 80.
5. Color temperature: 4000K.
6. Total harmonic distortion (THD): 20% maximum.
7. Power factor: 0.9 minimum.
8. Temperature: Rated for -20 degrees C to 40 degrees C operation.

D. Hardware: Provide all necessary hangers, supports, conduit adapters, reducers, hooks, brackets, and other hardware required for safe fixture mounting. Hardware shall have protective, non-corrosive finish.

E. Outdoor Fixtures: Provide each fixture to be installed outdoors with full cut-off distribution lens to reduce light pollution emissions.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
   1. Fixture mounting heights and locations indicated on the Drawings are approximate and are subject to revision in the field where necessary to clear conflicts and obstructions.
   2. Mounting Heights: Mounting heights or elevations are to bottom of fixture or to centerline of device.
   3. Install fixtures in accordance with the Contract Documents and manufacturer instructions and recommendations.
   4. Mount fixtures so that sufficient access is available for ready and safe maintenance.
   5. Securely fasten equipment to walls or other surfaces on which equipment is mounted. Provide hanger rods with channel supports anchored to structure for adequate support of fixtures.

B. Boxes and Fixtures:
   1. For units mounted against masonry or concrete walls, provide suitable 1/2-inch spacers to prevent mounting back of box directly against wall.
   2. Bolt units rigidly to building with expansion anchors, toggle bolts, hangers, or Unistrut.
   3. Do not install boxes with open conduit holes.
   4. Cable each circuit and identify with tag.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 26 51 00

HEAT TRACING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide heat tracing for sustaining effluent water and FOG (Fat, Oils and Grease) in exposed piping above minimum temperatures where indicated on the Drawings. CONTRACTOR shall provide heat tracing in accordance with the requirements of this Section and information shown on the Drawings.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the heat tracing of process piping and equipment Work.

C. Related Sections:
   1. Division 26, Electrical.
   2. Section 40 42 00, Insulation of Process Piping and Equipment.

1.2 REFERENCES

A. Heat tracing to comply with the latest applicable provisions and recommendations of the following:
   1. American Society of Testing and Materials (ASTM).
   2. Institute of Electrical and Electronic Engineers (IEEE).
      a. IEEE 515 – Testing, Design, Installation and Maintenance of Electrical Resistance Heat Tracing for Industrial Applications.
      b. IEEE 622 – Design and Installation of Electric Heat Tracing.
   3. National Electrical Manufacturer’s Association (NEMA).
   4. National Fire Protection Association (NFPA).
      a. NFPA 70 - National Electrical Code (NEC).
   5. Underwriters Laboratories, Inc. (UL).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years’ experience of producing substantially similar equipment/systems and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section from a single heat tracing equipment manufacturer.
   2. The heat tracing equipment manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. The heat tracing system supplier shall provide calculations verifying power requirements and components necessary to maintain the piping at the specified temperatures.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Manufacturer's literature, illustrations, specifications, and engineering data that indicate performance, dimensions, materials, size, and weight.
   2. Schematic and wiring diagrams.
   3. Bill of Materials with complete list of components and catalog identification.
   4. Layout drawings showing physical locations of power taps, power supplies, and thermostats. Include length, size and type of heat tape for each pipe size and run on the drawings.
   5. Sizing calculations for confirming operating power requirements for each run of heat trace. Calculations shall include:
      a. Ambient temperature and wind loss used.
      b. Temperature maintained in material.
      c. Circuit breaker rating based upon inrush current at minimum expected start-up temperature.
      d. Verify length and watts/foot of heat tape required based upon pipe size and insulation thickness.
      e. Power requirements for each circuit based upon actual length of heat trace and maintained temperature.

B. Informational Submittals: Submit the following:
   1. Field Quality Control Submittals: Submit certified test reports of field testing.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.
   2. Material shall be packed and shipped in corrugated carton.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store all materials in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
   3. Store material in clean, dry area, out of the weather.
   4. Material shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.
   5. Material shall remain in original cartons until time of installation.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers:
   1. Raychem.
   2. Chromalox.
   3. Thermon.

2.2 SERVICE CONDITIONS

A. Pipe heat tracing system shall be provided as shown on the Drawings and as specified to maintain water and FOG piping above 70°F throughout the following ambient conditions:
   1. Minimum ambient temperature for design of heat tracing is 15°F.
   2. Average minimum ambient temperature ranges from 32°F to 100°F.
   3. 20 mile per hour wind.

B. Heat tracing calculations should be performed with the assumption that the liquid in the piping is not moving, that the heat tracing will be installed outside a layer of insulation.

2.3 MATERIALS

A. Self-regulating heating cable:
   1. Cables shall vary the heat output relative to the temperature of the surface of the pipe and shall allow the cable to be crossed over itself without overheating.
   2. Cables shall be designed so that the material can be cut to any length without significantly changing the heater output per unit length.
   3. Cables shall be rated for 225°F, 120VAC and be UL listed. Cable construction shall consist of stranded copper bus wires, self-regulating semi-conductive core, fluoropolymer jacket, tinned copper shield and fluoropolymer outer jacket.
   4. The outer jacket of fluoropolymer shall be provided of suitable thickness and corrosion resistant properties to prevent corrosion.

B. Heat Trace Distribution Panel:
   1. The heat tracing system shall be provided with a UL listed power distribution panel consisting of a panelboard with a main circuit breaker and 20A/1P GFEP type branch circuit breakers that provide 120V power to each heat tracing circuit. Circuit breakers shall provide a 30mA trip setpoint for ground fault protection.
   2. Enclosure shall be NEMA 4X 316 SS construction. Main circuit breaker shall be provided with an associated through-the-door type disconnect switch mounted on the outside of the enclosure. Operation

of the disconnect switch shall remove power from all internal components. Provide equipment nameplate identifying the enclosure in accordance with Section 26 05 53, Identification for Electrical Systems.

3. Provide Raychem HTPG or approved equal.

C. Heat Trace Connection Enclosure:

1. Power connection kit with electronic controller for connecting each heat tracing circuit to the power circuit. Provide controller with digital display for indicating monitored and setpoint temperatures and pushbuttons for programming set point temperature. Controller shall be rated 120VAC and shall be capable of switching current up to 30A.
2. Enclosure shall be NEMA 4X construction with a single entry point for connection of external power connection, heating cable, and sensing RTD connection.
3. Provide Raychem JBS-100-ECP-A or approved equal.

D. Lighted End Seal:

1. Each cable shall be provided with an LED type lighted end seal kit for termination of cable and for providing indication that 120V power is present at the end seal.
2. End seals shall be impact resistant, high temperature, and UV resistant construction and shall prevent ingress of moisture and dust.
3. Provide Raychem E-100-LA or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Inspect items immediately upon delivery to site for damage. Test each reel of heat cable to determine that the cable has not been damaged in shipment.

B. Install items as shown on the Drawings and in conformance with the manufacturer's installation instructions and recommendations. Provide fibrous glass tape utilizing thermosetting electrical grade adhesive with low halide content to fix heater to piping in 1 foot intervals, unless otherwise recommended by the manufacturer.

C. Do not exceed the manufacturer's recommended maximum length per circuit.

D. Install heat tracing in straight runs on the pipe. Spiral wrapping is not acceptable.

E. Provide peel-off self-sticking black on yellow "Electric Traced" warning labels for every ten feet of pipe along the outer insulation covering. Labels shall be Raychem ETL, or approved equal.

F. Provide required mounting and control accessories, including bolts, nuts, ties, junction boxes and adhesives.

G. Install heating elements before insulation is installed and piping has been tested, inspected and released for application of heating elements and insulation.

H. Install vapor/moisture barrier at penetrations through and terminations of the weatherproof jacket including but not limited to pipe supports, fittings and jacket terminations. Apply vapor/moisture barrier the same day as weatherproof jacketing is installed.

I. Verify that insulation is dry when installed, and before and during application of weatherproof jacketing.

3.2 TESTING

A. Testing shall be performed in accordance with the latest edition of IEEE 515 and applicable manufacturer's standards. Documentation of test results shall be submitted to the ENGINEER and shall verify the following:
   1. Heating cable model numbers and associated ratings.
   2. Insulation resistance of individual circuit heating cables.
   3. Location of connection enclosures, end seals, and other system components for each circuit as shown on the submittal layout drawings.
   4. Confirmation lighted end seals are operational upon application of circuit voltage.

+ + END OF SECTION + +

SECTION 31 20 00

EARTH MOVING

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals required to perform all excavating, filling, and grading, and disposing of earth materials as shown, specified, and required for construction of structures, Underground Facilities, roads, and other facilities required to complete the Work.
   2. Preparation of subgrade for slabs and pavements is included under this Section.
   3. No classification of excavated materials will be made. Excavation includes all materials regardless of type, character, composition, moisture, or condition thereof.

C. Related Sections:
   1. Section 03 00 05, Concrete.

D. General:
   1. The soils encountered generally consist of black loose to medium dense FILL, classified as Silty Sand (SM) in the upper 8 feet, underlain by medium dense Silty Sand (SM) to a depth of 15 feet. Below 15 feet, the soils encountered consist of medium dense Poorly Graded Sand with Silt (SP-SM) to boring termination. Debris was encountered in the upper 8 feet. Overall, the soils were brown, and dry to moist at the time of the field exploration.
      Based upon the information gathered from the soil borings and laboratory testing, the soils encountered at this site within the seasonally active zone have a low potential for expansion and are not considered a design concern for this project. However, the site has low blow count fill soils in the upper 4 feet and will require remediation. The structure can be placed on conventional spread footings with a soil supported floor slab.
      Building pad improvement should consist of removing the upper soils to the recommended minimum over-excavation depth, compacting the exposed subgrade, and placement and compaction of the select fill to finish floor grade.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/AISC 360, Specification for Structural Steel for Buildings.

2. ASTM D422, Test Method for Particle-Size Analysis of Soils.
3. ASTM D698, Test Methods for Laboratory Compaction Characteristics of Soil Using Standard Effort (12 400 ft-lbf/ft^3 (600 kN-m/m^3)).
4. ASTM D1556, Test Method for Density and Unit Weight of Soil in Place by the Sand-Cone Method.
5. ASTM D1557, Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
6. ASTM D2216, Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
7. ASTM D4253, Test Methods for Maximum Index Density and Unit Weight of Soils Using a Vibratory Table.
8. ASTM D4254, Test Methods for Minimum Index Density and Unit Weight of Soils and Calculation of Relative Density.
9. ASTM D4318, Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
11. ASTM D6938, Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
12. ASTM E329, Specification for Agencies Engaged in Construction Inspection and/or Testing.

B. Geotechnical Engineering Report. June 4, 2021 by Professional Service Industries, Inc.

1.3 TERMINOLOGY

A. The following words or terms are not defined but, when used in this Section, have the following meaning:
   1. “Subgrade” is the uppermost surface of native soil material unmoved from cuts; the bottom of excavation.

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 the materials specified in this Section.
      b. Do not employ the same laboratory hired by OWNER for field quality control testing under the field quality control Article of this Section.
      c. Testing laboratory shall comply with ASTM E329 and requirements of Section 01 45 29.13, Testing Laboratory Services Furnished by Contractor.
      d. Testing laboratory shall be experienced in the types of testing required.
      e. Selection of testing laboratory is subject to ENGINEER's acceptance.

B. Quality Assurance Testing:
   1. Quality assurance testing is in addition to field quality control testing required under Part 3 of this Section.

2. Materials used in the Work may require testing and retesting, as directed by ENGINEER, during the Project. Allow free access to material stockpiles and facilities at all times. Tests not specifically indicated to be performed at OWNER's expense, including retesting of rejected materials and installed Work, shall be performed at CONTRACTOR's expense.
3. CONTRACTOR's Testing Laboratory Scope:
   a. Collect samples and perform testing of proposed fill materials in the laboratory and in the field to demonstrate compliance of the Work 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 ENGINEER and CONTRACTOR written report results of each test.
4. Required Quality Assurance Material Testing by CONTRACTOR's Testing Laboratory:
   a. Gradation in accordance with ASTM D422. Perform one test for every 1,000 cubic yards of each material incorporated into the Work.
   b. Atterberg limits in accordance with ASTM D4318. Perform one test for every 1,000 cubic yards of the following types of materials incorporated into the Work: general fill, and pipe bedding material.
   c. Moisture/density relations in accordance with ASTM D698, ASTM D1557, ASTM D4253, or ASTM D4254, as applicable. Perform one test for every 5,000 cubic yards of each material incorporated into the Work.
   d. Moisture content of stockpiled or borrow material in accordance with ASTM D2216. Perform one test for every 1,000 cubic yards of each material incorporated into the Work.

C. Regulatory Requirements:
1. Perform excavation work in compliance with requirements of authorities having jurisdiction and Laws and Regulations, including:
   a. OSHA, 29 CFR Part 1926, Section .650 (Subpart P – Excavations).
2. Obtain required permits and approvals for excavation and fill Work, including work permits from right-of-way owners and permits from environmental authorities having jurisdiction over discharge of water from excavations.

1.5 SUBMITTALS

A. Action Submittals: Submit the following:
1. Shop Drawings:
   a. Modifications to the Work proposed due to intended excavation plan.
2. Samples:
   a. Submit Sample of each aggregate and soil material required under this Section. Deliver Samples to Resident Project Representative. Samples shall be of sufficient size to demonstrate the array of gradation and material types expected in the Work.

B. Informational Submittals: Submit the following:
   1. Procedure Submittals:
      a. Excavation Plan: Prior to starting excavation operations, submit written plan to demonstrate compliance with OSHA 29 CFR Part 1926.650. As a minimum, excavation plan shall include:
         1) Name of CONTRACTOR's "competent person" in responsible charge of excavation and fill Work.
         2) Excavation method(s).
         3) Copies of required permits and approvals, from authorities having jurisdiction and affected utility owners, for excavation methods proposed.
      b. Proposed 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.
   2. Quality Assurance Test Results Submittals:
      a. Submit results of quality assurance testing performed by in accordance with Paragraph 1.4.B of this Section, unless included as part of another submittal under this Section. Submit results for the following quality assurance testing:
         1) Tests on borrow fill material.
         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) Field density testing.
         2) Tests of actual unconfined compressive strength or bearing tests of each stratum.
   4. Qualifications Statements:
      a. Quality Assurance Testing laboratory. Submit name and qualifications of testing laboratory to be employed, and qualifications of testing laboratory's personnel that will perform quality assurance testing required in this Section.

1.6 SITE CONDITIONS

A. Subsurface Information: The Supplementary Conditions indicate information available relative to subsurface conditions at the Site. Such information and data is 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. OWNER will not be responsible for interpretations or conclusions drawn therefrom by CONTRACTOR.

B. Soil borings and other exploratory operations may be made by CONTRACTOR, at no additional cost to OWNER. Coordinate CONTRACTOR-performed test

borings and other exploratory operations with OWNER and utility owners as appropriate. Perform such explorations without disrupting or otherwise adversely affecting operations of OWNER or utility owners. Comply with Laws and Regulations relative to required notifications.

C. Existing Structures:
   1. 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 OWNER.
   2. Movement or operation of construction equipment over Underground Facilities shall be at CONTRACTOR's sole risk and only after CONTRACTOR has prepared and submitted to ENGINEER and utility owners (as applicable), and received acceptance therefrom, a plan describing CONTRACTOR's analysis of the loads to be imparted and CONTRACTOR's proposed measures to protect structures and Underground Facilities during the Project.
   3. Coordinate with utility owners for shut-off of services in active piping and conduits. When required by utility owner, OWNER 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.
   4. Not used.
   5. Do not interrupt existing utilities serving facilities occupied and used by OWNER or others, except when such interruption is indicated in the Contract Documents or when allowed in writing by ENGINEER after acceptable temporary utility services are provided by CONTRACTOR for the affected structure or property.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Select Fill:
   1. Material shall be well-graded, crushed aggregate, free of organic material, complying with the following in accordance with the Geotechnical Engineering Report:

Existing Soils Used as Structural Fill	To properly prepare the native soils to receive fill or support various project elements, over-excavated soil that can be used as engineered structural fill should be stockpiled on the site. The on-site material proposed for reuse as

	structural fill should be verified by the Geotechnical Engineer to meet structural fill requirements prior to placement.
Structural Fill Thickness	4 feet minimum + as required to achieve bottom of tank slab elevation
Engineered Structural Fill Material Requirements	Materials to be used for engineered structural fill should be free of organic or other deleterious materials and should have a maximum particle size less than three (3) inches. They should be classified in accordance with procedures stated in ASTM D2487. Soils will be considered satisfactory for engineered structural fill when classified as follows: GW, GP, GC, GM, GC-GM, GP-GM, GP-GC, SW, SP, SC, SM, SC-SM, SP-SM, SP-SC.
Materials Unsatisfactory for Use as Structural Fill	PT, OL, OH, MH, ML, CL, CH, or, any soil having a plasticity index exceeding 15.
Compaction Considerations	Compaction of the fill material should be performed with appropriate types of power, pneumatic or tamping equipment. Monitoring of the backfilling should include sufficient compaction testing by the Geotechnical Engineering representative to document that each lift of fill has been compacted to the required density prior to placement of subsequent lifts. Any lift or portion of a lift does not conform to the density requirements, should be thoroughly scarified and re-compacted until the required density is obtained. If water must be added, it should be uniformly applied and thoroughly mixed into the soil by disking or scarifying. Care should be taken to apply compactive effort throughout the extent of the fill including any fill slope areas.
Moisture Control	The soils at the site tend to be dry and could dry quickly as a result of low humidity, wind, and/or high temperatures. It is recommended that the moisture content of the prepared soils at the site be maintained throughout construction. Excessive drying (or wetting) can cause surface instability of the native soils.

E. Pipe Bedding Material:
   1. Aggregate 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. Material shall comply with the requirements of Section 3.8.1 of the Geotechnical Engineering Report.

2.2 SOURCE QUALITY CONTROL

A. Perform quality assurance testing, and submit results to ENGINEER, in accordance with the ‘Quality Assurance” Article in Part 1 of this Section.

PART 3 – EXECUTION

3.1 INSPECTION

A. Provide ENGINEER with sufficient notice and with means to examine areas and conditions under which excavating, filling, and grading will be performed. ENGINEER will advise CONTRACTOR in writing when ENGINEER 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.

3.3 PREPARATION

A. Site Preparation:
   1. Clear areas to be occupied by permanent construction of all trees, brush, roots, stumps, logs, wood and other materials and debris. Clean and strip vegetation, sod, topsoil, and organic matter from subgrades where fills will be placed, and from areas where structures will be constructed. Remove from the Site and properly dispose of all waste materials.
   2. Burning is not allowed at the Site.

B. Use of Explosives:

   1. Use of explosives is not allowed.

C. Dust Control:
   1. Control objectionable dust caused by CONTRACTOR's operation of vehicles and equipment, clearing, and other actions. To minimize airborne dust, apply water or use other methods subject to ENGINEER’s acceptance and approval of authorities having jurisdiction.

D. Maintenance and Protection of Traffic:
   1. Hydrants, valves, fire alarm boxes, postal boxes and delivery service boxes, and other facilities that may require access during construction shall be kept accessible for use.
   2. Provide temporary signage, signals, barricades, flares, lights and other equipment, service, and personnel required to regulate and protect traffic and warn of hazards. Such Work shall comply with requirements of owner of right-of-way and authorities having jurisdiction at the Site. Remove temporary equipment and facilities when no longer required, and restore grounds to original or to specified conditions, as applicable.

3.4 EXCAVATION

A. Perform all excavation required to complete the Work as shown, specified, and required. Excavations shall include removing and handling of earth, sand, clay, gravel, hardpan, soft, weathered or decomposed rock, pavements, rubbish, and other materials within the excavation limits.

B. 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. Excavation Less Than Five Feet Deep: Excavations in stable rock or in soil conditions where there is no potential for a cave-in may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.
   3. Excavations Greater Than Five Feet Deep: Excavations in stable rock may be made with vertical sides. Under all other conditions, excavations shall be sloped and benched, shielded, or shored and braced.

C. Maintain excavations in dry condition in accordance with “Dewatering” Article in Part 3 of this Section.

D. Elevation of bottom of footings shown is approximate. ENGINEER may direct such minor changes in dimensions and elevations as may be required to secure a satisfactory footing.

E. When excavations are made below required grades without written order of ENGINEER, fill such excavations with compacted select fill, as directed by ENGINEER, at CONTRACTOR’s expense.

F. Extend excavations sufficiently on each side of structures, footings, and similar construction to allow setting of forms, installation of excavation supports, and the safe sloping of banks, as necessary.

G. Subgrades – General:
   1. Subgrades shall be firm, dense, and thoroughly compacted and consolidated; shall be free from mud, muck, and other soft or unsuitable materials; and shall remain firm and intact under all construction operations. Subgrades that are otherwise solid but become soft or mucky on top due to construction operations shall be reinforced in accordance to section 4.1.1 of the Geotechnical Engineering Report. Finished elevation of stabilized subgrades shall not be above subgrade elevations shown.
   2. If, in ENGINEER’s opinion, subgrade becomes softened or mucky because of construction delays, failure to dewater properly, or other cause within CONTRACTOR’s control, subgrade shall be excavated to firm material, trimmed, and backfilled with select fill material at CONTRACTOR’s expense.

H. Pipe Trench Preparation:

1. Not more than 50 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. Refer to the Drawings for trench requirements. In no case should trench be wider at top of pipe than pipe barrel OD plus two feet, unless otherwise shown or indicated.
   b. Enlargement of trench width at pipe joints may be made when required and approved by ENGINEER.
   c. Trench width shall be sufficient for shoring and bracing, or shielding and dewatering.
   d. Trench width shall be sufficient to allow thorough compaction of fill adjacent to bottom half of pipe.
   e. Do not use excavating equipment that requires the trench to be excavated to excessive width.
3. Depth of trench shall be as shown or indicated. If required and approved by ENGINEER in writing, depths may be revised.
4. Where ENGINEER considers existing material beneath bedding material unsuitable, remove and replace such unsuitable material with select fill material.

3.5 UNAUTHORIZED EXCAVATION

A. All excavations outside lines and grades shown or indicated and that are not approved by ENGINEER, together with removing and disposing of the associated material, shall be at CONTRACTOR's expense. Fill unauthorized excavations with properly-compacted select fill material at CONTRACTOR’s expense.

3.6 EROSION AND SEDIMENT CONTROLS

A. Provide temporary erosion and sediment controls in accordance with Section 01 57 05, Temporary Controls. When applicable, also comply with requirements of the erosion and sediment control plan approved by authorities having jurisdiction.

3.7 TRENCH SHIELDS

A. Excavation of earth material below bottom of trench shield shall not exceed the limits established in Laws and Regulations.

B. When using a shield for installing piping:
   1. Portions of trench shield extending below the mid-diameter of an installed, rigid pipe, such as prestressed concrete pipe and other types of rigid pipe, shall be raised above the pipe’s mid-diameter elevation prior to moving the shield along the trench for further construction.

2. Bottom of shield shall not at any time extend below mid-diameter of installed pipe that is flexible or has flexing capability, such as steel, ductile iron, PVC, CPVC, polyethylene, and other pipe that has flexing capability.

C. When using a shield for installing structures, bottom of the shield shall not extend below the top of the bedding for the structures.

D. When removing the shield or moving the shield ahead, exercise extreme care to prevent moving piping, structures, and other Underground Facilities, and prevent disturbance of bedding material for piping, structures, and other Underground Facilities. When piping, structures, or Underground Facilities are disturbed, remove and reinstall the disturbed items in accordance with the Contract Documents.

3.8 FILL AND COMPACTION – GENERAL PROVISIONS

A. Provide and compact all fill required for the finished grades as shown and as specified in this Section.

B. Place fill in excavations as promptly as progress of the Work allows, but not until completing the following:
   1. ENGINEER's authorization after observation of construction below finish grade, including dampproofing, waterproofing, perimeter insulation, and similar Work.
   2. Inspection, testing, approval, and recording of locations of Underground Facilities.
   3. Removal of concrete formwork.
   4. Removal of shoring and bracing, and filling of voids with satisfactory materials.
   5. Removal of trash and debris.
   6. Permanent or temporary horizontal bracing is in place on horizontally-supported walls.
   7. Field testing of tanks, Underground Facilities including piping and conduits, and water-retaining structures.

C. Fill that includes organic materials or other unacceptable material shall be removed and replaced with approved fill material in accordance with the Contract Documents.

D. Placement – General:
   1. Place fill to the grades shown or indicated. Bring up evenly on all sides fill around structures and Underground Facilities.
   2. Place fill materials at moisture content and density as specified in this Article's requirements on compaction density. Furnish and use equipment capable of adding measured amounts of water to the fill materials to bring fill materials to a condition within required moisture content range. Furnish and use equipment capable of discing, aerating, and mixing the fill materials to ensure reasonable uniformity of moisture content throughout the fill

materials, and to reduce moisture content of borrow materials by air drying, when necessary. When subgrade or lift of 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. Materials at moisture content in excess of specified limit shall be dried by aeration or stockpiled for drying.

3. Perform compaction with equipment suitable for the type of fill material placed. Select and use equipment capable of providing the minimum density required in the Contract Documents. Use light compaction equipment, with equipment gross weight not exceeding 7,000 pounds within horizontal distance of ten feet from the wall of completed, below-grade structures. Furnish and use equipment capable of compacting in restricted areas next to structures and around piping and Underground Facilities. Effectiveness of the equipment selected by CONTRACTOR shall be tested at start of compacted fill Work by constructing a small section of fill within the area where fill will be placed. If tests on the test section of fill indicate that required compaction is not obtained, do one or more of the following: increase the amount of coverages, decrease the lift thicknesses, or use different compactor equipment.
4. Place fill materials in horizontal, loose lifts, not exceeding specified uncompacted thickness. Place fill in a manner ensuring uniform lift thickness after placing. Mechanically compact each lift, by not less than two complete coverages of the 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. Compaction of fill materials by inundation with water is unacceptable.
5. Do not place fill materials when standing water is present on surface of the area where fill will be placed. Do not compact fill when standing water is present on the fill to be compacted. Do not place or compact fill in a frozen condition or on top of frozen material. Fill containing organic 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, CONTRACTOR shall perform all work required to provide the required densities. Such work shall include, at no additional cost to OWNER, complete removal of unacceptable fill areas and replacement and re-compaction until acceptable fill is provided.
7. Repair, at CONTRACTOR's expense, observed or measured settlement. Make repairs and replacements as required within 30 days after being so advised by ENGINEER.

E. Fill Against Concrete:
1. Placing fill against concrete below finished grade is not allowed until the concrete has attained its specified strength, as determined by duration of concrete curing and testing of field-cured concrete cylinders. Requirements for strength and curing time are in Section 03 30 00, Cast-in-Place Concrete.

2. Elevation of fill placed against concrete walls shall not differ by more than two feet on each side of walls, unless walls are adequately braced or all floor framing is in place up to and including grade level slabs.
3. Backfill structural foundation units as soon as practicable, in accordance with this Section, after concrete has gained sufficient strength to avoid damage, to avoid ponding of surface water and accumulation of debris.
4. Where fill is placed against waterproofed surface, exercise care that waterproofing material is not damaged.

F. Fill in Electrical Ductbank Trenches:
1. Provide general fill for full depth of electrical ductbank trench, below and above electrical ductbank. Where one ductbank passes beneath another pipe or ductbank, provide select fill to the elevation of the bottom of upper ductbank or pipe, as applicable.
2. Placing and compacting fill in electrical ductbank trenches shall comply with requirements of Paragraph “G. Fill in Pipe Trenches”, of this Article.

G. Fill in Pipe Trenches:
1. Piping Installed in Fills Above Pre-construction Grade:
   a. Prior to installing piping, place the fill in accordance with the Contract Documents until the fill reaches a minimum elevation two feet higher than the top of piping to be installed. Excavate the trench; install the piping, and backfill. Subsequently provide the remainder of the fill required for the Work.
2. Piping trenches may be backfilled prior to testing of piping, unless nature of the test requires observation of pipe during testing. Do not construct building or structure over piping until piping has been successfully tested and passed.
3. Pipe Bedding: Pipe bettering material shall be as follows:
   a. Install PVC, CPVC, HDPE, and FRP piping on a layer of sand. Sand shall extend to 12 inches above top of pipe and to the trenchwalls on each side of the pipe.
   b. Unless otherwise shown, install other types of piping on not less than six-inch layer of aggregate pipe bedding material. Aggregate pipe bedding material shall extend 12 inches above top of the pipe.
4. Placing and Compacting Pipe Trench Fill: Unless otherwise shown, placement and compaction of pipe trench fill materials shall comply with the following:
   a. 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. Slight disturbance of installed pipe bedding material surface during withdrawal of pipe slings or other lifting tackle is acceptable.
   b. 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 the pipe and back of the bell or end thereof to hold piping in proper

position and maintain alignment during subsequent pipe jointing and embedment operations. Deposit and compact pipe trench fill material uniformly and simultaneously on each side of piping to prevent lateral displacement of piping. Place and compact pipe trench fill material to an elevation 12 inches above top of pipe, unless otherwise shown or specified.

c. Each layer of pipe trench fill material shall be compacted by at least two complete coverages of all portions of surface of each lift using appropriate compaction equipment.

d. Method of compaction and compaction equipment used shall be appropriate for material to be compacted and shall not transmit damaging shocks to the piping.

H. Temporary Pavement:

1. Place 1.5 inches of temporary asphalt concrete pavement immediately after filling excavations in paved roadways and other paved areas that will remain for permanent use.
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, unless otherwise shown or specified.

I. Subbase Placement:

1. Provide subbase material where shown to the limits shown or indicated.
2. Place subbase material in compacted lifts not exceeding depth of six inches each.

J. Drainage Fill Placement:

1. Provide drainage fill material where shown to the limits shown or indicated.
2. Place drainage fill material in compacted layers of uniform thickness not exceeding depth of six inches each. Compact lifts of drainage fill using suitable compaction equipment.

K. Compaction Density Requirements:

1. Minimum density for fill materials shall be 100 percent of maximum density obtained in the laboratory in accordance with ASTM D698. Compaction of fill materials less than five feet below final grade, behind concrete walls, and pipe bedding materials when not located below structures or pavement shall be 95 percent of maximum density in accordance with ASTM D698.
2. Place fill in trenches below Underground Facilities, foundations or paved areas in horizontal, uncompacted lifts not greater than eight inches deep, and thoroughly compact each lift before placing the next lift. In other pipe trenches, horizontal uncompacted lifts shall be six inches deep.
3. Fill shall be wetted and thoroughly mixed to achieve optimum moisture content plus-or-minus three percent, with the following exceptions:
   a. On-site clayey soils: Optimum to plus three percent.

4. Replace natural, undisturbed soils or compacted soil subsequently disturbed or removed by construction operations with materials compacted as indicated.
5. 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 specified in the "Field Quality Control" Article in Part 3 of this Section.
6. When field quality control testing indicates unsatisfactory compaction, provide additional compaction necessary to obtain the specified compaction. Perform additional compaction Work at no additional cost to OWNER until specified compaction is obtained. Such work includes complete removal of unacceptable (as determined by ENGINEER) fill areas and replacement and re-compaction until acceptable fill is provided in accordance with the Contract Documents.

L. Replacement of Unacceptable Excavated Materials: In cases where over-excavation to replace unacceptable soil materials is required, backfill the excavation to required subgrade with select fill material and thoroughly compact in accordance with the "Compaction Density Requirements" in this Article. Slope the sides of excavation in accordance with the maximum inclinations specified for each structure location.

3.9 GRADING

A. 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: Grade areas adjacent to building lines to drain away from structures and to prevent ponding. Finish surfaces free of irregular surface changes, and shall comply with the following:
1. Not used.
2. Not used.
3. Pavements: Shape surface of areas under pavement to line, grade, and cross section, with finish surface not more than 1/2-inch above or below the required subgrade elevation.

C. Grading Surface of Fill Under Concrete Slabs: Grade smooth and even, free of voids, compacted as specified, and to required elevation. Provide final grades within a tolerance of 1/2-inch when tested with a ten foot straight edge.

D. Compaction:
1. After grading, compact subgrade surfaces to the depth and percentage of maximum density for each area classification.

3.10 PAVEMENT SUBBASE COURSE

A. General:
   1. Place subbase material, in layers of specified thickness, over ground surface to support pavement base course.
   2. After completing filling and grading, shape and compact pavement subgrade to an even, firm foundation in accordance with this Section. Remove unsuitable subgrade materials, including soft materials, boulders, vegetation, and loose stones, and replace with compacted fill material as directed by ENGINEER.

B. Grade Control:
   1. During construction, maintain lines and grades including crown and cross-slope of subbase course.

C. Placing of Pavement Subbase Course:
   1. Place subbase course material on prepared subgrade in layers of uniform thickness, in accordance with indicated cross-section and thickness. Maintain optimum moisture content for compacting subbase material during placing operations.
   2. After completing compaction, other than that necessary for bringing material for the next course, do not haul or drive over the compacted subbase.
   3. Do not install pavement subbase in excess of 500 feet in length without compacting to prevent softening of the subgrade.
   4. If subgrade material becomes churned up into or mixed with the subbase material, remove the mixed material and replace with clean, compacted subbase material.

3.11 DISPOSAL OF EXCAVATED MATERIALS

A. General:
   1. CONTRACTOR shall haul away material removed from excavations that does not comply with requirements for fill, or is in excess of the quantity required for fill.
   2. Disposal of materials shall be in compliance with Laws and Regulations, at no additional cost to OWNER.

3.12 FIELD QUALITY CONTROL

A. Site Tests: OWNER will employ a testing laboratory to perform field quality control testing.
   1. Testing Laboratory Scope:
      a. Perform field moisture content and density tests to ensure that the specified compaction of fill materials has been obtained.
      b. Tests of actual unconfined compressive strength or bearing tests on each stratum.
      c. Report results of each test to ENGINEER and CONTRACTOR.

2. Required Material Tests:
   a. Compaction: Comply with ASTM D1556 and ASTM D6938, as applicable.
3. Authority and Duties of Testing Laboratory:
   a. Technicians representing the testing laboratory shall inspect the materials in the field, perform testing, and report findings to ENGINEER and CONTRACTOR. When materials furnished or the Work performed does not comply with the Contract Documents, technician will direct attention of ENGINEER and CONTRACTOR to such failure.
   b. Technician will not act as foreman or perform other duties for CONTRACTOR. Work will be checked as it progresses, but failure to detect defective Work or non-complying materials shall not in any way prevent later rejection when defect is discovered, nor shall it obligate ENGINEER 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.
4. Responsibilities and Duties of CONTRACTOR:
   a. Use of testing laboratory shall in no way relieve CONTRACTOR of the responsibility to provide materials and Work in full compliance with the Contract Documents.
   b. To facilitate testing laboratory, CONTRACTOR shall advise testing laboratory at least two days in advance of filling operations to allow for completion of field quality control testing and for assignment of personnel.
   c. It shall be CONTRACTOR's responsibility to accomplish the specified compaction for fill and other earthwork. CONTRACTOR shall control construction operations by confirmation tests to verify and confirm that CONTRACTOR has complied, and is complying at all times, with the Contract Documents relative to compaction, control.
   d. 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 select fill.
      3) 100 cubic yards of general fill.
      4) 50 cubic yards of subbase material.
5. 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 taken as follows:
   a. Trenches for Structures, and 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. Footing Subgrade: For each stratum of soil on which footings will be placed, perform not less than one test to verify required design bearing capacities. Subsequent verification and approval of each footing subgrade may be based on a visual comparison of each subgrade with related tested strata, when acceptable to ENGINEER.

c. For Select Fill: On 30-foot intervals on all sides of the structure for every compacted lift, but not less than one per lift on each side of the structure for structures less than 60 feet long on a side.

d. For General Fill: One per 1,000 square feet on every compacted lift.

e. Subbase Material: One per 1,000 square feet on every compacted lift.

6. Periodic compliance tests will be made by ENGINEER to verify that compaction is complying with the requirements specified, at no cost to CONTRACTOR. CONTRACTOR shall remove the overburden above the level at which ENGINEER wishes to test and shall fill and re-compact the excavation after testing is complete.

7. If testing laboratory reports or inspections indicate subgrade, fills, or bedding compaction below specified density, CONTRACTOR shall remove unacceptable materials as necessary and replace with specified materials and provide additional compaction at CONTRACTOR's expense until subgrades, bedding, and fill are acceptable. Costs for retesting of subgrade, fills, or bedding materials that did not originally comply with specified density shall be paid by CONTRACTOR.

+ + END OF SECTION + +

• OSHA REGULATIONS •

• REGARDING TRENCH SAFETY (FROM FEDERAL REGISTER)

(2) The employer shall ensure that there is in the vicinity of each barge in use at least one U.S. Coast Guard-approved 30-inch lifering with not less than 90 feet of line attached, and at least one portable or permanent ladder which will reach the top of the apron to the surface of the water. If the above equipment is not available at the pier, the employer shall furnish it during the time that he is working the barge.

(3) Employees walking or working on the unguarded decks of barges shall be protected with U.S. Coast Guard-approved work vests or buoyant vests.

(e) *Commercial diving operations.* Commercial diving operations shall be subject to subpart T of part 1910, §§ 1910.401-1910.441, of this chapter.

[39 FR 22801, June 24, 1974, as amended at 42 FR 37674, July 22, 1977]

§ 1926.606 Definitions applicable to this subpart.

(a) *Apron*—The area along the waterfront edge of the pier or wharf.

(b) *Bulwark*—The side of a ship above the upper deck.

(c) *Coaming*—The raised frame, as around a hatchway in the deck, to keep out water.

(d) *Jacob's ladder*—A marine ladder of rope or chain with wooden or metal rungs.

(e) *Rail*, for the purpose of § 1926.605, means a light structure serving as a guard at the outer edge of a ship's deck.

Subpart P—Excavations

AUTHORITY: Sec. 107, Contract Worker Hours and Safety Standards Act (Construction Safety Act) (40 U.S.C. 333); Secs. 4, 6, 8, Occupational Safety and Health Act of 1970 (29 U.S.C. 653, 655, 657); Secretary of Labor's Order No. 12-71 (36 FR 8754), 8-76 (41 FR 25059), or 9-83 (48 FR 35736), as applicable, and 29 CFR part 1911.

SOURCE: 54 FR 45959, Oct. 31, 1989, unless otherwise noted.

§ 1926.650 Scope, application, and definitions applicable to this subpart.

(a) *Scope and application.* This subpart applies to all open excavations made in the earth's surface. Excavations are defined to include trenches.

(b) *Definitions applicable to this subpart.*

Accepted engineering practices means those requirements which are compatible with standards of practice required by a registered professional engineer.

Aluminum Hydraulic Shoring means a pre-engineered shoring system comprised of aluminum hydraulic cylinders (crossbraces) used in conjunction with vertical rails (uprights) or horizontal rails (walers). Such system is designed, specifically to support the sidewalls of an excavation and prevent cave-ins.

Bell-bottom pier hole means a type of shaft or footing excavation, the bottom of which is made larger than the cross section above to form a belled shape.

Benching (Benching system) means a method of protecting employees from cave-ins by excavating the sides of an excavation to form one or a series of horizontal levels or steps, usually with vertical or near-vertical surfaces between levels.

Cave-in means the separation of a mass of soil or rock material from the side of an excavation, or the loss of soil from under a trench shield or support system, and its sudden movement into the excavation, either by falling or sliding, in sufficient quantity so that it could entrap, bury, or otherwise injure and immobilize a person.

Competent person means one who is capable of identifying existing and predictable hazards in the surroundings, or working conditions which are unsanitary, hazardous, or dangerous to employees, and who has authorization to take prompt corrective measures to eliminate them.

Cross braces mean the horizontal members of a shoring system installed perpendicular to the sides of the excavation, the ends of which bear against either uprights or wales.

Excavation means any man-made cut, cavity, trench, or depression in an earth surface, formed by earth removal.

Faces or *sides* means the vertical or inclined earth surfaces formed as a result of excavation work.

Failure means the breakage, displacement, or permanent deformation of a structural member or connection so as to reduce its structural integrity and its supportive capabilities.

Hazardous atmosphere means an atmosphere which by reason of being explosive, flammable, poisonous, corrosive, oxidizing, irritating, oxygen deficient, toxic, or otherwise harmful, may cause death, illness, or injury.

Kickout means the accidental release or failure of a cross brace.

Protective system means a method of protecting employees from cave-ins, from material that could fall or roll from an excavation face or into an excavation, or from the collapse of adjacent structures. Protective systems include support systems, sloping and benching systems, shield systems, and other systems that provide the necessary protection.

Ramp means an inclined walking or working surface that is used to gain access to one point from another, and is constructed from earth or from structural materials such as steel or wood.

Registered Professional Engineer means a person who is registered as a professional engineer in the state where the work is to be performed. However, a professional engineer, registered in any state is deemed to be a "registered professional engineer" within the meaning of this standard when approving designs for "manufactured protective systems" or "tabulated data" to be used in interstate commerce.

Sheeting means the members of a shoring system that retain the earth in position and in turn are supported by other members of the shoring system.

Shield (Shield system) means a structure that is able to withstand the forces imposed on it by a cave-in and thereby protect employees within the structure. Shields can be permanent structures or can be designed to be portable and moved along as work progresses. Additionally, shields can be either premanufactured or job-built in accordance with § 1926.652 (c)(3) or (c)(4). Shields used in trenches are usually referred to as "trench boxes" or "trench shields."

Shoring (Shoring system) means a structure such as a metal hydraulic, mechanical or timber shoring system that supports the sides of an excavation and which is designed to prevent cave-ins.

Sides. See "Faces."

Sloping (Sloping system) means a method of protecting employees from cave-ins by excavating to form sides of an excavation that are inclined away from the excavation so as to prevent cave-ins. The angle of incline required to prevent a cave-in varies with differences in such factors as the soil type, environmental conditions of exposure, and application of surcharge loads.

Stable rock means natural solid mineral material that can be excavated with vertical sides and will remain intact while exposed. Unstable rock is considered to be stable when the rock material on the side or sides of the excavation is secured against caving-in or movement by rock bolts or by another protective system that has been designed by a registered professional engineer.

Structural ramp means a ramp built of steel or wood, usually used for vehicle access. Ramps made of soil or rock are not considered structural ramps.

Support system means a structure such as underpinning, bracing, or shoring, which provides support to an adjacent structure, underground installation, or the sides of an excavation.

Tabulated data means tables and charts approved by a registered professional engineer and used to design and construct a protective system.

Trench (Trench excavation) means a narrow excavation (in relation to its length) made below the surface of the ground. In general, the depth is greater than the width, but the width of a trench (measured at the bottom) is not greater than 15 feet (4.6 m). If forms or other structures are installed or constructed in an excavation so as to reduce the dimension measured from the forms or structure to the side of the excavation to 15 feet (4.6 m) or less (measured at the bottom of the excavation), the excavation is also considered to be a trench.

Trench box. See "Shield."

Trench shield. See "Shield."

Uprights means the vertical members of a trench shoring system placed in contact with the earth and usually positioned so that individual members do not contact each other. Uprights placed so that individual members are closely spaced, in contact with or

interconnected to each other, are often called "sheeting."

Wales means horizontal members of a shoring system placed parallel to the excavation face whose sides bear against the vertical members of the shoring system or earth.

§ 1926.651 Specific excavation requirements.

(a) *Surface encumbrances.* All surface encumbrances that are located so as to create a hazard to employees shall be removed or supported, as necessary, to safeguard employees.

(b) *Underground installations.* (1) The estimated location of utility installations, such as sewer, telephone, fuel, electric, water lines, or any other underground installations that reasonably may be expected to be encountered during excavation work, shall be determined prior to opening an excavation.

(2) Utility companies or owners shall be contacted within established or customary local response times, advised of the proposed work, and asked to establish the location of the utility underground installations prior to the start of actual excavation. When utility companies or owners cannot respond to a request to locate underground utility installations within 24 hours (unless a longer period is required by state or local law), or cannot establish the exact location of these installations, the employer may proceed, provided the employer does so with caution, and provided detection equipment or other acceptable means to locate utility installations are used.

(3) When excavation operations approach the estimated location of underground installations, the exact location of the installations shall be determined by safe and acceptable means.

(4) While the excavation is open, underground installations shall be protected, supported or removed as necessary to safeguard employees.

(c) *Access and egress*—(1) *Structural ramps.* (i) Structural ramps that are used solely by employees as a means of access or egress from excavations shall be designed by a competent person. Structural ramps used for access or egress of equipment shall be designed by a competent person qualified in structural design, and shall be constructed in accordance with the design.

(ii) Ramps and runways constructed of two or more structural members shall have the structural members connected together to prevent displacement.

(iii) Structural members used for ramps and runways shall be of uniform thickness.

(iv) Cleats or other appropriate means used to connect runway structural members shall be attached to the bottom of the runway or shall be attached in a manner to prevent tripping.

(v) Structural ramps used in lieu of steps shall be provided with cleats or other surface treatments on the top surface to prevent slipping.

(2) *Means of egress from trench excavations.* A stairway, ladder, ramp or other safe means of egress shall be located in trench excavations that are 4 feet (1.22 m) or more in depth so as to require no more than 25 feet (7.62 m) of lateral travel for employees.

(d) *Exposure to vehicular traffic.* Employees exposed to public vehicular traffic shall be provided with, and shall wear, warning vests or other suitable garments marked with or made of reflectorized or high-visibility material.

(e) *Exposure to falling loads.* No employee shall be permitted underneath loads handled by lifting or digging equipment. Employees shall be required to stand away from any vehicle being loaded or unloaded to avoid being struck by any spillage or falling materials. Operators may remain in the cabs of vehicles being loaded or unloaded when the vehicles are equipped, in accordance with § 1926.601(b)(6), to provide adequate protection for the operator during loading and unloading operations.

(f) *Warning system for mobile equipment.* When mobile equipment is operated adjacent to an excavation, or when such equipment is required to approach the edge of an excavation, and the operator does not have a clear and direct view of the edge of the excavation, a warning system shall be utilized such as barricades, hand or mechanical signals, or stop logs. If possible, the grade should be away from the excavation.

(g) *Hazardous atmospheres*—(1) *Testing and controls.* In addition to the requirements set forth in subparts D and E of this part (29 CFR 1926.50–1926.107) to prevent exposure to harmful levels of atmospheric contaminants and to assure acceptable atmospheric conditions, the following requirements shall apply:

(i) Where oxygen deficiency (atmospheres containing less than 19.5 percent oxygen) or a hazardous atmosphere exists or could reasonably be expected to exist, such as in excavations in landfill areas or excavations in areas where hazardous substances are stored nearby, the atmospheres in the excavation shall be tested before employees enter excavations greater than 4 feet (1.22 m) in depth.

(ii) Adequate precautions shall be taken to prevent employee exposure to atmospheres containing less than 19.5 percent oxygen and other hazardous atmospheres. These precautions include providing proper respiratory protection or ventilation in accordance with subparts D and E of this part respectively.

(iii) Adequate precaution shall be taken such as providing ventilation, to prevent employee exposure to an atmosphere containing a concentration of a flammable gas in excess of 20 percent of the lower flammable limit of the gas.

(iv) When controls are used that are intended to reduce the level of atmospheric contaminants to acceptable levels, testing shall be conducted as often as necessary to ensure that the atmosphere remains safe.

(2) *Emergency rescue equipment.* (i) Emergency rescue equipment, such as breathing apparatus, a safety harness and line, or a basket stretcher, shall be readily available where hazardous atmospheric conditions exist or may reasonably be expected to develop during work in an excavation. This equipment shall be attended when in use.

(ii) Employees entering bell-bottom pier holes, or other similar deep and confined footing excavations, shall wear a harness with a life-line securely attached to it. The lifeline shall be separate from any line used to handle materials, and shall be individually attended at all times while the employee wearing the lifeline is in the excavation.

(h) *Protection from hazards associated with water accumulation.* (1) Employees shall not work in excavations in which there is accumulated water, or in excavations in which water is accumulating, unless adequate precautions have been taken to protect employees against the hazards posed by water accumulation. The precautions necessary to protect employees adequately vary with each situation, but could include special support or shield systems to protect from cave-ins, water removal to control the level of accumulating water, or use of a safety harness and lifeline.

(2) If water is controlled or prevented from accumulating by the use of water removal equipment, the water removal equipment and operations shall be monitored by a competent person to ensure proper operation.

(3) If excavation work interrupts the natural drainage of surface water (such as streams), diversion ditches, dikes, or other suitable means shall be used to prevent surface water from entering the excavation and to provide adequate drainage of the area adjacent to the excavation. Excavations subject to runoff from heavy rains will require an inspection by a competent person and compliance with paragraphs (h)(1) and (h)(2) of this section.

(i) *Stability of adjacent structures.* (1) Where the stability of adjoining buildings, walls, or other structures is endangered by excavation operations, support systems such as shoring, bracing, or underpinning shall be provided to ensure the stability of such structures for the protection of employees.

(2) Excavation below the level of the base or footing of any foundation or retaining wall that could be reasonably expected to pose a hazard to employees shall not be permitted except when:

(i) A support system, such as underpinning, is provided to ensure the safety of employees and the stability of the structure; or

(ii) The excavation is in stable rock; or

(iii) A registered professional engineer has approved the determination that the structure is sufficently removed from the excavation so as to be

unaffected by the excavation activity; or

(iv) A registered professional engineer has approved the determination that such excavation work will not pose a hazard to employees.

(3) Sidewalks, pavements, and appurtenant structure shall not be undermined unless a support system or another method of protection is provided to protect employees from the possible collapse of such structures.

(j) *Protection of employees from loose rock or soil.* (1) Adequate protection shall be provided to protect employees from loose rock or soil that could pose a hazard by falling or rolling from an excavation face. Such protection shall consist of scaling to remove loose material; installation of protective barricades at intervals as necessary on the face to stop and contain falling material; or other means that provide equivalent protection.

(2) Employees shall be protected from excavated or other materials or equipment that could pose a hazard by falling or rolling into excavations. Protection shall be provided by placing and keeping such materials or equipment at least 2 feet (.61 m) from the edge of excavations, or by the use of retaining devices that are sufficient to prevent materials or equipment from falling or rolling into excavations, or by a combination of both if necessary.

(k) *Inspections.* (1) Daily inspections of excavations, the adjacent areas, and protective systems shall be made by a competent person for evidence of a situation that could result in possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions. An inspection shall be conducted by the competent person prior to the start of work and as needed throughout the shift. Inspections shall also be made after every rainstorm or other hazard increasing occurrence. These inspections are only required when employee exposure can be reasonably anticipated.

(2) Where the competent person finds evidence of a situation that could result in a possible cave-in, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions, exposed employees shall be removed from the hazardous area until the necessary precautions have been taken to ensure their safety.

(l) Walkways shall be provided where employees or equipment are required or permitted to cross over excavations. Guardrails which comply with § 1926.502(b) shall be provided where walkways are 6 feet (1.8 m) or more above lower levels.

[54 FR 45959, Oct. 31, 1989, as amended by 59 FR 40730, Aug. 9, 1994]

§ 1926.652 Requirements for protective systems.

(a) *Protection of employees in excavations.* (1) Each employee in an excavation shall be protected from cave-ins by an adequate protective system designed in accordance with paragraph (b) or (c) of this section except when:

(i) Excavations are made entirely in stable rock; or

(ii) Excavations are less than 5 feet (1.52m) in depth and examination of the ground by a competent person provides no indication of a potential cave-in.

(2) Protective systems shall have the capacity to resist without failure all loads that are intended or could reasonably be expected to be applied or transmitted to the system.

(b) *Design of sloping and benching systems.* The slopes and configurations of sloping and benching systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (b)(1); or, in the alternative, paragraph (b)(2); or, in the alternative, paragraph (b)(3), or, in the alternative, paragraph (b)(4), as follows:

(1) *Option (1)—Allowable configurations and slopes.* (i) Excavations shall be sloped at an angle not steeper than one and one-half horizontal to one vertical (34 degrees measured from the horizontal), unless the employer uses one of the other options listed below.

(ii) Slopes specified in paragraph (b)(1)(i) of this section, shall be excavated to form configurations that are in accordance with the slopes shown for Type C soil in Appendix B to this subpart.

(2) *Option (2)—Determination of slopes and configurations using Appendices A and B.* Maximum allowable slopes, and allowable configurations for sloping

and benching systems, shall be determined in accordance with the conditions and requirements set forth in appendices A and B to this subpart.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of sloping or benching systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and shall include all of the following:

(A) Identification of the parameters that affect the selection of a sloping or benching system drawn from such data;

(B) Identification of the limits of use of the data, to include the magnitude and configuration of slopes determined to be safe;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Sloping and benching systems not utilizing Option (1) or Option (2) or Option (3) under paragraph (b) of this section shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include at least the following:

(A) The magnitude of the slopes that were determined to be safe for the particular project;

(B) The configurations that were determined to be safe for the particular project; and

(C) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite while the slope is being constructed. After that time the design need not be at the jobsite, but a copy shall be made available to the Secretary upon request.

(c) *Design of support systems, shield systems, and other protective systems.* Designs of support systems shield systems, and other protective systems shall be selected and constructed by the employer or his designee and shall be in accordance with the requirements of paragraph (c)(1); or, in the alternative, paragraph (c)(2); or, in the alternative, paragraph (c)(3); or, in the alternative, paragraph (c)(4) as follows:

(1) *Option (1)—Designs using appendices A, C and D.* Designs for timber shoring in trenches shall be determined in accordance with the conditions and requirements set forth in appendices A and C to this subpart. Designs for aluminum hydraulic shoring shall be in accordance with paragraph (c)(2) of this section, but if manufacturer's tabulated data cannot be utilized, designs shall be in accordance with appendix D.

(2) *Option (2)—Designs Using Manufacturer's Tabulated Data.* (i) Design of support systems, shield systems, or other protective systems that are drawn from manufacturer's tabulated data shall be in accordance with all specifications, recommendations, and limitations issued or made by the manufacturer.

(ii) Deviation from the specifications, recommendations, and limitations issued or made by the manufacturer shall only be allowed after the manufacturer issues specific written approval.

(iii) Manufacturer's specifications, recommendations, and limitations, and manufacturer's approval to deviate from the specifications, recommendations, and limitations shall be in written form at the jobsite during construction of the protective system. After that time this data may be stored off the jobsite, but a copy shall be made available to the Secretary upon request.

(3) *Option (3)—Designs using other tabulated data.* (i) Designs of support systems, shield systems, or other protective systems shall be selected from and be in accordance with tabulated data, such as tables and charts.

(ii) The tabulated data shall be in written form and include all of the following:

(A) Identification of the parameters that affect the selection of a protective system drawn from such data;

(B) Identification of the limits of use of the data;

(C) Explanatory information as may be necessary to aid the user in making a correct selection of a protective system from the data.

(iii) At least one copy of the tabulated data, which identifies the registered professional engineer who approved the data, shall be maintained at the jobsite during construction of the protective system. After that time the data may be stored off the jobsite, but a copy of the data shall be made available to the Secretary upon request.

(4) *Option (4)—Design by a registered professional engineer.* (i) Support systems, shield systems, and other protective systems not utilizing Option 1, Option 2 or Option 3, above, shall be approved by a registered professional engineer.

(ii) Designs shall be in written form and shall include the following:

(A) A plan indicating the sizes, types, and configurations of the materials to be used in the protective system; and

(B) The identity of the registered professional engineer approving the design.

(iii) At least one copy of the design shall be maintained at the jobsite during construction of the protective system. After that time, the design may be stored off the jobsite, but a copy of the design shall be made available to the Secretary upon request.

(d) *Materials and equipment.* (1) Materials and equipment used for protective systems shall be free from damage or defects that might impair their proper function.

(2) Manufactured materials and equipment used for protective systems shall be used and maintained in a manner that is consistent with the recommendations of the manufacturer, and in a manner that will prevent employee exposure to hazards.

(3) When material or equipment that is used for protective systems is damaged, a competent person shall examine the material or equipment and evaluate its suitability for continued use. If the competent person cannot assure the material or equipment is able to support the intended loads or is otherwise suitable for safe use, then such material or equipment shall be removed from service, and shall be evaluated and approved by a registered professional engineer before being returned to service.

(e) *Installation and removal of support*—(1) *General.* (i) Members of support systems shall be securely connected together to prevent sliding, falling, kickouts, or other predictable failure.

(ii) Support systems shall be installed and removed in a manner that protects employees from cave-ins, structural collapses, or from being struck by members of the support system.

(iii) Individual members of support systems shall not be subjected to loads exceeding those which those members were designed to withstand.

(iv) Before temporary removal of individual members begins, additional precautions shall be taken to ensure the safety of employees, such as installing other structural members to carry the loads imposed on the support system.

(v) Removal shall begin at, and progress from, the bottom of the excavation. Members shall be released slowly so as to note any indication of possible failure of the remaining members of the structure or possible cave-in of the sides of the excavation.

(vi) Backfilling shall progress together with the removal of support systems from excavations.

(2) *Additional requirements for support systems for trench excavations.* (i) Excavation of material to a level no greater than 2 feet (.61 m) below the bottom of the members of a support system shall be permitted, but only if the system is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the support system.

(ii) Installation of a support system shall be closely coordinated with the excavation of trenches.

(f) *Sloping and benching systems.* Employees shall not be permitted to work on the faces of sloped or benched excavations at levels above other employees except when employees at the lower levels are adequately protected from

the hazard of falling, rolling, or sliding material or equipment.

(g) *Shield systems*—(1) *General.* (i) Shield systems shall not be subjected to loads exceeding those which the system was designed to withstand.

(ii) Shields shall be installed in a manner to restrict lateral or other hazardous movement of the shield in the event of the application of sudden lateral loads.

(iii) Employees shall be protected from the hazard of cave-ins when entering or exiting the areas protected by shields.

(iv) Employees shall not be allowed in shields when shields are being installed, removed, or moved vertically.

(2) *Additional requirement for shield systems used in trench excavations.* Excavations of earth material to a level not greater than 2 feet (.61 m) below the bottom of a shield shall be permitted, but only if the shield is designed to resist the forces calculated for the full depth of the trench, and there are no indications while the trench is open of a possible loss of soil from behind or below the bottom of the shield.

APPENDIX A TO SUBPART P—SOIL CLASSIFICATION

(a) *Scope and application*—(1) *Scope.* This appendix describes a method of classifying soil and rock deposits based on site and environmental conditions, and on the structure and composition of the earth deposits. The appendix contains definitions, sets forth requirements, and describes acceptable visual and manual tests for use in classifying soils.

(2) *Application.* This appendix applies when a sloping or benching system is designed in accordance with the requirements set forth in §1926.652(b)(2) as a method of protection for employees from cave-ins. This appendix also applies when timber shoring for excavations is designed as a method of protection from cave-ins in accordance with appendix C to subpart P of part 1926, and when aluminum hydraulic shoring is designed in accordance with appendix D. This Appendix also applies if other protective systems are designed and selected for use from data prepared in accordance with the requirements set forth in §1926.652(c), and the use of the data is predicated on the use of the soil classification system set forth in this appendix.

(b) *Definitions.* The definitions and examples given below are based on, in whole or in part, the following: American Society for Testing Materials (ASTM) Standards D653–85 and D2488; The Unified Soils Classification System, The U.S. Department of Agriculture (USDA) Textural Classification Scheme; and The National Bureau of Standards Report BSS–121.

Cemented soil means a soil in which the particles are held together by a chemical agent, such as calcium carbonate, such that a hand-size sample cannot be crushed into powder or individual soil particles by finger pressure.

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 sideslopes, and is plastic when moist. Cohesive soil is hard to break up when dry, and exhibits significant cohesion when submerged. Cohesive soils include clayey silt, sandy clay, silty clay, clay and organic clay.

Dry soil means soil that does not exhibit visible signs of moisture content.

Fissured means a soil material that has a tendency to break along definite planes of fracture with little resistance, or a material that exhibits open cracks, such as tension cracks, in an exposed surface.

Granular soil 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.

Layered system means two or more distinctly different soil or rock types arranged in layers. Micaceous seams or weakened planes in rock or shale are considered layered.

Moist soil means a condition in which a soil looks and feels damp. Moist cohesive soil can easily be shaped into a ball and rolled into small diameter threads before crumbling. Moist granular soil that contains some cohesive material will exhibit signs of cohesion between particles.

Plastic means a property of a soil which allows the soil to be deformed or molded without cracking, or appreciable volume change.

Saturated soil means a soil in which the voids are filled with water. Saturation does not require flow. Saturation, or near saturation, is necessary for the proper use of instruments such as a pocket penetrometer or sheer vane.

Soil classification system means, for the purpose of this subpart, a method of categorizing soil and rock deposits in a hierarchy of Stable Rock, Type A, Type B, and Type C, in decreasing order of stability. The categories are determined based on an analysis of the properties and performance characteristics of the deposits and the environmental conditions of exposure.

Stable rock means natural solid mineral matter that can be excavated with vertical sides and remain intact while exposed.

Submerged soil means soil which is underwater or is free seeping.

Type A means cohesive soils with an unconfined compressive strength of 1.5 ton per square foot (tsf) (144 kPa) or greater. Examples of cohesive soils are: clay, silty clay, sandy clay, clay loam and, in some cases, silty clay loam and sandy clay loam. Cemented soils such as caliche and hardpan are also considered Type A. However, no soil is Type A if:

(i) The soil is fissured; or

(ii) The soil is subject to vibration from heavy traffic, pile driving, or similar effects; or

(iii) The soil has been previously disturbed; or

(iv) The soil is part of a sloped, layered system where the layers dip into the excavation on a slope of four horizontal to one vertical (4H:1V) or greater; or

(v) The material is subject to other factors that would require it to be classified as a less stable material.

Type B means:

(i) Cohesive soil with an unconfined compressive strength greater than 0.5 tsf (48 kPa) but less than 1.5 tsf (144 kPa); or

(ii) Granular cohesionless soils including: angular gravel (similar to crushed rock), silt, silt loam, sandy loam and, in some cases, silty clay loam and sandy clay loam.

(iii) Previously disturbed soils except those which would otherwise be classed as Type C soil.

(iv) Soil that meets the unconfined compressive strength or cementation requirements for Type A, but is fissured or subject to vibration; or

(v) Dry rock that is not stable; or

(vi) Material that is part of a sloped, layered system where the layers dip into the excavation on a slope less steep than four horizontal to one vertical (4H:1V), but only if the material would otherwise be classified as Type B.

Type C means:

(i) Cohesive soil with an unconfined compressive strength of 0.5 tsf (48 kPa) or less; or

(ii) Granular soils including gravel, sand, and loamy sand; or

(iii) Submerged soil or soil from which water is freely seeping; or

(iv) Submerged rock that is not stable, or

(v) Material in a sloped, layered system where the layers dip into the excavation or a slope of four horizontal to one vertical (4H:1V) or steeper.

Unconfined compressive strength means the load per unit area at which a soil will fail in compression. It can be determined by laboratory testing, or estimated in the field using a pocket penetrometer, by thumb penetration tests, and other methods.

Wet soil means soil that contains significantly more moisture than moist soil, but in such a range of values that cohesive material will slump or begin to flow when vibrated. Granular material that would exhibit cohesive properties when moist will lose those cohesive properties when wet.

(c) *Requirements*—(1) *Classification of soil and rock deposits.* Each soil and rock deposit shall be classified by a competent person as Stable Rock, Type A, Type B, or Type C in accordance with the definitions set forth in paragraph (b) of this appendix.

(2) *Basis of classification.* The classification of the deposits shall be made based on the results of at least one visual and at least one manual analysis. Such analyses shall be conducted by a competent person using tests described in paragraph (d) below, or in other recognized methods of soil classification and testing such as those adopted by the America Society for Testing Materials, or the U.S. Department of Agriculture textural classification system.

(3) *Visual and manual analyses.* The visual and manual analyses, such as those noted as being acceptable in paragraph (d) of this appendix, shall be designed and conducted to provide sufficient quantitative and qualitative information as may be necessary to identify properly the properties, factors, and conditions affecting the classification of the deposits.

(4) *Layered systems.* In a layered system, the system shall be classified in accordance with its weakest layer. However, each layer may be classified individually where a more stable layer lies under a less stable layer.

(5) *Reclassification.* If, after classifying a deposit, the properties, factors, or conditions affecting its classification change in any way, the changes shall be evaluated by a competent person. The deposit shall be reclassified as necessary to reflect the changed circumstances.

(d) *Acceptable visual and manual tests.*—(1) *Visual tests.* Visual analysis is conducted to determine qualitative information regarding the excavation site in general, the soil adjacent to the excavation, the soil forming the sides of the open excavation, and the soil taken as samples from excavated material.

(i) Observe samples of soil that are excavated and soil in the sides of the excavation. Estimate the range of particle sizes and the relative amounts of the particle sizes. Soil that is primarily composed of fine-grained material is cohesive material. Soil composed primarily of coarse-grained sand or gravel is granular material.

(ii) Observe soil as it is excavated. Soil that remains in clumps when excavated is cohesive. Soil that breaks up easily and does not stay in clumps is granular.

(iii) Observe the side of the opened excavation and the surface area adjacent to the excavation. Crack-like openings such as tension cracks could indicate fissured material. If chunks of soil spall off a vertical side, the soil could be fissured. Small spalls are evidence of moving ground and are indications of potentially hazardous situations.

(iv) Observe the area adjacent to the excavation and the excavation itself for evidence of existing utility and other underground structures, and to identify previously disturbed soil.

(v) Observe the opened side of the excavation to identify layered systems. Examine layered systems to identify if the layers slope toward the excavation. Estimate the degree of slope of the layers.

(vi) Observe the area adjacent to the excavation and the sides of the opened excavation for evidence of surface water, water seeping from the sides of the excavation, or the location of the level of the water table.

(vii) Observe the area adjacent to the excavation and the area within the excavation for sources of vibration that may affect the stability of the excavation face.

(2) *Manual tests.* Manual analysis of soil samples is conducted to determine quantitative as well as qualitative properties of soil and to provide more information in order to classify soil properly.

(i) *Plasticity.* Mold a moist or wet sample of soil into a ball and attempt to roll it into threads as thin as ⅛-inch in diameter. Cohesive material can be successfully rolled into threads without crumbling. For example, if at least a two inch (50 mm) length of ⅛-inch thread can be held on one end without tearing, the soil is cohesive.

(ii) *Dry strength.* If the soil is dry and crumbles on its own or with moderate pressure into individual grains or fine powder, it is granular (any combination of gravel, sand, or silt). If the soil is dry and falls into clumps which break up into smaller clumps, but the smaller clumps can only be broken up with difficulty, it may be clay in any combination with gravel, sand or silt. If the dry soil breaks into clumps which do not break up into small clumps and which can only be broken with difficulty, and there is no visual indication the soil is fissured, the soil may be considered unfissured.

(iii) *Thumb penetration.* The thumb penetration test can be used to estimate the unconfined compressive strength of cohesive soils. (This test is based on the thumb penetration test described in American Society for Testing and Materials (ASTM) Standard designation D2488—"Standard Recommended Practice for Description of Soils (Visual—Manual Procedure).") Type A soils with an unconfined compressive strength of 1.5 tsf can be readily indented by the thumb; however, they can be penetrated by the thumb only with very great effort. Type C soils with an unconfined compressive strength of 0.5 tsf can be easily penetrated several inches by the thumb, and can be molded by light finger pressure. This test should be conducted on an undisturbed soil sample, such as a large clump of spoil, as soon as practicable after excavation to keep to a miminum the effects of exposure to drying influences. If the excavation is later exposed to wetting influences (rain, flooding), the classification of the soil must be changed accordingly.

(iv) *Other strength tests.* Estimates of unconfined compressive strength of soils can also be obtained by use of a pocket penetrometer or by using a hand-operated shearvane.

(v) *Drying test.* The basic purpose of the drying test is to differentiate between cohesive material with fissures, unfissured cohesive material, and granular material. The procedure for the drying test involves drying a sample of soil that is approximately one inch thick (2.54 cm) and six inches (15.24 cm) in diameter until it is thoroughly dry:

(A) If the sample develops cracks as it dries, significant fissures are indicated.

(B) Samples that dry without cracking are to be broken by hand. If considerable force is necessary to break a sample, the soil has significant cohesive material content. The soil can be classified as a unfissured cohesive material and the unconfined compressive strength should be determined.

(C) If a sample breaks easily by hand, it is either a fissured cohesive material or a granular material. To distinguish between the two, pulverize the dried clumps of the sample by hand or by stepping on them. If the clumps do not pulverize easily, the material is cohesive with fissures. If they pulverize easily into very small fragments, the material is granular.

APPENDIX B TO SUBPART P—SLOPING AND BENCHING

(a) *Scope and application.* This appendix contains specifications for sloping and benching when used as methods of protecting employees working in excavations from cave-ins. The requirements of this appendix apply when the design of sloping and benching protective systems is to be performed in accordance with the requirements set forth in § 1926.652(b)(2).

(b) *Definitions.*

Actual slope means the slope to which an excavation face is excavated.

Distress means that the soil is in a condition where a cave-in is imminent or is likely to occur. Distress is evidenced by such phenomena as the development of fissures in the face of or adjacent to an open excavation; the subsidence of the edge of an excavation; the slumping of material from the face or the bulging or heaving of material from the bottom of an excavation; the spalling of material from the face of an excavation; and ravelling, i.e., small amounts of material such as pebbles or little clumps of material suddenly separating from the face of an excavation and trickling or rolling down into the excavation.

Maximum allowable slope means the steepest incline of an excavation face that is acceptable for the most favorable site conditions as protection against cave-ins, and is expressed as the ratio of horizontal distance to vertical rise (H:V).

Short term exposure means a period of time less than or equal to 24 hours that an excavation is open.

(c) *Requirements*—(1) *Soil classification.* Soil and rock deposits shall be classified in accordance with appendix A to subpart P of part 1926.

(2) *Maximum allowable slope.* The maximum allowable slope for a soil or rock deposit shall be determined from Table B-1 of this appendix.

(3) *Actual slope.* (i) The actual slope shall not be steeper than the maximum allowable slope.

(ii) The actual slope shall be less steep than the maximum allowable slope, when there are signs of distress. If that situation occurs, the slope shall be cut back to an actual slope which is at least ½ horizontal to one vertical (½H:1V) less steep than the maximum allowable slope.

(iii) When surcharge loads from stored material or equipment, operating equipment, or traffic are present, a competent person shall determine the degree to which the actual slope must be reduced below the maximum allowable slope, and shall assure that such reduction is achieved. Surcharge loads from adjacent structures shall be evaluated in accordance with § 1926.651(i).

(4) *Configurations.* Configurations of sloping and benching systems shall be in accordance with Figure B-1.

TABLE B-1

MAXIMUM ALLOWABLE SLOPES

SOIL OR ROCK TYPE	MAXIMUM ALLOWABLE SLOPES (H:V) [1] FOR EXCAVATIONS LESS THAN 20 FEET DEEP [3]
STABLE ROCK TYPE A [2] TYPE B TYPE C	VERTICAL (90°) 3/4 : 1 (53°) 1:1 (45°) 1½: 1 (34°)

NOTES:

1. Numbers shown in parentheses next to maximum allowable slopes are angles expressed in degrees from the horizontal. Angles have been rounded off.
2. A short-term maximum allowable slope of 1/2H:1V (63°) is allowed in excavations in Type A soil that are 12 feet (3.67 m) or less in depth. Short-term maximum allowable slopes for excavations greater than 12 feet (3.67 m) in depth shall be 3/4H:1V (53°).
3. Sloping or benching for excavations greater than 20 feet deep shall be designed by a registered professional engineer.

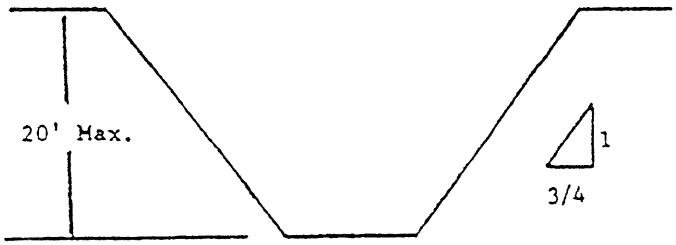
Figure B-1

Slope Configurations

(All slopes stated below are in the horizontal to vertical ratio)

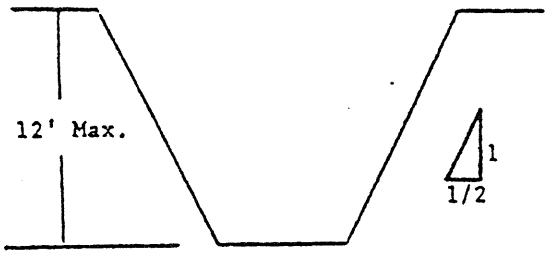
B-1.1 Excavations made in Type A soil.

1. All simple slope excavation 20 feet or less in depth shall have a maximum allowable slope of ¾:1.



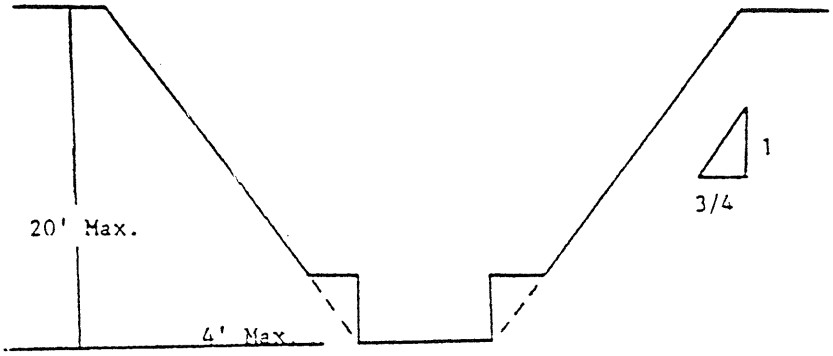
SIMPLE SLOPE—GENERAL

Exception: Simple slope excavations which are open 24 hours or less (short term) and which are 12 feet or less in depth shall have a maximum allowable slope of ½:1.

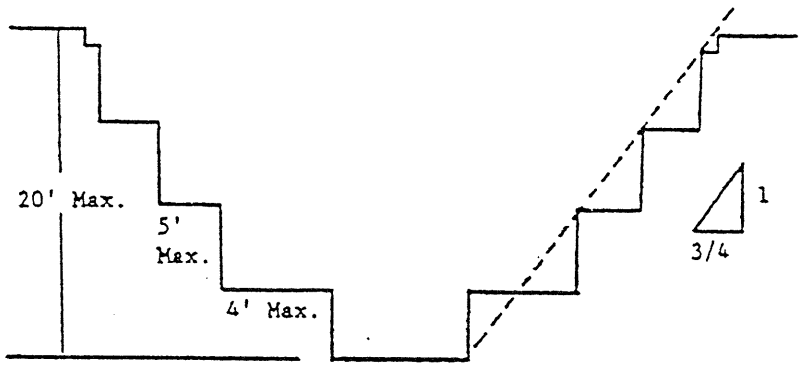


SIMPLE SLOPE—SHORT TERM

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of ¾ to 1 and maximum bench dimensions as follows:

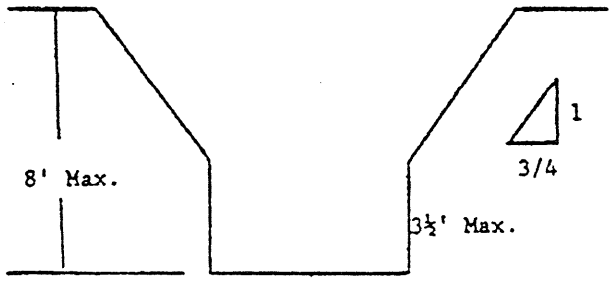


SIMPLE BENCH



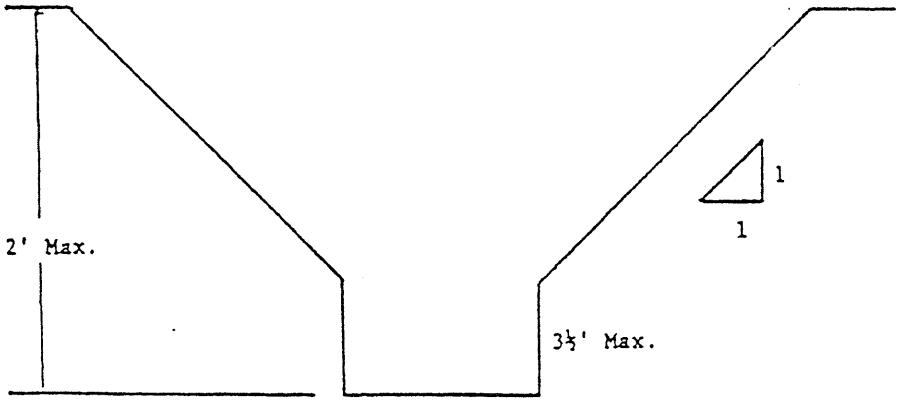
MULTIPLE BENCH

3. All excavations 8 feet or less in depth which have unsupported vertically sided lower portions shall have a maximum vertical side of 3½ feet.



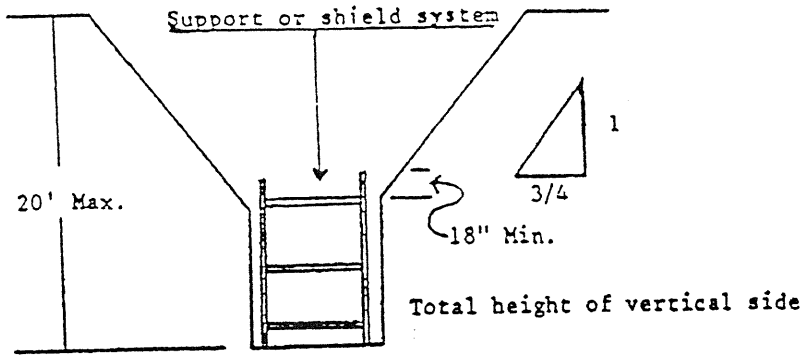
UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 8 FEET IN DEPTH

All excavations more than 8 feet but not more than 12 feet in depth which unsupported vertically sided lower portions shall have a maximum allowable slope of 1:1 and a maximum vertical side of 3½ feet.



UNSUPPORTED VERTICALLY SIDED LOWER PORTION—MAXIMUM 12 FEET IN DEPTH

All excavations 20 feet or less in depth which have vertically sided lower portions that are supported or shielded shall have a maximum allowable slope of ¾:1. The support or shield system must extend at least 18 inches above the top of the vertical side.

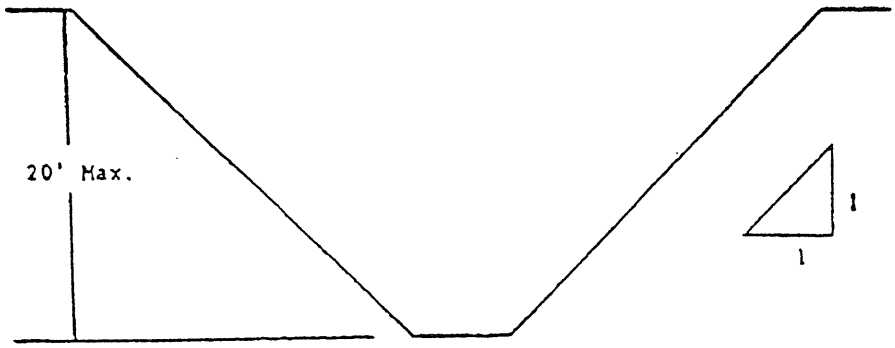


SUPPORTED OR SHIELDED VERTICALLY SIDED LOWER PORTION

4. All other simple slope, compound slope, and vertically sided lower portion excavations shall be in accordance with the other options permitted under § 1926.652(b).

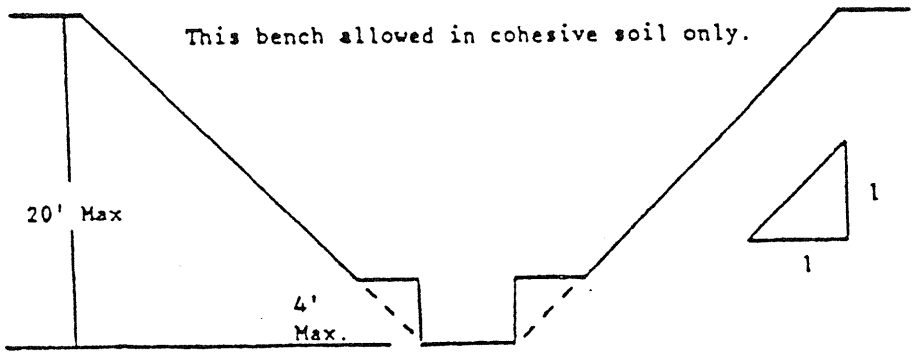
B-1.2 Excavations Made in Type B Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1.

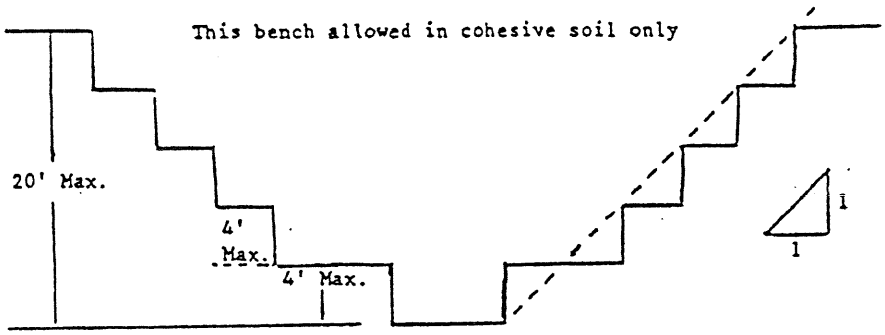


SIMPLE SLOPE

2. All benched excavations 20 feet or less in depth shall have a maximum allowable slope of 1:1 and maximum bench dimensions as follows:

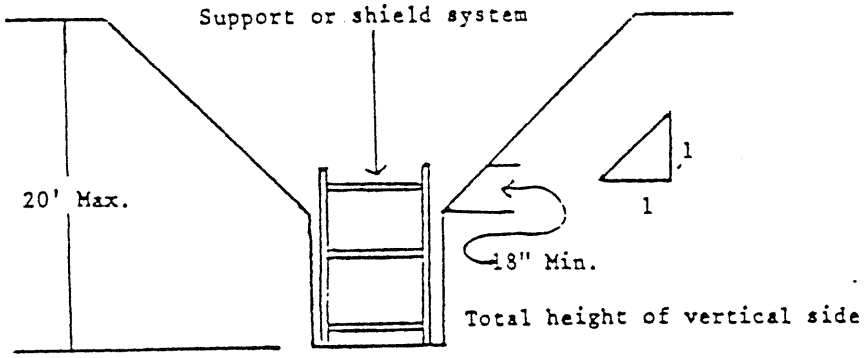


SINGLE BENCH



MULTIPLE BENCH

3. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1:1.

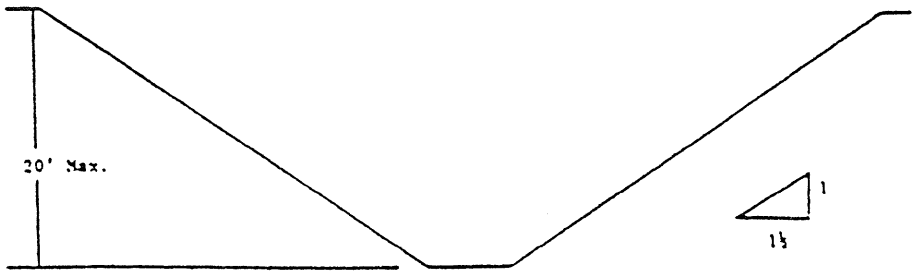


VERTICALLY SIDED LOWER PORTION

4. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

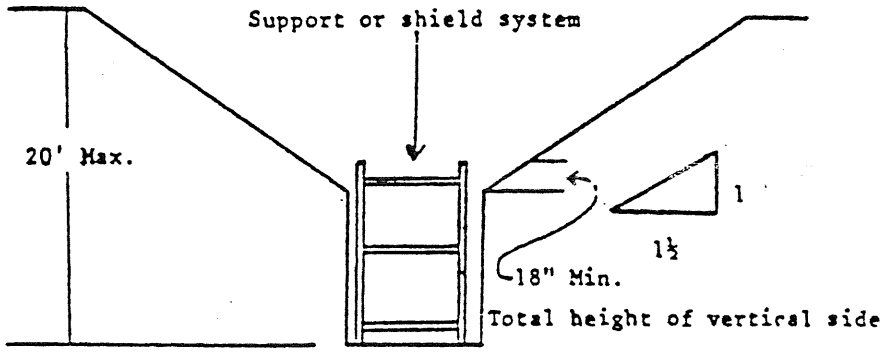
B-1.3 Excavations Made in Type C Soil

1. All simple slope excavations 20 feet or less in depth shall have a maximum allowable slope of 1½:1.



SIMPLE SLOPE

2. All excavations 20 feet or less in depth which have vertically sided lower portions shall be shielded or supported to a height at least 18 inches above the top of the vertical side. All such excavations shall have a maximum allowable slope of 1½:1.

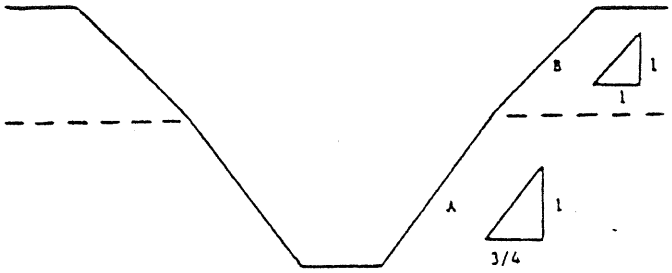


VERTICAL SIDED LOWER PORTION

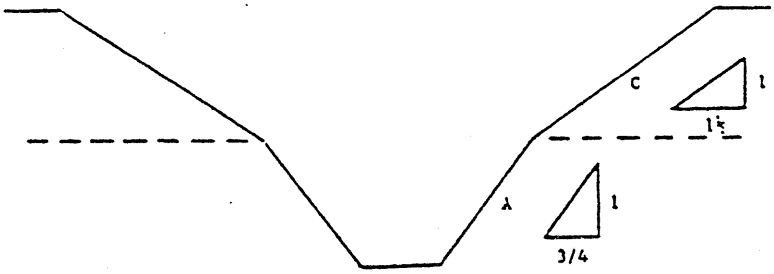
3. All other sloped excavations shall be in accordance with the other options permitted in § 1926.652(b).

B-1.4 Excavations Made in Layered Soils

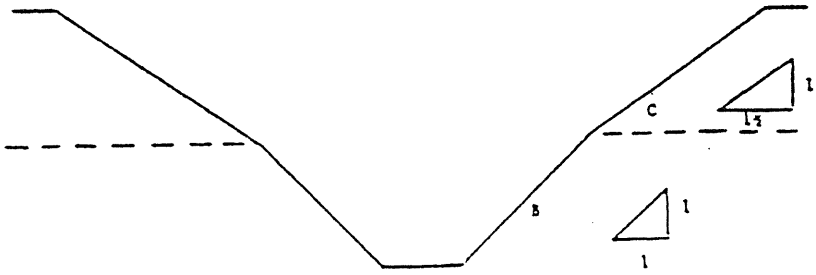
1. All excavations 20 feet or less in depth made in layered soils shall have a maximum allowable slope for each layer as set forth below.



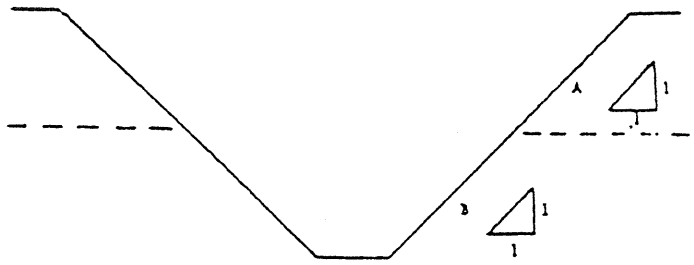
B OVER A



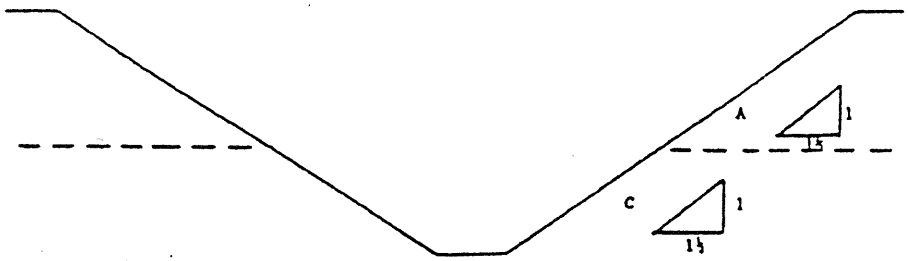
C OVER A



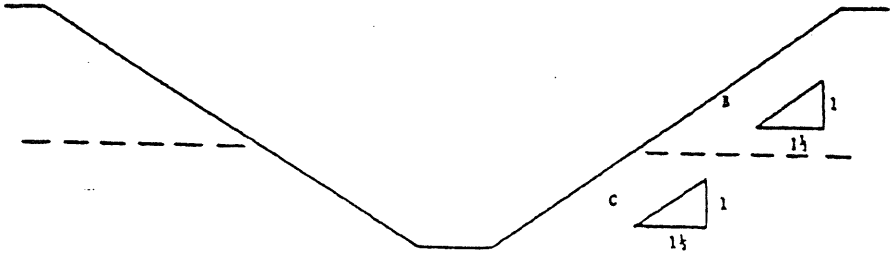
C OVER B



A OVER B



A OVER C



B OVER C

2. All other sloped excavations shall be in accordance with the other options permitted in §1926.652(b).

APPENDIX C TO SUBPART P—TIMBER SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used timber shoring is provided as a method of protection from cave-ins in trenches that do not exceed 20 feet (6.1 m) in depth. This appendix must be used when design of timber shoring protective systems is to be performed in accordance with §1926.652(c)(1). Other timber shoring configurations; other systems of support such as hydraulic and pneumatic systems; and other protective systems such as sloping, benching, shielding, and freezing systems must be designed in accordance with the requirements set forth in §1926.652(b) and §1926.652(c).

(b) *Soil Classification.* In order to use the data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of this part.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables C-1.1, C-1.2, and C-1.3, and Tables C-2.1, C-2.2 and C-2.3 following paragraph (g) of the appendix. Each table presents the minimum sizes of timber members to use in a shoring system, and each table contains data only for the particular soil

type in which the excavation or portion of the excavation is made. The data are arranged to allow the user the flexibility to select from among several acceptable configurations of members based on varying the horizontal spacing of the crossbraces. Stable rock is exempt from shoring requirements and therefore, no data are presented for this condition.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix, and on the tables themselves.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations regarding Tables C-1.1 through C-1.3 and Tables C-2.1 through C-2.3 are presented in paragraph (g) of this Appendix.

(d) *Basis and limitations of the data.*—(1) *Dimensions of timber members.* (i) The sizes of the timber members listed in Tables C-1.1 through C-1.3 are taken from the National Bureau of Standards (NBS) report, "Recommended Technical Provisions for Construction Practice in Shoring and Sloping of Trenches and Excavations." In addition, where NBS did not recommend specific sizes of members, member sizes are based on an analysis of the sizes required for use by existing codes and on empirical practice.

(ii) The required dimensions of the members listed in Tables C-1.1 through C-1.3 refer to actual dimensions and not nominal dimensions of the timber. Employers wanting to use nominal size shoring are directed to Tables C-2.1 through C-2.3, or have this choice under § 1926.652(c)(3), and are referred to The Corps of Engineers, The Bureau of Reclamation or data from other acceptable sources.

(2) *Limitation of application.* (i) It is not intended that the timber shoring specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be designed as specified in § 1926.652(c).

(ii) When any of the following conditions are present, the members specified in the tables are not considered adequate. Either an alternate timber shoring system must be designed or another type of protective system designed in accordance with § 1926.652.

(A) When loads imposed by structures or by stored material adjacent to the trench weigh in excess of the load imposed by a two-foot soil surcharge. The term "adjacent" as used here means the area within a horizontal distance from the edge of the trench equal to the depth of the trench.

(B) When vertical loads imposed on cross braces exceed a 240-pound gravity load distributed on a one-foot section of the center of the crossbrace.

(C) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(D) When only the lower portion of a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables.* The members of the shoring system that are to be selected using this information are the cross braces, the uprights, and the wales, where wales are required. Minimum sizes of members are specified for use in different types of soil. There are six tables of information, two for each soil type. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is then made. The selection is based on the depth and width of the trench where the members are to be installed and, in most instances, the selection is also based on the horizontal spacing of the crossbraces. Instances where a choice of horizontal spacing of crossbracing is available, the horizontal spacing of the crossbraces must be chosen by the user before the size of any member can be determined. When the soil type, the width and depth of the trench, and the horizontal spacing of the crossbraces are known, the size and vertical spacing of the crossbraces, the size and vertical spacing of the wales, and the size and horizontal spacing of the uprights can be read from the appropriate table.

(f) *Examples to Illustrate the Use of Tables C-1.1 through C-1.3.*

(1) *Example 1.*

A trench dug in Type A soil is 13 feet deep and five feet wide.

From *Table C-1.1*, for acceptable arrangements of timber can be used.

Arrangement #1

Space 4x4 crossbraces at six feet horizontally and four feet vertically.

Wales are not required.

Space 3x8 uprights at six feet horizontally. This arrangement is commonly called "skip shoring."

Arrangement #2

Space 4x6 crossbraces at eight feet horizontally and four feet vertically.

Space 8x8 wales at four feet vertically.

Space 2x6 uprights at four feet horizontally.

Arrangement #3

Space 6x6 crossbraces at 10 feet horizontally and four feet vertically.

Space 8x10 wales at four feet vertically.

Space 2x6 uprights at five feet horizontally.

Arrangement #4

Space 6x6 crossbraces at 12 feet horizontally and four feet vertically.

Space 10x10 wales at four feet vertically.

Spaces 3x8 uprights at six feet horizontally.

(2) *Example 2.*

A trench dug in Type B soil in 13 feet deep and five feet wide. From Table C-1.2 three acceptable arrangements of members are listed.

Arrangement #1

Space 6x6 crossbraces at six feet horizontally and five feet vertically.

Space 8x8 wales at five feet vertically.

Space 2x6 uprights at two feet horizontally.

Arrangement #2

Space 6x8 crossbraces at eight feet horizontally and five feet vertically.

Space 10x10 wales at five feet vertically.

Space 2x6 uprights at two feet horizontally.

Arrangement #3

Space 8x8 crossbraces at 10 feet horizontally and five feet vertically.

Space 10x12 wales at five feet vertically.

Space 2x6 uprights at two feet vertically.

(3) *Example 3.*

A trench dug in Type C soil is 13 feet deep and five feet wide.

From Table C-1.3 two acceptable arrangements of members can be used.

Arrangement #1

Space 8x8 crossbraces at six feet horizontally and five feet vertically.

Space 10x12 wales at five feet vertically.

Position 2x6 uprights as closely together as possible.

If water must be retained use special tongue and groove uprights to form tight sheeting.

Arrangement #2

Space 8x10 crossbraces at eight feet horizontally and five feet vertically.

Space 12x12 wales at five feet vertically.

Position 2x6 uprights in a close sheeting configuration unless water pressure must be resisted. Tight sheeting must be used where water must be retained.

(4) *Example 4.*

A trench dug in Type C soil is 20 feet deep and 11 feet wide. The size and spacing of members for the section of trench that is over 15 feet in depth is determined using Table C-1.3. Only one arrangement of members is provided.

Space 8x10 crossbraces at six feet horizontally and five feet vertically.

Space 12x12 wales at five feet vertically.

Use 3x6 tight sheeting.

Use of Tables C-2.1 through C-2.3 would follow the same procedures.

(g) *Notes for all Tables.*

1. Member sizes at spacings other than indicated are to be determined as specified in §1926.652(c), "Design of Protective Systems."

2. When conditions are saturated or submerged use Tight Sheeting. Tight Sheeting refers to the use of specially-edged timber planks (e.g., tongue and groove) at least three inches thick, steel sheet piling, or similar construction that when driven or placed in position provide a tight wall to resist the lateral pressure of water and to prevent the loss of backfill material. Close Sheeting refers to the placement of planks side-by-side allowing as little space as possible between them.

3. All spacing indicated is measured center to center.

4. Wales to be installed with greater dimension horizontal.

5. If the vertical distance from the center of the lowest crossbrace to the bottom of the trench exceeds two and one-half feet, uprights shall be firmly embedded or a mudsill shall be used. Where uprights are embedded, the vertical distance from the center of the lowest crossbrace to the bottom of the trench shall not exceed 36 inches. When mudsills are used, the vertical distance shall not exceed 42 inches. Mudsills are wales that are installed at the toe of the trench side.

6. Trench jacks may be used in lieu of or in combination with timber crossbraces.

7. Placement of crossbraces. When the vertical spacing of crossbraces is four feet, place the top crossbrace no more than two feet below the top of the trench. When the vertical spacing of crossbraces is five feet, place the top crossbrace no more than 2.5 feet below the top of the trench.

TABLE C-1.1

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A $P_a = 25 \times H + 72$ psf (2 ft Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---				2X6	
	UP TO 8	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---					2X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			2X6		
	UP TO 12	4X6	4X6	6X6	6X6	6X6	4	8X8	4				2X6	
10 TO 15	UP TO 6	4X4	4X4	4X6	6X6	6X6	4	Not Req'd	---				3X8	
	UP TO 8	4X6	4X6	6X6	6X6	6X6	4	8X8	4		2X6			
	UP TO 10	6X6	6X5	6X6	6X8	6X8	4	8X10	4			2X6		
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	10X10	4				3X8	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X8	6X8	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X8	6X8	4	8X8	4	3X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X10	4	8X10	4	3X6				
	UP TO 12	8X8	8X8	8X8	8X8	8X10	4	10X10	4	3X6				
OVER 20	SEE NOTE 1													

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may by substituted for wood.

TABLE C-1.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B $P_a = 45 \times H + 72$ psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**														
	CROSS BRACES							WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)					
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3			
5 TO 10	UP TO 6	4X6	4X6	6X6	6X6	6X6	5	6X8	5			2X6			
	UP TO 8	6X6	6X6	6X6	6X8	6X8	5	8X10	5			2X6			
	UP TO 10	6X6	6X6	6X6	6X8	6X8	5	10X10	5			2X6			
	See Note 1														
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5		2X6				
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5		2X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X10	5	10X12	5		2X6				
	See Note 1														
15 TO 20	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	3X6					
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	3X6					
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6					
	See Note 1														
OVER 20	SEE NOTE 1														

* Mixed oak or equivalent with a bending strength not less than 850 psi.
** Manufactured members of equivalent strength may by substituted for wood.

TABLE C-1.3

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C $P_a = 80 \times H + 72$ psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (ACTUAL) AND SPACING OF MEMBERS**													
	CROSS BRACES									UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET) (See Note 2)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE				
5 TO 10	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	8X10	5	2X6				
	UP TO 8	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 10	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
10 TO 15	UP TO 6	8X8	8X8	8X8	8X8	8X10	5	10X12	5	2X6				
	UP TO 8	8X10	8X10	8X10	8X10	10X10	5	12X12	5	2X6				
	See Note 1													
	See Note 1													
15 TO 20	UP TO 6	8X10	8X10	8X10	8X10	10X10	5	12X12	5	3X6				
	See Note 1													
	See Note 1													
	See Note 1													
OVER 20	SEE NOTE 1													

* Mixed Oak or equivalent with a bending strength not less than 850 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.1

TIMBER TRENCH SHORING — MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE A P_a = 25 X H ± 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **														
	CROSS BRACES							WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)					
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	4	5	6	8
5 TO 10	UP TO 6	4X4	4X4	4X4	4X4	4X6	4	Not Req'd	Not Req'd				4X6	
	UP TO 8	4X4	4X4	4X4	4X6	4X6	4	Not Req'd	Not Req'd					4X8
	UP TO 10	4X6	4X6	4X6	6X6	6X6	4	8X8	4			4X6		
	UP TO 12	4X6	4X6	4X6	6X6	6X6	4	8X8	4				4X6	
10 TO 15	UP TO 6	4X4	4X4	4X4	6X6	6X6	4	Not Req'd	Not Req'd				4X10	
	UP TO 8	4X6	4X6	4X6	6X6	6X6	4	6X8	4		4X6			
	UP TO 10	6X6	6X6	6X6	6X6	6X6	4	8X8	4			4X8		
	UP TO 12	6X6	6X6	6X6	6X6	6X6	4	8X10	4		4X6		4X10	
15 TO 20	UP TO 6	6X6	6X6	6X6	6X6	6X6	4	6X8	4	3X6				
	UP TO 8	6X6	6X6	6X6	6X6	6X6	4	8X8	4	3X6	4X12			
	UP TO 10	6X6	6X6	6X6	6X6	6X8	4	8X10	4	3X6				
	UP TO 12	6X6	6X6	6X6	6X8	6X8	4	8X12	4	3X6	4X12			
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.2

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE B P_a = 45 X H + 72 psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **													
	CROSS BRACES							WALES		UPRIGHTS				
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)				
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE	2	3	4	6
5 TO 10	UP TO 6	4X6	4X6	4X6	6X6	6X6	5	6X8	5			3X12 4X8		4X12
	UP TO 8	4X6	4X6	6X6	6X6	6X6	5	8X8	5		3X8		4X8	
	UP TO 10	4X6	4X6	6X6	6X6	6X8	5	8X10	5			4X8		
	See Note 1													
10 TO 15	UP TO 6	6X6	6X6	6X6	6X8	6X8	5	8X8	5	3X6	4X10			
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X10	5	3X6	4X10			
	UP TO 10	6X8	6X8	8X8	8X8	8X8	5	10X12	5	3X6	4X10			
	See Note 1													
15 TO 20	UP TO 6	6X8	6X8	6X8	6X8	8X8	5	8X10	5	4X6				
	UP TO 8	6X8	6X8	6X8	8X8	8X8	5	10X12	5	4X6				
	UP TO 10	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6				
	See Note 1													
OVER 20	SEE NOTE 1													

* Douglas fir or equivalent with a bending strength not less than 1500 psi.

** Manufactured members of equivalent strength may be substituted for wood.

TABLE C-2.3

TIMBER TRENCH SHORING -- MINIMUM TIMBER REQUIREMENTS *

SOIL TYPE C $P_a = 80 \times H + 72$ psf (2 ft. Surcharge)

DEPTH OF TRENCH (FEET)	SIZE (S4S) AND SPACING OF MEMBERS **														
	CROSS BRACES							WALES		UPRIGHTS					
	HORIZ. SPACING (FEET)	WIDTH OF TRENCH (FEET)					VERT. SPACING (FEET)	SIZE (IN)	VERT. SPACING (FEET)	MAXIMUM ALLOWABLE HORIZONTAL SPACING (FEET)					
		UP TO 4	UP TO 6	UP TO 9	UP TO 12	UP TO 15				CLOSE					
5 TO 10	UP TO 6	6X6	6X6	6X6	6X6	8X8	5	8X8	5	3X6					
	UP TO 8	6X6	6X6	6X6	8X8	8X8	5	10X10	5	3X6					
	UP TO 10	6X6	6X6	8X8	8X8	8X8	5	10X12	5	3X6					
	See Note 1														
10 TO 15	UP TO 6	6X8	6X8	6X8	8X8	8X8	5	10X10	5	4X6					
	UP TO 8	8X8	8X8	8X8	8X8	8X8	5	12X12	5	4X6					
	See Note 1														
	See Note 1														
15 TO 20	UP TO 6	8X8	8X8	8X8	8X10	8X10	5	10X12	5	4X6					
	See Note 1														
	See Note 1														
	See Note 1														
OVER 20	SEE NOTE 1														

* Douglas fir or equivalent with a bending strength not less than 1500 psi.
** Manufactured members of equivalent strength may be substituted for wood.

APPENDIX D TO SUBPART P—ALUMINUM HYDRAULIC SHORING FOR TRENCHES

(a) *Scope.* This appendix contains information that can be used when aluminum hydraulic shoring is provided as a method of protection against cave-ins in trenches that do not exceed 20 feet (6.1m) in depth. This appendix must be used when design of the aluminum hydraulic protective system cannot be performed in accordance with §1926.652(c)(2).

(b) *Soil Classification.* In order to use data presented in this appendix, the soil type or types in which the excavation is made must first be determined using the soil classification method set forth in appendix A of subpart P of part 1926.

(c) *Presentation of Information.* Information is presented in several forms as follows:

(1) Information is presented in tabular form in Tables D-1.1, D-1.2, D-1.3 and E-1.4. Each table presents the maximum vertical and horizontal spacings that may be used with various aluminum member sizes and various hydraulic cylinder sizes. Each table contains data only for the particular soil type in which the excavation or portion of the excavation is made. Tables D-1.1 and D-1.2 are for vertical shores in Types A and B soil. Tables D-1.3 and D1.4 are for horizontal waler systems in Types B and C soil.

(2) Information concerning the basis of the tabular data and the limitations of the data is presented in paragraph (d) of this appendix.

(3) Information explaining the use of the tabular data is presented in paragraph (e) of this appendix.

(4) Information illustrating the use of the tabular data is presented in paragraph (f) of this appendix.

(5) Miscellaneous notations (footnotes) regarding Table D-1.1 through D-1.4 are presented in paragraph (g) of this appendix.

(6) Figures, illustrating typical installations of hydraulic shoring, are included just prior to the Tables. The illustrations page is entitled "Aluminum Hydraulic Shoring; Typical Installations."

(d) *Basis and limitations of the data.*

(1) Vertical shore rails and horizontal wales are those that meet the Section Modulus requirements in the D-1 Tables. Aluminum material is 6061-T6 or material of equivalent strength and properties.

(2) Hydraulic cylinders specifications. (i) 2-inch cylinders shall be a minimum 2-inch inside diameter with a minimum safe working capacity of no less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufaturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe working capacity of not less than 30,000 pounds axial compressive load at extensions as recommended by product manufacturer.

(3) Limitation of application.

(i) It is not intended that the aluminum hydraulic specification apply to every situation that may be experienced in the field. These data were developed to apply to the situations that are most commonly experienced in current trenching practice. Shoring systems for use in situations that are not covered by the data in this appendix must be otherwise designed as specified in §1926.652(c).

(ii) When any of the following conditions are present, the members specified in the Tables are not considered adequate. In this case, an alternative aluminum hydraulic shoring system or other type of protective system must be designed in accordance with §1926.652.

(A) When vertical loads imposed on cross braces exceed a 100 Pound gravity load distributed on a one foot section of the center of the hydraulic cylinder.

(B) When surcharge loads are present from equipment weighing in excess of 20,000 pounds.

(C) When only the lower portion or a trench is shored and the remaining portion of the trench is sloped or benched unless: The sloped portion is sloped at an angle less steep than three horizontal to one vertical; or the members are selected from the tables for use at a depth which is determined from the top of the overall trench, and not from the toe of the sloped portion.

(e) *Use of Tables D-1.1, D-1.2, D-1.3 and D-1.4.* The members of the shoring system that are to be selected using this information are the hydraulic cylinders, and either the vertical shores or the horizontal wales. When a waler system is used the vertical timber sheeting to be used is also selected from these tables. The Tables D-1.1 and D-1.2 for vertical shores are used in Type A and B soils that do not require sheeting. Type B soils that may require sheeting, and Type C soils that always require sheeting are found in the horizontal wale Tables D-1.3 and D-1.4. The soil type must first be determined in accordance with the soil classification system described in appendix A to subpart P of part 1926. Using the appropriate table, the selection of the size and spacing of the members is made. The selection is based on the depth and width of the trench where the members are to be installed. In these tables the vertical spacing is held constant at four feet on center. The tables show the maximum horizontal spacing of cylinders allowed for each size of wale in the waler system tables, and in the vertical shore tables, the hydraulic cylinder horizontal spacing is the same as the vertical shore spacing.

(f) *Example to Illustrate the Use of the Tables:*

(1) Example 1:

A trench dug in Type A soil is 6 feet deep and 3 feet wide. From Table D-1.1: Find vertical shores and 2 inch diameter cylinders spaced 8 feet on center (o.c.) horizontally and 4 feet on center (o.c.) vertically. (See Figures 1 & 3 for typical installations.)

(2) Example 2:

A trench is dug in Type B soil that does not require sheeting, 13 feet deep and 5 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinders spaced 6.5 feet o.c. horizontally and 4 feet o.c. vertically. (See Figures 1 & 3 for typical installations.)

(3) A trench is dug in Type B soil that does not require sheeting, but does experience some minor raveling of the trench face. The trench is 16 feet deep and 9 feet wide. From Table D-1.2: Find vertical shores and 2 inch diameter cylinder (with special oversleeves as designated by footnote #2) spaced 5.5 feet o.c. horizontally and 4 feet o.c. vertically, plywood (per footnote (g)(7) to the D-1 Table) should be used behind the shores. (See Figures 2 & 3 for typical installations.)

(4) Example 4: A trench is dug in previously disturbed Type B soil, with characteristics of a Type C soil, and will require sheeting. The trench is 18 feet deep and 12 feet wide. 8 foot horizontal spacing between cylinders is desired for working space. From Table D-1.3: Find horizontal wale with a section modulus of 14.0 spaced at 4 feet o.c. vertically and 3 inch diameter cylinder spaced at 9 feet maximum o.c. horizontally. 3x12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(5) Example 5: A trench is dug in Type C soil, 9 feet deep and 4 feet wide. Horizontal cylinder spacing in excess of 6 feet is desired for working space. From Table D-1.4: Find horizontal wale with a section modulus of 7.0 and 2 inch diameter cylinders spaced at 6.5 feet o.c. horizontally. Or, find horizontal wale with a 14.0 section modulus and 3 inch diameter cylinder spaced at 10 feet o.c. horizontally. Both wales are spaced 4 feet o.c. vertically. 3x12 timber sheeting is required at close spacing vertically. (See Figure 4 for typical installation.)

(g) *Footnotes, and general notes, for Tables D-1.1, D-1.2, D-1.3, and D-1.4.*

(1) For applications other than those listed in the tables, refer to §1926.652(c)(2) for use of manufacturer's tabulated data. For trench depths in excess of 20 feet, refer to §1926.652(c)(2) and §1926.652(c)(3).

(2) 2 inch diameter cylinders, at this width, shall have structural steel tube (3.5x3.5x0.1875) oversleeves, or structural oversleeves of manufacturer's specification, extending the full, collapsed length.

(3) Hydraulic cylinders capacities. (i) 2 inch cylinders shall be a minimum 2-inch inside diameter with a safe working capacity of not less than 18,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(ii) 3-inch cylinders shall be a minimum 3-inch inside diameter with a safe work capacity of not less than 30,000 pounds axial compressive load at maximum extension. Maximum extension is to include full range of cylinder extensions as recommended by product manufacturer.

(4) All spacing indicated is measured center to center.

(5) Vertical shoring rails shall have a minimum section modulus of 0.40 inch.

(6) When vertical shores are used, there must be a minimum of three shores spaced equally, horizontally, in a group.

(7) Plywood shall be 1.125 in. thick softwood or 0.75 inch. thick, 14 ply, arctic white birch (Finland form). Please note that plywood is not intended as a structural member, but only for prevention of local raveling (sloughing of the trench face) between shores.

(8) See appendix C for timber specifications.

(9) Wales are calculated for simple span conditions.

(10) See appendix D, item (d), for basis and limitations of the data.

ALUMINUM HYDRAULIC SHORING
TYPICAL INSTALLATIONS

FIGURE NO. 1

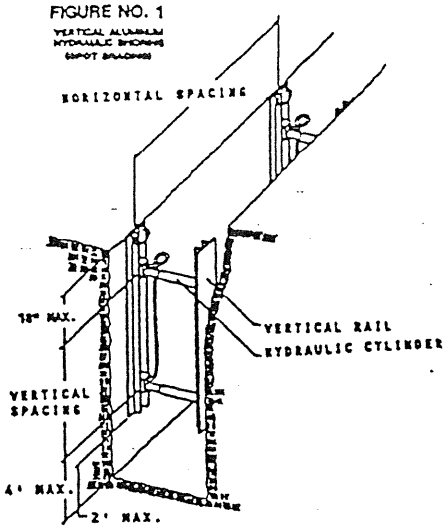


FIGURE NO. 2

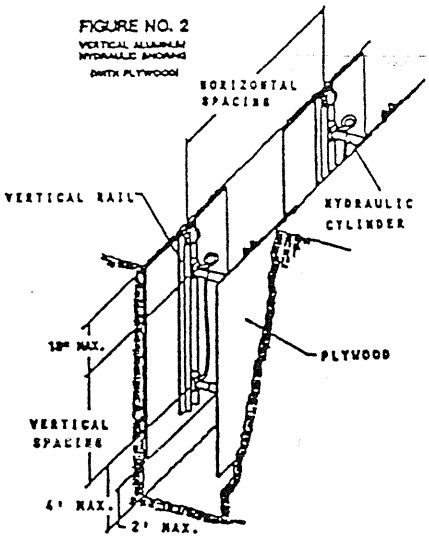


FIGURE NO. 3

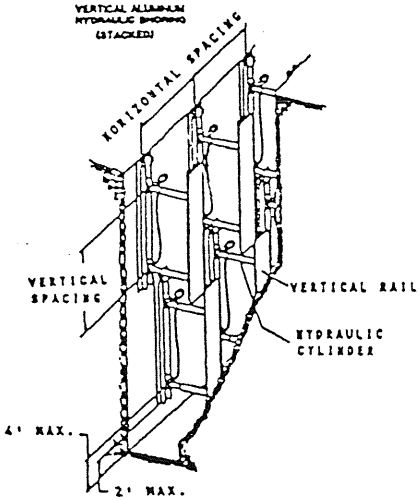


FIGURE NO. 4

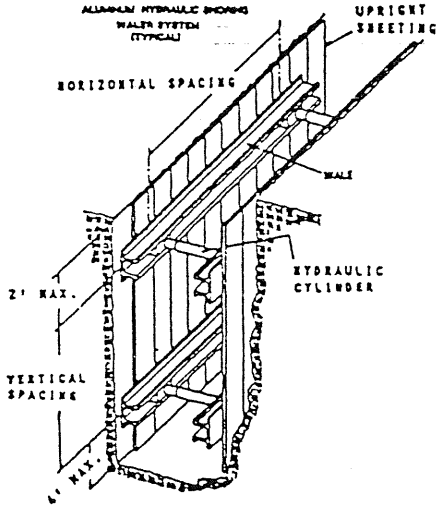


TABLE D - 1.1
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE A

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	8				
OVER 15 UP TO 20	7				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.2
ALUMINUM HYDRAULIC SHORING
VERTICAL SHORES
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	HYDRAULIC CYLINDERS				
	MAXIMUM HORIZONTAL SPACING (FEET)	MAXIMUM VERTICAL SPACING (FEET)	WIDTH OF TRENCH (FEET)		
			UP TO 8	OVER 8 UP TO 12	OVER 12 UP TO 15
OVER 5 UP TO 10	8	4	2 INCH DIAMETER	2 INCH DIAMETER NOTE (2)	3 INCH DIAMETER
OVER 10 UP TO 15	6.5				
OVER 15 UP TO 20	5.5				
OVER 20	NOTE (1)				

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Note (1): See Appendix D, Item (g) (1)
Note (2): See Appendix D, Item (g) (2)

TABLE D - 1.3
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE B

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ.SPACING (ON CENTER)		
	VERTICAL SPACING (FEET)	* SECTION MODULUS (IN^3)	UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	8.0	2 IN	8.0	2 IN NOTE(2)	8.0	3 IN	—	—	3x12
		7.0	9.0	2 IN	9.0	2 IN NOTE(2)	9.0	3 IN			
		14.0	12.0	3 IN	12.0	3 IN	12.0	3 IN			
OVER 10 UP TO 15	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	—	3x12	—
		7.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 15 UP TO 20	4	3.5	5.5	2 IN	5.5	2 IN NOTE(2)	5.5	3 IN	3x12	—	—
		7.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
		14.0	9.0	3 IN	9.0	3 IN	9.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

TABLE D - 1.4
ALUMINUM HYDRAULIC SHORING
WALER SYSTEMS
FOR SOIL TYPE C

DEPTH OF TRENCH (FEET)	WALES		HYDRAULIC CYLINDERS						TIMBER UPRIGHTS		
			WIDTH OF TRENCH (FEET)						MAX.HORIZ SPACING (ON CENTER)		
	VERTICAL SPACING (FEET)	* SECTION MODULUS (IN³)	UP TO 8		OVER 8 UP TO 12		OVER 12 UP TO 15		SOLID SHEET	2 FT.	3 FT.
			HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER	HORIZ. SPACING	CYLINDER DIAMETER			
OVER 5 UP TO 10	4	3.5	6.0	2 IN	6.0	2 IN NOTE(2)	6.0	3 IN	3x12	—	—
		7.0	6.5	2 IN	6.5	2 IN NOTE(2)	6.5	3 IN			
		14.0	10.0	3 IN	10.0	3 IN	10.0	3 IN			
OVER 10 UP TO 15	4	3.5	4.0	2 IN	4.0	2 IN NOTE(2)	4.0	3 IN	3x12	—	—
		7.0	5.5	3 IN	5.5	3 IN	5.5	3 IN			
		14.0	8.0	3 IN	8.0	3 IN	8.0	3 IN			
OVER 15 UP TO 20	4	3.5	3.5	2 IN	3.5	2 IN NOTE(2)	3.5	3 IN	3x12	—	—
		7.0	5.0	3 IN	5.0	3 IN	5.0	3 IN			
		14.0	6.0	3 IN	6.0	3 IN	6.0	3 IN			
OVER 20	NOTE (1)										

Footnotes to tables, and general notes on hydraulic shoring, are found in Appendix D, Item (g)
Notes (1): See Appendix D, item (g) (1)
Notes (2): See Appendix D, Item (g) (2)
* Consult product manufacturer and/or qualified engineer for Section Modulus of available wales.

APPENDIX E TO SUBPART P—ALTERNATIVES TO TIMBER SHORING

Figure 1. Aluminum Hydraulic Shoring

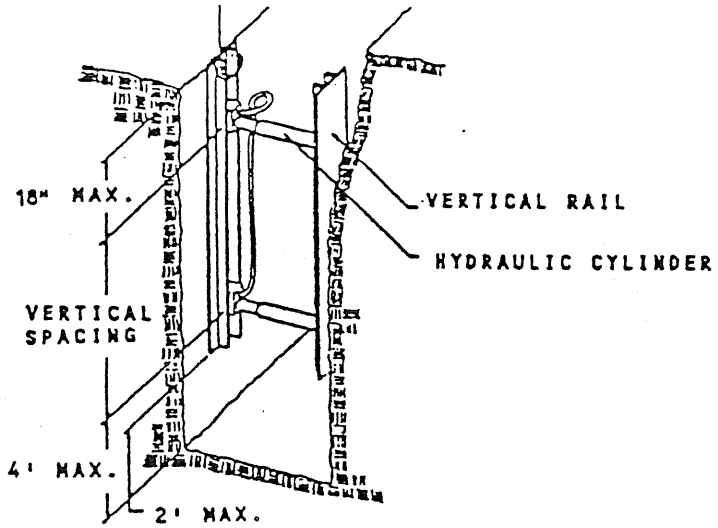


Figure 2. Pneumatic/hydraulic Shoring

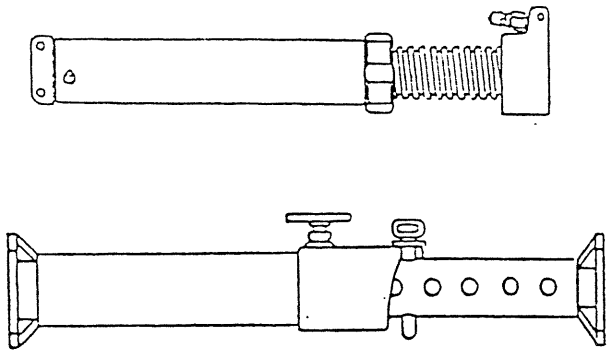


Figure 3. Trench Jacks (Screw Jacks)

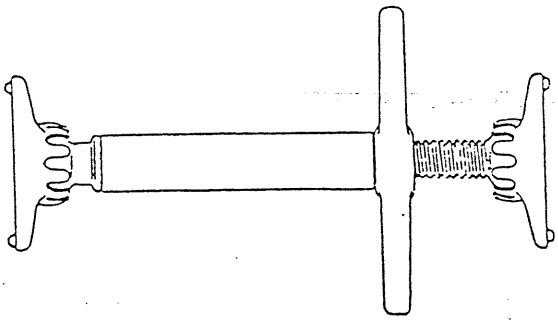
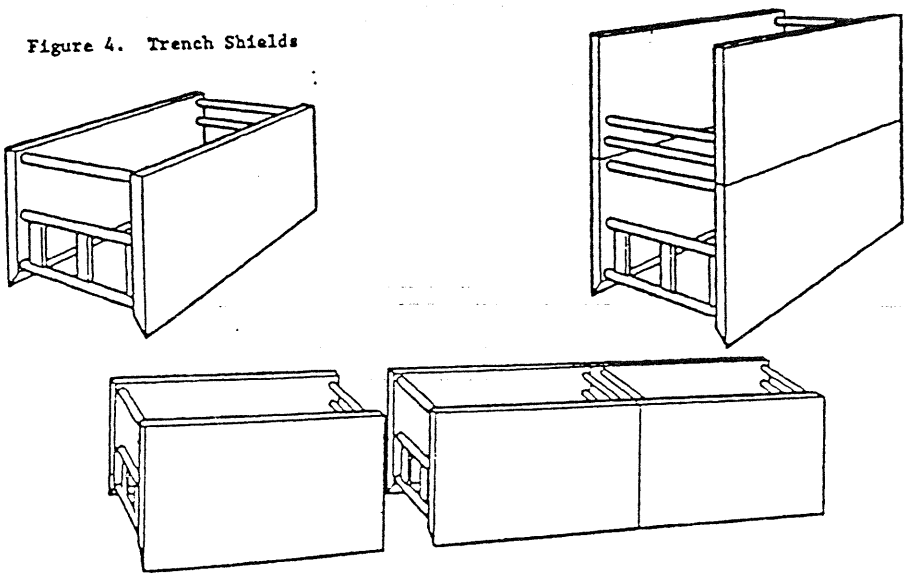


Figure 4. Trench Shields



APPENDIX F TO SUBPART P—SELECTION OF PROTECTIVE SYSTEMS

The following figures are a graphic summary of the requirements contained in subpart P for excavations 20 feet or less in depth. Protective systems for use in excavations more than 20 feet in depth must be designed by a registered professional engineer in accordance with § 1926.652 (b) and (c).

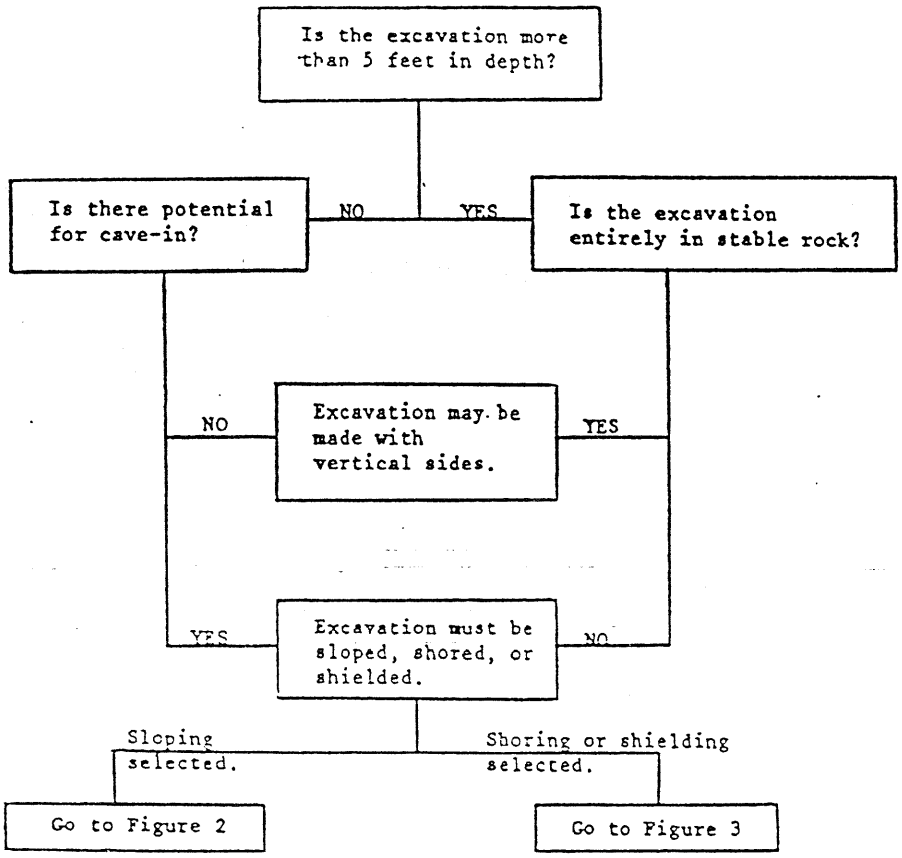


FIGURE 1 - PRELIMINARY DECISIONS

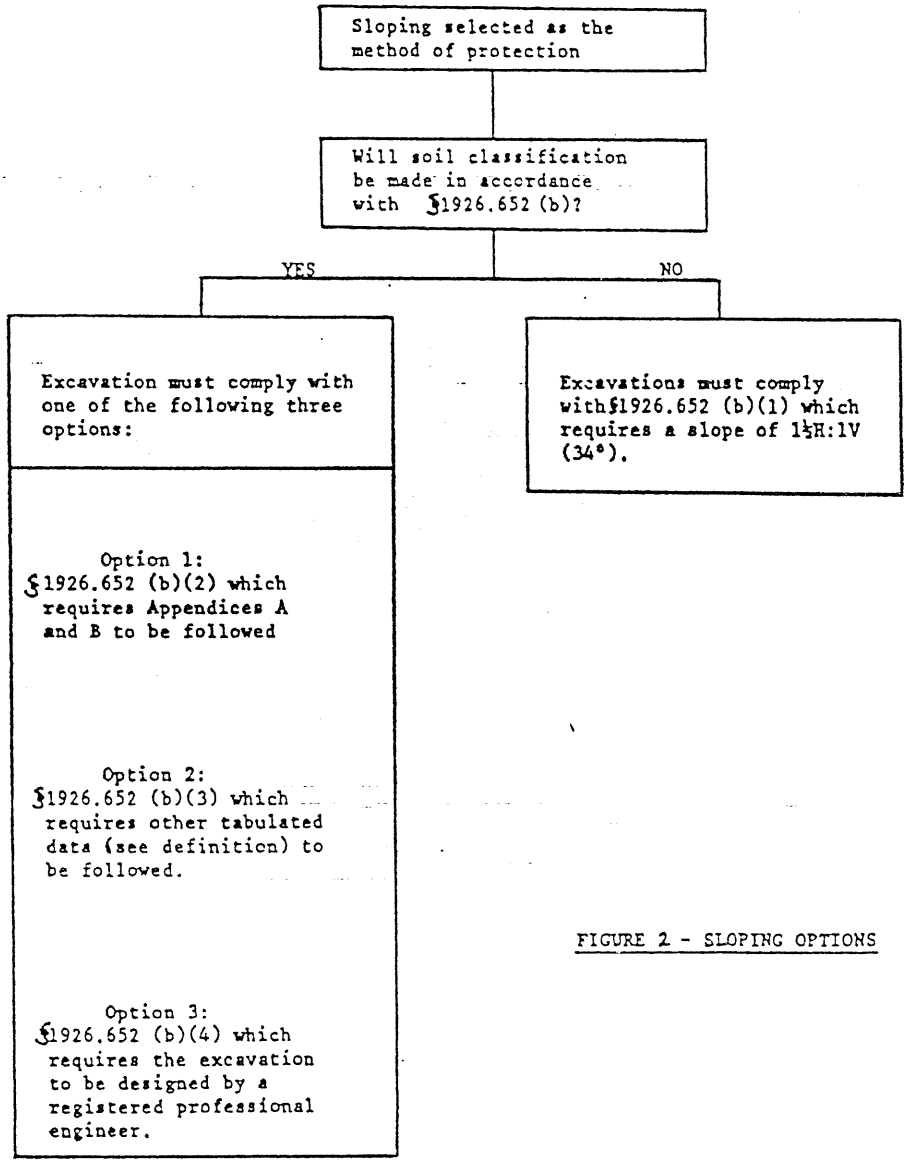


FIGURE 2 - SLOPING OPTIONS

Shoring or shielding selected as the method of protection.

Soil classification is required when shoring or shielding is used. The excavation must comply with one of the following four options:

Option 1
§1926.652 (c)(1) which requires Appendices A and C to be followed (e.g. timber shoring).

Option 2
§1926.652 (c)(2) which requires manufacturers data to be followed (e.g. hydraulic shoring, trench jacks, air shores, shields).

Option 3
§1926.652 (c)(3) which requires tabulated data (see definition) to be followed (e.g. any system as per the tabulated data).

Option 4
§1926.652 (c)(4) which requires the excavation to be designed by a registered professional engineer (e.g. any designed system).

FIGURE 3 - SHORING AND SHIELDING OPTIONS

[THIS PAGE INTENTIONALLY LEFT BLANK]

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 33 05 05

BUREIED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to install and test all buried piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of buried piping, except where buried piping installations are specified under other Sections or other contracts.
      b. Unless otherwise shown or specified, this Section includes all buried piping Work required, beginning at the outside face of structures or structure foundations, including piping beneath structures, and extending away from structures.
      c. Work on or affecting existing buried piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, cathodic protection, and other Work required for a complete, buried piping installation.
      e. Supports, restraints, and thrust blocks.
      f. Pipe encasements, with the exception of piping embedded in concrete within a structure or foundation specified under Section 40 05 05, Exposed Piping Installation.
      g. Field quality control, including testing.
      h. Cleaning and disinfecting.
      i. Incorporation of valves, meters, and special items shown or specified into piping systems in accordance with the Contract Documents and as required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before buried piping Work.
   2. Coordinate with appropriate piping Sections of Division 40, Process Integration.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 09 91 00, Painting.
   3. Section 10 14 00, Signage.
   4. Section 31 20 00, Earth Moving.
   5. Section 40 05 05, Exposed Piping Installation.
   6. Section 40 05 19, Ductile Iron Process Pipe.
   7. Section 40 05 31, Thermoplastic Process Pipe.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASME B31.3, Process Piping.
   2. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   3. ASTM B32, Specification for Solder Metal.
   4. ASTM C924, Practice for Testing Concrete Pipe Sewer Lines by Low-Pressure Test Method.
   5. ASTM D2321, Practice for Underground Installation of Thermoplastic Pipe for Sewers and other Gravity-Flow Applications.
   6. ASTM D2774, Practice for Underground Installation of Thermoplastic Pressure Piping.
   7. ASTM F1417, Test Method for Installation Acceptance of Plastic Gravity Sewer Lines using Low-Pressure Air.
   8. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure.
   9. ANSI/AWWA C105, Polyethylene Encasement for Ductile-Iron Pipe Systems.
   10. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   11. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
   12. ANSI/AWWA C600, Installation of Ductile-Iron Water Mains and Their Appurtenances.
   13. ANSI/AWWA C605, Underground Installation of Polyvinyl Chloride (PVC) Pressure Pipe and Fittings for Water.
   14. ANSI/AWWA C606, Grooved and Shouldered Joints.
   15. ANSI/AWWA C651, Disinfecting Water Mains.
   16. AWWA M9, Concrete Pressure Pipe.
   17. AWWA M11, Steel Water Pipe - A Guide for Design and Installation.
   18. AWWA M23, PVC Pipe - Design and Installation.
   19. AWWA M41, Ductile-Iron Pipe and Fittings.
   20. ASCE 37, Design and Construction of Sanitary and Storm Sewers.
   21. Chlorine Institute, Inc., Piping Systems for Dry Chlorine, Pamphlet No. 6.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Obtain required permits for Work in roads, rights-of-way, railroads, and other areas of the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

a. Details of piping, specials, joints, harnessing and thrust blocks, and connections to piping, structures, equipment, and appurtenances.

2. Product Data:
   a. Manufacturer's literature and specifications, as applicable, for products specified in this Section.
3. Testing Procedures:
   a. Submit proposed testing procedures, methods, apparatus, and sequencing. Obtain ENGINEER's approval prior to commencing testing.

B. Informational Submittals: Submit the following:
1. Certificates:
   a. Certificate signed by manufacturer of each product certifying that product conforms to applicable referenced standards.
2. Field Quality Control Submittals:
   a. Results of each specified field quality control test.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
   a. Maintain accurate and up-to-date record documents showing modifications made in the field, in accordance with approved submittals, and other Contract modifications relative to buried piping Work. Submittal shall show actual location of all piping Work and appurtenances at same scale as the Drawings.
   b. Show piping with elevations referenced to Project datum and dimensions from permanent structures. For each horizontal bend in piping, include dimensions to at least three permanent structures, when possible. For straight runs of piping provide offset dimensions as required to document piping location.
   c. Include profile drawings with buried piping record documents when the Contract Documents include piping profile drawings.
   d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
2. Upon delivery inspect pipe and appurtenances for cracking, gouging, chipping, denting, and other damage and immediately remove from Site and replace with acceptable material.

B. Storage:
1. Store materials to allow convenient access for inspection and identification. Store material off ground using pallets, platforms, or other supports. Protect packaged materials from corrosion and deterioration.
2. Pipe and fittings other than PVC may be stored outdoors without cover. Cover PVC pipe and fittings stored outdoors.

C. Handling:
   1. Handle pipe, fittings, specials, and accessories carefully in accordance with pipe manufacturer's recommendations. Do not drop or roll material off trucks. Do not drop, roll or skid piping.
   2. Avoid unnecessary handling of pipe.
   3. Keep pipe interiors free from dirt and foreign matter.
   4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Buried Piping Schedule at end of this Section. Piping materials shall conform to Specifications for each type of pipe and piping appurtenances in applicable Sections of Division 40, Process Integration.

B. General:
   1. Pipe Markings:
      a. Manufacturer shall cast or paint on each length of pipe and each fitting pipe material, diameter, and pressure or thickness class.

C. Polyethylene Encasement:
   1. Polyethylene may be supplied in tubes or sheets.
   2. Polyethylene encasement materials shall be in accordance with ANSI/AWWA C105.

2.2 BURIED PIPING IDENTIFICATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
   1. Tracer tape shall be of inert, acid- and alkali-resistant, polyethylene, four mils thick, six inches wide, suitable for direct burial. Tape shall be capable of stretching to twice its original length.
   2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other service as appropriate, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW", with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as pipeline colors specified for associated pipe service in Section 09 91 00, Painting.
   3. Manufacturer: Provide products of one of the following:
      a. Brady Corporation
      b. Seton Identification Products
      c. Marking Services, Inc.
      d. Or equal.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
   1. Tape shall be of inert, acid- and alkali-resistant, polyethylene, five mils thick, six inches wide, with aluminum backing, and have 15,000 psi tensile strength and 80 percent elongation capability. Tape shall be suitable for direct burial.
   2. Message shall read, "CAUTION [insert customized name of pipe service, i.e., "POTABLE WATER", "SANITARY SEWER", "CHLORINE GAS", or other appropriate service, as indicated in the Buried Pipe Schedule at the end of this Section] PIPE BURIED BELOW" with bold letters approximately two inches high. Messages shall be printed at maximum intervals of two feet. Tape shall be custom colored the same as the pipeline colors as specified for the associated pipe service in Section 09 91 00, Painting.
   3. Manufacturer: Provide products of one of the following:
      a. Brady Corporation
      b. Seton Identification Products
      c. Marking Services, Inc.
      d. Or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:
   1. Install piping as shown, specified, and as recommended by pipe and fittings manufacturer.
   2. In event of conflict between manufacturer's recommendations and the Contract Documents, request interpretation from ENGINEER before proceeding.
   3. ENGINEER will observe excavations and bedding prior to laying pipe by CONTRACTOR. Notify ENGINEER in advance of excavating, bedding, pipe laying, and backfilling operations.
   4. Minimum cover over buried piping shall be as shown on the drawings, to match existing conditions, unless otherwise shown or approved by ENGINEER.
   5. Earthwork is specified in Section 31 20 00, Earth Moving.
   6. Excavation in excess of that required or shown, and that is not authorized by ENGINEER shall be filled at CONTRACTOR's expense with granular material furnished, placed, and compacted in accordance with Section 31 20 00, Earth Moving.
   7. Comply with NFPA 24 for "Outside Protection", where applicable to water piping systems used for fire protection.

B. Separation of Sewers and Potable Water Piping:
   1. Horizontal Separation:
      a. Where possible, existing and proposed potable water mains and service lines, and sanitary, combined, and storm sewers shall be separated horizontally by clear distance of at least ten feet.

b. If local conditions preclude the specified clear horizontal separation, installation will be allowed if potable water main is in separate trench or on undistributed earth shelf on one side of sewer and with bottom of potable water main at least 18 inches above top of sewer.

c. Exception:

1) Where it is not possible to provide minimum horizontal separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe complying with public water supply design standards of authority having jurisdiction. Hydrostatically test water main and sewer as specified in this Section prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2. Vertical Separation:

a. Provide minimum vertical distance of 18 inches between outside of potable water main and outside of sewer when sewer crosses over potable water main.

b. Center a section of potable water main pipe at least 17.5 feet long over sewer so that sewer joints are equidistant from potable water main joints.

c. Provide adequate structural support where potable water main crosses under sewer. At minimum, provide compacted select backfill for ten feet on each side of crossing.

d. Exceptions:

1) Where it is not possible to provide minimum vertical separation described above, construct potable water main of cement-lined ductile iron pipe with restrained push-on joint or restrained mechanical joint pipe. Hydrostatically test water main and sewer as specified in this Section, prior to backfilling. Hydrostatic test pressure at crossing shall be at least 150 psi.

2) Encase either potable water main or sewer in watertight carrier pipe extending ten feet on each side of crossing, measured perpendicular to potable water main.

C. Plugs:

1. Temporarily plug installed pipe at end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.

2. Install standard plugs in bells at dead ends, tees, and crosses. Cap spigot and plain ends.

3. Fully secure and block plugs, caps, and bulkheads installed for testing to withstand specified test pressure.

4. Where plugging is required for phasing of the Work or subsequent connection of piping, install watertight, permanent type plugs, caps, or bulkhead acceptable to ENGINEER.

D. Bedding Pipe: Bed pipe as specified and in accordance with details on the Drawings.

1. Trench excavation and backfill, and bedding materials shall conform to Section 31 20 00, Earth Moving, as applicable.
2. Where ENGINEER deems existing bedding material unsuitable, remove and replace existing bedding with approved granular material furnished, placed, and compacted in accordance with 31 20 00, Earth Moving. Payment for additional excavation and providing granular material will be made under the unit price payment items in the Contract.
3. Where pipe is installed in rock excavation, provide minimum of three inches of granular bedding material underneath pipe smaller than four-inch nominal diameter, and minimum of six inches of granular bedding material underneath pipes four-inch nominal diameter and larger.
4. Excavate trenches below bottom of pipe by amount shown and indicated in the Contract Documents. Remove loose and unsuitable material from bottom of trench.
5. Carefully and thoroughly compact pipe bedding with hand held pneumatic compactors.
6. Do not lay pipe until ENGINEER approves bedding condition.
7. Do not bring pipe into position until preceding length of pipe has been bedded and secured in its final position.

E. Laying Pipe:
1. Conform to manufacturer's instructions and requirements of standards and manuals listed below, as applicable:
   a. Ductile Iron Pipe: ANSI/AWWA C600, ANSI/AWWA C105, AWWA M41.
   b. Thermoplastic Pipe: ASTM D2321, ASTM D2774, ANSI/AWWA C605, AWWA M23, AWWA M45, AWWA, M55.
   c. Sanitary and Storm Sewers: ASCE 37.
2. Install pipe accurately to line and grade shown and indicated in the Contract Documents, unless otherwise approved by ENGINEER. Remove and reinstall pipes that are not installed correctly.
3. Slope piping uniformly between elevations shown.
4. Keep groundwater level in trench at least 24 inches below bottom of pipe before laying pipe. Do not lay pipe in water. Maintain dry trench conditions until jointing and backfilling are complete. Keep clean and protect interiors of pipe, fittings, valves, and appurtenances.
5. Start laying pipe at lowest point and proceed towards higher elevations, unless otherwise approved by ENGINEER.
6. Place bell and spigot-type pipe so that bells face the direction of laying, unless otherwise approved by ENGINEER.
7. Place concrete pipe containing elliptical reinforcement with minor axis of reinforcement in vertical position.
8. Excavate around joints in bedding and lay pipe so that pipe barrel bears uniformly on trench bottom.
9. Deflections at joints shall not exceed 75 percent of amount allowed by pipe manufacturer, unless otherwise approved by ENGINEER.
10. For PVC piping with solvent welded joints, 2.5-nch diameter and smaller, snake piping in trench to compensate for thermal expansion and contraction.

11. Carefully examine pipe, fittings, valves, and specials for cracks, damage, and other defects while suspended above trench before installation. Immediately remove defective materials from the Site and replace with acceptable products.
12. Inspect interior of all pipe, fittings, valves, and specials and completely remove all dirt, gravel, sand, debris, and other foreign material from pipe interior and joint recesses before pipe and appurtenances are moved into excavation. Bell and spigot-type mating surfaces shall be thoroughly wire brushed, and wiped clean and dry immediately before pipe is laid.
13. Field cut pipe, where required, with machine specially designed for cutting the type of pipe being installed. Make cuts carefully, without damage to pipe, coating or lining, and with smooth end at right angles to axis of pipe. Cut ends on push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.
14. Do not place blocking under pipe, unless specifically approved by ENGINEER for special conditions.
15. Touch up protective coatings in manner satisfactory to ENGINEER prior to backfilling.
16. Notify ENGINEER in advance of backfilling operations.
17. On steep slopes, take measures acceptable to ENGINEER to prevent movement of pipe during installation.

F. Jointing Pipe:
1. Ductile Iron Push-On Joint Pipe:
   a. Prior to assembling joints, thoroughly clean with wire brush the last eight inches of exterior surface of spigot and interior surface of bell, except where joints are lined or coated with a protective lining or coating.
   b. Wipe clean rubber gaskets and flex gaskets until resilient. Conform to manufacturer's instructions for procedures to ensure gasket resiliency when assembling joints in cold weather.
   c. Insert gasket into joint recess and smooth out entire circumference of gasket to remove bulges and to prevent interference with proper entry of spigot of entering pipe.
   d. Immediately prior to joint assembly, apply thin film of pipe manufacturer's recommended lubricant to surface of gasket that will come in contact with entering spigot end of pipe, or apply a thin film of lubricant to outside of spigot of entering pipe.
   e. For assembly, center spigot in pipe bell and push pipe forward until spigot just makes contact with rubber gasket. After gasket is compressed and before pipe is pushed or pulled in the rest of the way, carefully check gasket for proper position around the full circumference of joint. Final assembly shall be made by forcing spigot end of entering pipe past gasket until spigot makes contact with base of the bell. When more than a reasonable amount of force is required to assemble the joint, remove spigot end of pipe to verify proper positioning of gasket. Do not use gaskets that have been scored or otherwise damaged.

f. Maintain an adequate supply of gaskets and joint lubricant at the Site when pipe jointing operations are in progress.

3. Ductile Iron Proprietary Joints:
   a. Install pipe that utilizes proprietary joints for restraint specified in Section 40 05 19, Ductile Iron Process Pipe, or other such joints, in accordance with manufacturer's instructions.
2. Thermoplastic Pipe Joints:
   a. Bell and Spigot Joints:
      1) Bevel pipe ends, remove all burrs, and provide a reference mark at correct distance from pipe end before making joints.
      2) Clean spigot end and bell thoroughly before making the joint. Insert O-ring gasket while ensuring that gasket is properly oriented. Lubricate spigot with manufacturer's recommended lubricant. Do not lubricate bell and O-ring. Insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.

G. Backfilling:
1. Conform to applicable requirements of Section 31 20 00, Earth Moving.
2. Place backfill as Work progresses. Backfill by hand and use power tampers until pipe is covered by at least one foot of backfill.

H. Closures:
1. Provide closure pieces shown or required to complete the Work.

3.2 TRACER TAPE INSTALLATION

A. Polyethylene Underground Warning Tape for Metallic Pipelines:
1. Provide polyethylene tracer tape for buried metallic piping, which includes pipe that is steel, ductile iron, cast iron, concrete, copper, and corrugated metal.
2. Provide tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

B. Detectable Underground Warning Tape for Non-Metallic Pipelines:
1. Provide polyethylene tracer tape with aluminum backing for buried, non-metallic piping, which includes pipe that is PVC, CPVC, polyethylene, HDPE, FRP, ABS, and vitrified clay.
2. Provide magnetic tracer tape 12 to 18 inches below finished grade, above and parallel to buried pipe.
3. For pipelines buried eight feet or greater below finished grade, provide second line of magnetic tracer tape 2.5 feet above crown of buried pipe, aligned along the pipe centerline.
4. Tape shall be spread flat with message side up before backfilling.

3.3 THRUST RESTRAINT

A. Provide thrust restraint on pressure piping systems where shown or indicated in the Contract Documents.

B. Thrust restraint may be accomplished by using restrained pipe joints, concrete thrust blocks, or harnessing buried pipe. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Buried Piping Schedule at the end of this Section.

C. Place concrete thrust blocks against undisturbed soil. Where undisturbed soil does not exist, or for projects where the Site consists of backfill material, thrust restraint shall be provided by restrained pipe joints.

D. Restrained Pipe Joints:
   1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
      a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with proprietary restrained joint system as specified in Section 40 05 19, Ductile Iron Process Pipe; lugs and tie rods; or other joint restraint systems approved by ENGINEER.
      b. Thermoplastic Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across joint or other suitable joint restraint system, subject to the approval of ENGINEER.

3.4 WORK AFFECTING EXISTING PIPING

A. Location of Existing Underground Facilities:
   1. Locations of existing Underground Facilities shown on the Drawings should be considered approximate.
   2. Determine the true location of existing Underground Facilities to which connections are to be made, crossed, and that could be disturbed, and determine location of Underground Facilities that could be disturbed during excavation and backfilling operations, or that may be affected by the Work.

B. Taking Existing Pipelines and Underground Facilities Out of Service:
   1. Conform to Section 01 14 16, Coordination with Owner's Operations.
   2. Do not take pipelines or Underground Facilities out of service unless specifically listed in Section 01 14 16, Coordination with Owner's Operations, or approved by ENGINEER.
   3. Notify ENGINEER in writing prior to taking pipeline or Underground Facilities out of service. Shutdown notification shall be provided in advance of the shutdown in accordance with the General Conditions and Section 01 14 16, Coordination with Owner's Operations.

C. Work on Existing Pipelines or Underground Facilities:

1. Cut or tap piping or Underground Facilities as shown or required with machines specifically designed for cutting or tapping pipelines or Underground Facilities, as applicable.
2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations, Section 01 73 29, Cutting and Patching, and Section 01 73 24, Connections to Existing Facilities.

3.5 FIELD QUALITY CONTROL

A. General:
1. Test all piping, except as exempted in the Buried Piping Schedule in this Section.
2. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
3. Conduct all tests in presence of ENGINEER.
4. Remove or protect pipeline-mounted devices that could be damaged by testing.
5. Provide all apparatus and services required for testing, including:
   a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
   b. Temporary bulkheads, bracing, blocking, and thrust restraints.
6. Provide air if an air test is required, power if pumping is required, and gases if gases are required.
7. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into piping being tested. CONTRACTOR shall provide fluid for other types of testing required.
8. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
9. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of OWNER. Unless otherwise included in the Work, repair of existing piping or Underground Facilities will be paid as extra Work.

B. Test Schedule:
1. Refer to the Buried Piping Schedule in this Section for type of test required and required test pressure.
2. Unless otherwise specified, required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Buried Piping Schedule in this Section:

a. Hydrostatically test pipe that will convey liquid at a pressure greater than five psig. Provide process air pipe test for pipe that will convey air or gas under pressure or vacuum, except chlorine gas, which requires separate test.
b. Use exfiltration testing, low-pressure air testing, or vacuum testing for other piping.
c. Disinfect for bacteriological testing piping that conveys potable water.

4. Test Pressure:
   a. Use test pressures listed in Buried Piping Schedule in this Section.
   b. If test pressure is not listed in Buried Piping Schedule, or if test is required for piping not listed in the Buried Piping Schedule, test pressure will be determined by ENGINEER based on maximum anticipated sustained operating pressure and methods described in applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
1. Preparation for Testing:
   a. For thermoplastic pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
   b. For other piping follow procedures described in ANSI/AWWA Manual M9, except that minimum wetting period required immediately prior to testing for asbestos cement pipe shall be 24 hours rather than the 48 hours prescribed for concrete pipe. Wetting period is not required for pipe that is not cement mortar-lined.
   c. Prior to testing, ensure that adequate thrust protection is in place and joints are properly installed.
2. Test Procedure:
   a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in pipe being tested.
   b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
   c. Examine exposed joints and valves, and make repairs to eliminate visible leakage.
   d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
   e. Timed test period shall not begin until after pipe has been filled, exposed to required wetting period, air has been expelled, and pressure stabilized.
   f. Timed Test Period: After stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three hour expansion phase, reduce test pressure by ten psig and do not add liquid. Test pressure shall then remain steady for one hour, indicating no leakage.

g. Pump from test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at 15 minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
   b. Rates based on formula or table in ANSI/AWWA Manual M41:
      1) Metal and fiberglass pipe joined with rubber gaskets as sealing members, including the following joint types:
         a) Bell and spigot and push-on joints.
         b) Mechanical joints.
         c) Bolted sleeve type couplings.
         d) Grooved and shouldered couplings.
   c. Leakage shall not exceed that allowed by authority having jurisdiction.

D. Sewer Testing with Low Pressure Air:
   1. Plug and bulkhead ends and lateral connections of pipe segment to be tested.
   2. Required test pressure shall be increased by an amount equal to the elevation of groundwater above invert of lowest point of pipe segment being tested.
   3. Test in accordance with requirements of authority having jurisdiction.
   4. If there are no Laws and Regulations covering the test, use test procedures described in the following standards:
      a. Thermoplastic and HDPE Pipe: ASTM F1417.

3.6 CLEANING

A. Cleaning, General: Clean pipe systems as follows:
   1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in manner approved by ENGINEER, prior to placing in service. Flush chlorine solution and sodium hypochlorite piping with water.

3.7 SCHEDULES

A. Schedules listed below, following the “End of Section” designation, are part of this Specification section.
   1. Table 33 05 05-A, Buried Piping Schedule.

+ + END OF SECTION + +

TABLE 33 05 05-A, BURIED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thicknes s	Joint	Test	Remarks
D	1” to 1-1/2”	PVC	-	-	Sch 40	SW	AIR	
W3	1” to 2”	PVC	-	-	Sch 80	SW	HYD (150)	
D / SS	4” to 8”	PVC			DR 35	BS	HYD (25)	
MS	4”	DI	GL	PEW	Sch 40	RPOJ	HYD (100)	Existing Lines to be relocated

The following abbreviations are used in the Buried Piping Schedule.

A. Service Abbreviations

Service	Abbrev		Service	Abbrev.
Drain	D		Plant Effluent	W3
Sanitary Sewer	SS		Mixed Sludge	MS

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Ductile Iron	DI		Polyvinyl Chloride	PVC

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Glass Lined	GL		Polyethylene Wrapped	PEW

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Bell and Spigot	BS		Restrained Push-on Joint	RPOJ
Restrained Bell and Spigot	RBS		Solvent Weld	SW

E. Test Abbreviations

Test	Abbrev	
Hydrostatic Test (test pressure in psig)	HYD ( )	
Low-pressure Air Sewer Test	AIR	

SECTION 40 05 05

EXPOSED PIPING INSTALLATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified, and required to install and test all exposed piping, fittings, and specials. The Work includes the following:
      a. All types and sizes of exposed piping, except where exposed piping installations are specified under other Sections or other contracts.
      b. Unless otherwise shown or specified, this Section includes all piping beginning at the outside face of structures or structure foundations and extending into the structure. Piping embedded in concrete within a structure or foundation shall be considered as exposed and is included herein. Piping that is permanently or intermittently submerged, or installed in sub-aqueous environments, is considered as exposed and is included in this Section.
      c. Work on or affecting existing exposed piping.
      d. Installation of all jointing and gasket materials, specials, flexible couplings, mechanical couplings, harnessed and flanged adapters, sleeves, tie rods, and all Work required for a complete exposed piping installation.
      e. Supports, restraints, and other anchors.
      f. Field quality control, including testing.
      g. Cleaning.
      h. Incorporation of valves, meters, and special items shown or specified into the piping systems per the Contract Documents and as required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before exposed piping Work.

C. Related Sections:
   1. Section 01 14 16-3, Coordination with Owner’s Operations
   2. Section 01 73 24, Connections to Existing Facilities
      Section 09 91 00, Painting.
   2. Section 10 14 00, Signage.
   3. Section 33 05 05, Buried Piping Installation.
   4. Section 40 05 07, Pipe Hangers and Supports.

5. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
6. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.
7. Section 40 05 17, Copper Process Pipe
8. Section 40 05 19, Ductile Iron Process Pipe.
9. Section 40 05 31, Thermoplastic Process Pipe.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast Iron Pipe Flanges and Flanged Fittings
   2. ASME Boiler and Pressure Vessel Code.
   3. ASME B31.3, Process Piping.
   4. American Society for Non-Destructive Testing (ASNT), ASNT-TC-1A, Recommended Practice, Personnel Qualification, and Certification in Non-destructive Testing.
   5. ASTM A380, Standard Practice for Cleaning, Descaling, and Passivation of Stainless Steel Parts, Equipment, and Systems
   6. ASTM B32, Specification for Solder Metal.
   7. ASTM F2164, Standard Practice for Field Leak Testing of Polyethylene (PE) Pressure Piping Systems Using Hydrostatic Pressure
   8. AWS D1.1/D1.1M, Structural Welding Code-Steel.
   9. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
   9. ANSI/AWWA C206, Field Welding of Steel Water Pipe.
   10. ANSI/AWWA C606, Grooved and Shouldered Joints.
   11. AWWA M11, Steel Pipe - A Guide for Design and Installation.
   12. AWWA M23, PVC Piping - Design and Installation.
   13. AWWA M41, Ductile-Iron Pipe and Fittings.

1.3 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements and recommendations of authorities having jurisdiction over the Work.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings in plan and, as applicable, section.
      b. Details of piping, valves, supports, accessories, specials, joints, harnessing, and main anchor supports, and connections to existing piping, structures, equipment, and appurtenances.
      c. See section 01 14 16 for shutdown submittal requirement

   2. Testing Plans, Procedures, and Testing Limitations

a. Submit description of proposed testing methods, procedures, and apparatus, and obtain ENGINEER's approval prior to testing.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Submit a certificate, signed by manufacturer of each product, certifying that product complies with applicable referenced standards.
b. Welder's certificate in compliance with Paragraph 3.2.D.3.c of this Section.
2. Source Quality Control Submittals:
a. Submit copies of testing report for each test.
3. Site Quality Control Reports:
a. Submit copies of testing report for each test.

C. Closeout Submittals: Submit the following:
1. Record Documentation:
a. Maintain accurate and up-to-date record documents showing field and Shop Drawing modifications. Record documents for exposed piping Work shall show actual location of all piping and appurtenances on a copy of the Drawings, unless otherwise approved by ENGINEER.
b. Record documents shall show piping with elevations referenced to the project datum and dimensions from permanent structures. For straight runs of pipe provide offset dimensions as required to document pipe location.
c. Include section drawings with exposed piping record documents when the Contract Documents include section Drawings.
d. Conform to Section 01 78 39, Project Record Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery:
1. Deliver products to Site to ensure uninterrupted progress of the Work.
2. Upon delivery, inspect pipe and appurtenances for cracked, gouged, chipped, dented, and other damage and immediately remove damaged products from Site.
3. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

B. Storage:
1. Store products for convenient access for inspection and identification. Store products off the ground using pallets, platforms, or other supports. Protect packaged products from corrosion and deterioration.
2. Pipe and fittings other than thermoplastic materials may be stored outdoors without cover. Thermoplastic pipe and fittings stored outdoors shall be covered.

3. Conform to requirements of Section 01 66 00, Product Storage and Handling Requirements.

C. Handling:
1. Handle pipe, fittings, specials, and accessories carefully with approved handling devices. Do not drop or roll material of delivery vehicles. Do not otherwise drop, roll, or skid piping.
2. Avoid unnecessary handling of pipe.
3. Keep pipe interiors free of dirt and foreign matter.
4. Protect interior linings and exterior coatings of pipe and fittings from damage. Replace pipe and fittings with damaged lining regardless of cause of damage. Repair damaged coatings.
5. Conform to requirements of Section 01 65 00, Product Delivery Requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Piping materials are specified in the Exposed Piping Schedule at the end of this Section. Piping materials shall conform to Specification for each type of pipe and piping appurtenances in applicable sections of Division 40, Process Integration.

B. Markings and Identification:
1. Pipe Markings:
   a. Clearly mark each piece of pipe or fitting with a designation conforming to that shown on the approved Shop Drawings.
   b. Manufacturer shall cast or paint on each length of pipe and each fitting the pipe material, diameter, and pressure or thickness class.
2. Pipe Identification Markers and Arrows: Refer to Section 10 14 00, Signage.

C. Appurtenances: Provide products that comply with:
1. Section 40 05 07, Pipe Hangers and Supports.
2. Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.
3. Section 40 05 08, Wall Pipes, Floor Pipes and Pipe Sleeves.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which the Work is to be installed and notify ENGINEER in writing of conditions detrimental to the proper and timely completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install piping as shown, specified and as recommended by the pipe and fittings manufacturer.
   2. If there is a conflict between manufacturer's recommendations and the Contract Documents, request in writing instructions from ENGINEER before proceeding.
   3. Provide pipe manufacturer’s installation specialist at Site as specified on this Section.

B. Temporary Blind Flanges, Plugs, Caps, and Bulkheads:
   1. Temporarily plug installed pipe at the end of each day of work or other interruption of pipe installation to prevent entry of animals, liquids, and persons into pipe, and entrance or insertion of deleterious materials into pipe.
   2. Install standard plugs in all bells at dead ends, tees, and crosses. Cap all spigot and plain ends.
   3. Fully secure and block blind flanges, plugs, caps, and bulkheads installed for testing, designed to withstand specified test pressure.
   4. Where plugging is required for phasing of Work or subsequent connection of piping, install watertight, permanent type blind flanges, plugs, caps, or bulkhead acceptable to ENGINEER.

C. Piping Installation:
   1. Conform to manufacturer’s instructions and requirements of standards and manuals listed in this Section, as applicable:
      a. Ductile Iron Pipe: ANSI/AWWA C600, AWWA M41.
      b. Steel Pipe: ASME B31.3, ANSI/AWWA C206, AWWA M11.
      c. Thermoplastic Pipe: AWWA M23
   2. Install straight runs true to line and elevation.
   3. Install vertical pipe truly plumb in all directions.
   4. Install piping parallel or perpendicular to walls of structures. Piping at angles and 45 degree runs across corners of structures will not be accepted unless specifically shown on the Contract Documents or approved by the ENGINEER.
   5. Install small diameter piping generally as shown when specific locations and elevations are not indicated. Locate such piping as required to avoid ducts, equipment, beams, and other obstructions.
   6. Install piping to leave all corridors, walkways, work areas, and similar spaces unobstructed. Unless otherwise approved by ENGINEER provide a minimum headroom clearance under piping and pipe supports of 7.5 feet. Clearances beneath piping shall be measured from the outermost edge of piping, flanges or other type of joint that extends beyond the nominal outside diameter of piping.
   7. Protect and keep clean interiors, fittings, and valves of pipe that will convey potable water, chemicals, and other pipe designated by ENGINEER.

8. Cutting: Cut pipe from measurements verified at Site. Field cut pipe, where required, with a machine specially designed for cutting type of pipe being installed. Make cuts carefully without damage to pipe, coating, or lining, and with a smooth end at right angles to axis of pipe. Cut ends of push-on joint type pipe shall be tapered and sharp edges filed off smooth. Do not flame-cut pipe.

D. Jointing Pipe:
1. General:
   a. Make joints in accordance with pipe manufacturer's recommendations and Contract Documents.
   b. Cut piping accurately and squarely and install without forcing or springing.
   c. Ream out pipes and tubing to full inside diameter after cutting. Remove all sharp edges on end cuts.
   d. Remove all cuttings and foreign matter from inside of pipe and tubing before installation. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
2. Ductile Iron and Steel Flanged Joints:
   a. Assemble flanged joints using ring-type gaskets, with thickness as recommended by pipe manufacturer but not less than 1/8-inch thick, for raised-face flanges. Use full-face gaskets for flat-face flanges, unless otherwise approved by ENGINEER or recommended by pipe manufacturer. Gaskets shall be suitable for the service intended in accordance with the manufacturer's ratings and instructions. Gaskets shall be properly centered.
   b. Tighten bolts in a sequence that provides equal distribution of bolt loads.
   c. Length of bolts shall be uniform. Bolts shall not project beyond the nut more than 1/4-inch or fall short of the nut when fully taken up. Machine-cut ends of bolts to be neatly rounded. Do not use washers.
   d. Prior to assembly of flanged joints, lubricate bolt threads and gasket faces.
   e. Alternately tighten bolts 180 degrees apart to compress the gasket evenly.
   f. After assembly, coat all bolts and nuts, except stainless steel bolts and nuts, with same coating specified in Section 09 91 00, Painting, for material of pipe and fittings being joined.
3. Steel Pipe Threaded Joints:
   a. For threaded joints, use standard, right hand tapered full depth threads on steel piping and apply a manufacturer's recommended joint compound to male threads only, before installation.
   b. Remove cuttings and foreign matter from inside of pipe.
   c. Thoroughly clean all pipe, fittings, valves, specials, and accessories before installing.
4. Thermoplastic Pipe Joints:
   a. Solvent Cement Welded Joints:

1) Bevel pipe ends and remove all burrs before making joint. Clean pipe and fittings thoroughly. Do not make solvent cement joints if temperature is below 40 degrees F. Do not make solvent cement welded joints in wet conditions.
2) Use solvent cement supplied or recommended by pipe manufacturer.
3) Apply joint primer and solvent cement and assemble joints in accordance with recommendations and instructions of manufacturer of joint materials and pipe manufacturer.
4) Implement appropriate safety precautions when using joint primers and solvent cements. Allow air to circulate freely through pipelines to allow solvent vapors to escape. Slowly admit fluid when flushing or filling pipelines to prevent compression of gases within pipes.

b. Bell and Spigot Joints:

1) Bevel pipe ends, remove all burrs, and provide a reference mark at correct distance from pipe end before making joint.
2) Clean spigot end and bell thoroughly before making the joint. Insert O-ring gasket while ensuring that gasket is properly oriented. Lubricate spigot with manufacturer's recommended lubricant. Do not lubricate bell and O-ring. Insert spigot end of pipe carefully into bell until reference mark on spigot is flush with bell.

5. Mechanical Coupling Joints:
   a. Mechanical couplings include: sleeve-type flexible couplings, split flexible couplings, ANSI/AWWA C606 grooved or shouldered end couplings, plasticized PVC couplings, and other mechanical couplings used.
   b. Prior to installing and assembling mechanical couplings, thoroughly clean joint ends with a wire brush to remove foreign matter.
   c. For mechanical couplings that incorporate gaskets, after cleaning apply lubricant to rubber gasket or inside of coupling housing and to joint ends. After lubrication, install gasket around joint end of previously installed piece and mate joint end of subsequent piece to installed piece. Position gasket and place coupling housing around gasket and over grooved or shouldered joint ends. Insert bolts and install nuts tightly by hand. Tighten bolts uniformly to produce an equal pressure on all parts of housing. When housing clamps meet metal to metal, joint is complete and further tightening is not required.
   d. For plasticized PVC couplings, loosen the stainless steel clamping bands and remove the clamps from the coupling. Slide the coupling over the plain ends of the pipes to be joined without using lubricants. Place clamps over each end of coupling at grooved section and tighten with a torque wrench to torque recommended by manufacturer.

E. Installing Valves and Accessories:
   1. Provide supports for large valves, flow meters, and other heavy items as shown or required to prevent strain on adjoining piping.

2. Position flow measuring devices in pipe lines so that they have the amount of straight upstream and downstream runs recommended by the flow measuring device manufacturer, unless specific location dimensions are shown.
3. Position swing check valves and butterfly valves so that they do not conflict with upstream and downstream elements of the piping system.

F. Unions:
1. Install dielectric unions as specified in Section 40 05 06, Couplings, Adapters, and Specials for Process Piping**,** where dissimilar metals are connected, except for bronze or brass valves in ferrous piping.
2. Provide a union downstream of each valve with screwed connections.
3. Provide screwed or flanged unions at each piece of equipment, where shown, and where necessary to install or dismantle piping.

G. Transitions from One Type of Pipe to Another:
1. Provide all necessary adapters, specials, and connection pieces required when connecting different types and sizes of pipe or connecting pipe made by different manufacturers.

H. Closures:
1. Provide closure pieces, such as blind flanges and caps, shown or required to complete the Work.

3.2 THRUST RESTRAINT

A. Provide thrust restraint on all pressure piping systems and where otherwise shown or specified.

B. Thrust restraints shall be designed for axial thrust exerted by test pressure specified in the Exposed Piping Schedule at end of this Section.

C. Restrained Pipe Joints:
1. Pipe joints shall be restrained by means suitable for the type of pipe being installed.
   a. Ductile Iron, Push-on Joints and Mechanical Joints: Restrain with a proprietary restrained joint system as specified in Section 40 05 19. Ductile iron pipe, lugs, and tie rods, or other joint restraint systems approved by ENGINEER. Restrain ductile iron pipe connected by flexible couplings or flanged coupling adapters by harnessing across the coupling or adapter using tie rods or extended bolts connecting between flanges.
   b. Steel Pipe Joints: Provide butt-welded joints, lap welded joints, flanged joints, or mechanical coupling connections as shown and specified in Exposed Piping Schedule. Provide tie rods connected to lugs welded to the steel pipe for restraint at mechanical couplings.

c. Thermoplastic Joints: Where bell and spigot-type or other non-restrained joints are utilized, provide tie rods across the joint or other suitable joint restraint system, subject to approval of ENGINEER.

3.3 WORK AFFECTING EXISTING PIPING

A. Location of Existing Piping:
1. Locations of existing piping shown on Drawings is approximate.
2. Determine the true location of existing piping to which connections are to be made, crossed, and that could be disturbed, and determine location of other facilities that could be affected by the Work.

B. Taking Existing Pipelines Out of Service:
1. Conform to Section 01 14 16, Coordination with Owner's Operations.

C. Work on Existing Pipelines:
1. Cut or tap pipes as shown or required with machines and tools specifically designed for cutting or tapping pipelines.
2. Install temporary plugs to prevent entry of mud, dirt, water, and debris into pipe.
3. Provide necessary adapters, sleeves, fittings, pipe, and appurtenances required to complete the Work.
4. Conform to applicable requirements of Section 01 14 16, Coordination with Owner's Operations and Section 01 73 24, Connections to Existing Facilities.

3.4 PAINTING

A. Field painting shall conform to Section 09 91 00, Painting.

3.5 FIELD QUALITY CONTROL

A. Testing, General:
1. Test all piping, except as exempted in the Exposed Piping Schedule.
2. Notification:
   a. Notify ENGINEER at least 48 hours prior to testing.
   b. When authorities having jurisdiction are to witness tests, notify ENGINEER and authorities having jurisdiction in writing at least 48 hours in advance of testing.
3. Conduct all tests in presence of ENGINEER.
4. Remove or protect pipeline-mounted devices that could be damaged by testing.
5. Provide all apparatus and services required for testing, including:
   a. Test pumps, compressors, hoses, calibrated gages, meters, test containers, valves, fittings, and temporary pumping systems required to maintain OWNER's operations.
   b. Temporary bulkheads, bracing, blocking, and thrust restraints.

6. Unless otherwise specified, OWNER will provide fluid required for hydrostatic testing. CONTRACTOR shall provide means to convey fluid for hydrostatic testing into the pipe being tested. CONTRACTOR shall provide fluid for other types of testing required.
7. Repair observed leaks and repair pipe that fails to meet acceptance criteria. Retest after repair.
8. Unless otherwise specified, testing shall include existing piping systems that connect with new piping system. Test existing pipe to nearest valve. Piping not installed by CONTRACTOR and that fails the test shall be repaired upon authorization of ENGINEER or OWNER. Repair of existing piping will be paid as extra work unless otherwise specified.
9. Piping systems that contain both sections of exposed piping and buried piping shall have coordinated testing performed for a single piping system.

B. Test Schedule:
1. Refer to the Exposed Piping Schedule for type of test required and required test pressure.
2. Unless otherwise specified, the required test pressures are at lowest elevation of pipeline segment being tested.
3. For piping not listed in Exposed Piping Schedule:
   a. Hydrostatically test pipe that will convey liquid at a pressure greater than 5 psig.
4. Test Pressure:
   a. Use test pressures listed in Exposed Piping Schedule.
   b. If test pressure is not listed in Exposed Piping Schedule, or if a test is required for piping not listed in the Exposed Piping Schedule, test pressure will be determined by the ENGINEER based on the maximum anticipated sustained operating pressure and the methods described in the applicable ANSI/AWWA manual or standard that applies to the piping system.

C. Hydrostatic Testing:
1. Preparation for Testing:
   a. For thermoplastic pipe, follow procedures described in Section 7 of ANSI/AWWA Standard C605.
   b. For steel pipe, follow procedures described in AWWA Manual M11. Wetting period is not required for pipe that is not cement-lined.
   c. For other piping follow procedures described in AWWA Manual M9. A wetting period is not required for pipe that is not cement mortar-lined.
   d. Prior to testing, ensure that adequate thrust protection is in place and all joints are properly installed.
2. Test Procedure:
   a. Fill pipeline slowly to minimize air entrapment and surge pressures. Fill rate shall not exceed one foot of pipe length per second in the pipe being tested.

b. Expel air from pipe as required. Obtain approval of ENGINEER prior to tapping pipe for expelling air.
c. Examine joints and valves, and make repairs to eliminate visible leakage.
d. After specified wetting period, add fluid as required to pressurize line to required test pressure. Maintain test pressure for a stabilization period of ten minutes before beginning test.
e. Timed test period shall not begin until after the pipe has been filled, exposed to the required wetting period, air has been expelled, and pressure stabilized.
f. Timed Test Period: After the stabilization period, maintain test pressure for at least two hours. During timed testing period, add fluid as required to maintain pressure within five psig of required test pressure. For HDPE pipe, after three-hour expansion phase, reduce test pressure by ten psig and do not add liquid. The test pressure shall then remain steady for one hour, indicating no leakage.
g. Pump from a test container to maintain test pressure. Measure volume of fluid pumped from test container and record on test report. Record pressure at test pump at fifteen-minute intervals for duration of test.

3. Allowable Leakage Rates: Leakage is defined as the quantity of fluid supplied to pipe segment being tested to maintain pressure within five psi of the test pressure during timed test period. Allowable leakage rates for piping are:
   a. No Leakage: Pipe with flanged, welded, fused, threaded, soldered, or brazed joints.
   b. Rates based on formula or table in AWWA Manual M41:
      1) Metal pipe joined with rubber gaskets as sealing members, including the following joint types:
         a) Push-on joints.
         b) Grooved and shouldered couplings.
   c. Rates based on formula or table in ANSI/AWWA C605:
      1) Plastic pipe joined with O-ring gasket sealing members.

3.6 CLEANING

A. Cleaning, General: Clean pipe systems as follows:
   1. Thoroughly clean all piping, including flushing with water, dry air, or inert gas as required, in a manner approved by ENGINEER, prior to placing in service.

3.7 EXPOSED PIPING SCHEDULE

A. The schedules listed below, following the “End of Section” designation, are a part of this Specification section.
   1. Table 40 05 05-A, Exposed Piping Schedule.

+ + END OF SECTION + +

TABLE
40 05 05-A, EXPOSED PIPING SCHEDULE

Service	Diameter (inch)	Material	Interior Lining	Exterior Coating	Pressure Class/ Thickness	Joint	Test	Remarks
FOG	3”, 4”	Type 316L SS	-	-	Sch 40s	BW	HYD (150)	Flanges at valves and equipment. Provide GSEC as shown. Insulated and heat traced as shown on sheet I-03, Note 1
D	1”- 4”	CPVC	-	-	Sch 40	SW	HYD (15)	Flanges at valves and equipment, testing of exposed and buried drain lines shall be coordinated
VENT	6”	CPVC	-	-	Sch 40	SW	None	Flanges at valves and equipment
W3	¾” to 1”	Copper	-	-	Type K	Sd	HYD (90)	Flanges at valves and equipment. Insulated and Heat Traced as shown on sheet I-03, Note 2.

The following abbreviations are used in the Exposed Piping Schedule.

A. Service Abbreviations

Service	Abbrev.		Service	Abbrev.
Fat, Oils and Grease	FOG		Vent	VENT
Drain	D		Plant Effluent	W3

B. Material Abbreviations

Material	Abbrev		Material	Abbrev.
Class 316L Stainless Steel	316L SS		Ductile Iron	DI
Chlorinated Polyvinyl Chloride	CPVC		Polyvinyl Chloride	PVC

C. Lining/Coating Abbreviations

Lining	Abbrev		Coating	Abbrev.
Cement Mortar Lined	CL		Painted	P
			Insulated	I

D. Joint Abbreviations

Joint Type	Abbrev		Joint Type	Abbrev.
Braized	Bz		Grooved or Shouldered End Coupling	GSEC
Butt Weld	BW		Soldered	Sd
Butt Fusion Weld	BFW		Solvent Weld	SW
Flanged	Flg		Threaded	Thd

E. Test Abbreviations

Test	Abbrev
Hydrostatic Test (test pressure in psig)	HYD ( )

SECTION 40 05 06

COUPLINGS, ADAPTERS, AND SPECIALS FOR PROCESS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install all couplings, adapters, and specials for process piping.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before couplings, adapters, and specials for process piping Work.
   2. Notify other contractors in advance of the installation of couplings, adapters, and specials for process piping to provide them with sufficient time for installing items included in their contracts that must be installed with or before couplings, adapters, and specials for process piping Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 33 05 05, Buried Piping Installation
   3. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.39, Malleable Iron Threaded Pipe Unions.
   3. ASME B31, Standards of Pressure Piping.
   4. ASTM A53/A53M, Specification for Pipe, Steel, Black and Hot-dipped, Zinc-Coated, Welded and Seamless.
   5. ASTM A105/A105M, Specification for Carbon Steel Forgings and Piping Applications.
   6. ASTM B169/B169M Specification for Aluminum Bronze Sheet, Strip, and Rolled Bar.
   7. ASTM B650, Specification for Electro-Deposited Engineering Chromium Coatings of Ferrous Substrates.
   8. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs

9. AWWA C606, Grooved and Shouldered Joints.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have at least five years' experience producing substantial similar products to those specified and shall be able to provide documentation of at least five installations in satisfactory operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain each type of coupling, adapter, and special for process piping product included in this Section, regardless of component manufacturer, from a single couplings, adapters, and specials manufacturer.
   2. Supplier shall prepare, or review, and approve all submittals for components furnished under this Section.
   3. Components shall be suitable for specified service conditions and be integrated into overall assembly by the Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Product Data:
      a. Submit product data on each type of coupling, expansion joint, and other piping specialties and accessories, including gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. When requested by ENGINEER submit certificate attesting to compliance with standards referenced in this Section, signed by manufacturer.
   2. Manufacturer's Instructions:
      a. Provide instructions for handling, storing, installing, and adjusting of products.
   3. Source Quality Control:
      a. When requested by ENGINEER, submit results of source quality control tests.
   4. Qualifications Statements:
      a. Submit qualifications of manufacturer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 COUPLINGS

A. Flanged Coupling Adapters:
   1. Description: One end of adapter shall be flanged and opposite end shall have sleeve-type flexible coupling.
   2. Products and Manufacturers: Provide one of the following:
      a. Style 227, as manufactured by Dresser Piping Specialties, part of Dresser, Inc.
      b. Style 912, by Smith Blair, Inc.
      c. Or approved equal.
   3. Pressure and Service: Same as connected piping.
   4. Material: Ductile iron.
   5. Gasket: Recommended by the manufacturer.
   6. Bolts and Nuts: Alloy steel, corrosion-resistant, primer-coated.
   7. Harnessing:
      a. Harness adapters to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 40 05 05, Exposed Piping Installation.
      b. For flanged adapters 12-inch diameter and smaller, provide 1/2-inch diameter (minimum) Type 316 stainless steel anchor studs installed in pressure-tight anchor boss. For submerged applications, provide external bolting and other hardware of Type 316 stainless steel, including tie bolts, bolt plates, lugs, nuts, and washers. Provide number of studs required to restrain test pressure and service conditions. Harness shall be as designed and recommended by flanged adapter manufacturer. Provide the following minimum anchor studs unless otherwise approved by ENGINEER.
         1) Six-inch Diameter and Smaller: Two
         2) Eight-inch Diameter and Smaller: Four
   8. Harnessing:
      a. Harness couplings to restrain pressure piping. For pressure pipelines, test pressures are included in piping schedules in Section 40 05 05, Exposed Piping Installation.
      b. Harnessing shall conform to details shown.

B. Split-type Grooved or Shouldered End Couplings:
   1. Pressure and Service: Same as connected piping. Use shouldered end where required by pressure rating.

2. Products and Manufacturers:
   b. For coupling of stainless-steel pipe, provide products of one of the following:
      1) Style 489 Type 316 SS rigid coupling, as manufactured by Victaulic Company.
      2) Or approved equal.
3. Couplings shall conform to applicable requirements of AWWA C606, ASTM A351, A743 and A744.
4. Housing Material:
   a. For coupling of stainless steel pipe: Type 304 stainless steel, or equal.
5. Gaskets: NBR, rated for -20 to 180 degrees F.
6. Bolts and Nuts: Heat-treated carbon steel track bolts, plated.

C. Mechanical Joint Restraint:
   1. Products and Manufacturers: Provide one of the following:
      a. Romac Industries
      b. EBAA Iron Inc
   2. MJ Restraint shall conform to ANSI/AWWA C111/A21.11 or ANSI/AWWA C153/A21.53.
   3. Gland: shall be grade 65-45-12 ductile iron in accordance with ASTM A536
   4. Gripping Wedges: Shall be ductile iron ASTM A536-84 and heat traced within range of 370 to 470 BHN.
   5. Working pressure: Shall be a minimum of 250 psi.

2.2 RUBBER-TYPE EXPANSION JOINTS

A. General:
   1. Use rubber-type expansion joints at all expansion joint locations, except where other types of expansion joints are shown or specified.
B. Manufacturers:
   1. Provide products of one of the following:
      a. Mercer Rubber Company
      b. U.S. Rubber Supply Company, USA
      c. Red Valve/Tideflex
      d. Flexicraft
      d. Or approved equal.
C. Liquid Service:
   1. Construct expansion joints of neoprene or Buna-N suitable for temperatures up to 180 degrees F.
   2. Expansion joints shall be filled arch type. Provide Type 304 stainless steel backup or retaining rings as recommended by expansion joint manufacturer.
   3. Expansion joints shall be yoked in manner to provide transmission of tension loading to which expansion joint may be subjected during system operation. Compressive or lateral movement of expansion joint shall not be impaired by

yoking system. Details of expansion joint yoking shall be submitted for approval.

4. Allowable Axial Movement: 2 inches.

D. Harnessing:

1. Harness each expansion joint against thrust for test pressure in piping, as specified in piping schedules in Section 40 05 05, Exposed Piping Installation.
2. Harnessing shall be by control units consisting of two or more tie rods connected between flanges, set for maximum allowable elongation of expansion joint.
3. Provide epoxy-coated triangular plates to connect tie rods to flanges. Tie rods shall be Series 300 stainless steel. Rubber washers shall be used between triangular plates and tie rods.
4. Provide control units in accordance with recommendations of expansion joint manufacturer.

2.3 MISCELLANEOUS SPECIALTIES AND ACCESSORIES

A. Dielectric Connections:

1. General: Where pipes of dissimilar metals connect, provide either dielectric union or an insulating flange kits.
2. Insulating Flange Kits shall consist of the following:
   a. Gasket: phenolic
   b. isolation sleeve: laminated phenolic resin
   c. isolation washer sleeve: laminated phenolic resin
3. Manufacturers: Provide products of one of the following:
   a. PSI
   b. Maloney
   c. Or approved equal.
4. Dielectric Unions: Rated for 250 psi, ANSI B16.39.
5. Insulating Sections: Rated for same pressure as associated piping test pressure. Material shall be suitable for the application and service.

B. Dry Disconnect Coupling

1. Provide 4-in coupling in 316 Stainless Steel with BUNA-N seal, NPT threaded connection with a dust cap.
2. Liquid service with maximum operating pressure < 58 psig and maximum operating temperature < 140ºF.
3. Manufacturers:
   a. Camlok.
   b. Or equal.

C. Flame Arrester

1. Provide a 6-in 316L stainless steel flame arrester designed for horizontal installation. Include drain tap.
2. Design Requirements:
   a. Operational Temperature Range - less than or equal to 140°F(60°C)
   b. Maximum allowable pressure drop for 25 CFM flow: < 1 inWC
3. Manufacturers:

a. Groth.
b. Or equal.

D. Activated Carbon Canister
1. Provide 24-in x 34-in high epoxy lined carbon steel drum with PVC internal piping.
2. Provide first load of activated carbon.
3. Design Requirements:
a. Minimum design flow of 100 CFM
b. Maximum allowable pressure drop at 25CFM: < 1 inWC
c. Inlet and outlet size of 2-in FPT
4. Manufacturers:
a. Carbtrol.
b. Or equal.

E. Water Hose and Hose Hanger
1. Provide high-pressure water hose (100psig)
a. Length: 150ft
b. Diameter (internal): 5/8 inches
2. Provide stanchion-mounted hose hanger according to mechanical details in the drawings to accommodate water hose.
a. Provide anchor bolts in Stainless Steel 316 according to Section 05 05 33, Anchor Systems.
b. Manufacturers:
1) Yard Butler
2) Or equal.

2.4 PAINTING

A. Shop Painting:
1. Clean and prime-coat ferrous metal surfaces of products in the manufacturer's shop in accordance with Section 09 91 00, Painting, unless otherwise specified in this Section
2. Coat machined, polished and non-ferrous surfaces bearing surfaces and similar unpainted surfaces with corrosion prevention compound that shall be maintained during storage and until products are placed into operation.

B. Field painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect materials for defects in material and workmanship. Verify compatibility of products with pipe, fittings, valves, and appurtenances.

3.2 INSTALLATION

A. Installation:
   1. Install piping specialties in accordance with the Contract Documents and manufacturer's instructions.
   2. For buried installations, refer to Section 33 05 05, Buried Piping Installation.
   3. For exposed installations, refer to Section 40 05 05, Exposed Piping Installation.

B. Adjust expansion joints as required to ensure that expansion joints will be fully extended when ambient temperature is at minimum operating temperature, and fully compressed at maximum operating temperature for the system in which expansion joints are installed.

+ + END OF SECTION + +

SECTION 40 05 07

PIPE HANGERS AND SUPPORTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to design, furnish, and install all hangers, supports and appurtenances necessary to complete the Work.

B. Coordination:
   1. Review installation procedures under other Sections and coordinate the installation of items that must be installed with the pipe hangers and supports Work.

C. Related Sections:
   1. Section 03 30 00, Cast-In-Place Concrete.
   2. Section 05 50 13, Miscellaneous Metal Fabrications.
   3. Section 09 91 00, Painting.4. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
      a. ASTM A 575, Specification for Steel Bars Carbon, Merchant Quality, M-Grades.
      b. ASTM E 84, Test Method for Surface Burning Characteristics of Building Materials.
   2. Federal Specification, (FS).
      a. FS A-A-1192, Hangers, Pipe.
   3. Manufacturers Standardization Society of the Valve and Fittings Industry, (MSS).
      a. MSS SP 58, Pipe Hangers and Supports-Materials, Design and Manufacture.
      b. MSS SP 69, Pipe Hangers and Supports - Selection and Application.
   4. Underwriters' Laboratories, Inc., (UL).
      a. UL 203, Pipe Hanger Equipment for Fire Protection Service.

1.3 QUALITY ASSURANCE

A. Each type of pipe hanger or support shall be the product of one manufacturer.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single pipe hangers and supports manufacturer.
   2. The pipe hangers and supports equipment manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the pipe hangers and supports equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings showing all hangers and supports for each piping system specified. Shop Drawings shall show location, installation, material, loads or forces, and deflection of all hangers and supports.
      b. Each pipe system shall be analyzed for all loads and forces on the hangers and supports. Provide calculations of reaction forces to the structure to which they are fastened. Provide confirmation that hanger systems comply with support requirements and codes.
      c. Submit and coordinate these with Shop Drawings required for all piping systems.
      d. Shop drawings, pipe stress analysis results, and design calculations shall be prepared, signed, and sealed by a Professional Engineer registered in the State of Texas.
   2. Product Data:
      a. Submit manufacturers' catalogs, literature, and engineering data on all hangers and supports. Load ratings, materials and installation shall be consistent with the recommendations of the MSS SP 58, MSS SP 69 and Federal Specification A-A-1192.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
   2. Store materials in covered storage off the ground and prevent condensation.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 GENERAL

A. Hangers and supports shall meet with the following requirements:
   1. Standard and fabricated hangers and supports shall be furnished complete with necessary inserts, bolts, nuts, rods, washers, and other accessories.
   2. Generally, run piping in groups where practicable and parallel to building wall. Provide minimum clearance of 1-inch between pipe and other work.
   3. Install hangers or supports at all locations where pipe changes direction.
   4. All hangers and supports shall be capable of adjustment after placement of piping.
   5. Different types of hangers or supports shall be kept to a minimum.
   6. All suspended or supported ductile iron pipe shall have a hanger or support adjacent to each hub.
   7. Support vertical piping at each floor and between floors by stays or braces to prevent rattling and vibration.
   8. Hanger rods shall be straight and vertical. Chain, wire, strap or perforated bar hangers shall not be used. Hangers shall not be suspended from piping.
   9. Maximum support spacing unless otherwise shown or approved for standard weight steel pipe shall be as follows:

Pipe Size (inches)	Maximum Pipe Span [1] (feet)		
	Steel	Plastic [2]	Cast/Ductile Iron [4]
3/8 to 3/4	5	Cont. [3]	-
1	6	5	-
1-1/4	6	5	-
1-1/2	6	5	-
2	10	5	-
2-1/2	10	5	-
3	10	5	-
4	12	5	12 feet for pressure pipe
6	12	5	
8	12	5	
10	12	5	

Pipe Size (inches)	Maximum Pipe Span [1] (feet)		
	Steel	Plastic [2]	Cast/Ductile Iron [4]
12	12	10	10 feet for soil pipe

[1]Pipe shall not have pockets formed in the span due to sagging of the pipe between supports caused by the weight of the pipe, medium in the pipe, insulation, valves and fittings.
[2]Span shown is for Schedule 80 CPVC pipe at 100°F. Spans for other plastics, other CPVC pipe Schedules and pipes at higher temperatures shall be shortened in accordance with the pipe manufacturer's recommendations.
[3]Continuous means pipe shall be in unistrut or similar channel.
[4] Pipe hanger and support selection shall be as shown and in this Section.

10. Maximum support spacing, unless otherwise shown for plastic pipe at ambient temperature, shall be one-half of the values specified for steel pipe.
11. Plastic pipe at temperature greater than 130ºF shall be continuously supported in a metal cradle or tray.
12. Where proper hanger or support spacing does not correspond with joist or rib spacing, structural steel channels may be attached to joists or ribs and pipes suspended there from.
14. Isolate thin walled stainless steel piping from carbon steel by use of plastic coated hangers or supports or by taping at points of contact with PVC or vinyl.
15. Supports and hangers shall be of a material that is compatible with the fluid being conveyed in such pipe being supported.
16. Anchors for pipe support systems shall be compatible or protected by a coating system which is compatible with the fluid being conveyed in such pipe being supported.

B. Expansion compensation shall be designed for individual exposed piping systems with the following Design Criteria:
   1. $\Delta L = L \times \Delta T \times \alpha$
      a. Where ΔL = pipe length change (inches).
      b. L = pipe length between anchors (inches).
      c. ΔT = 100 (F).
      d. α = coefficient of thermal expansion (inches/inches/F).
   2. Expansion compensation shall be designed as an integral part of the piping hanger, support and anchorage system.
   3. Expansion compensation shall be achieved via expansion joints specified in Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

C. Pipe Stress Analysis (where applicable) shall be utilized in order to provide flexibility in the pipe system in order to limit the loading exerted on both the pipe and the primary structure caused by sustained or thermal expansion stresses. CONTRACTOR shall be responsible for the pipe stress analysis (where applicable) for the FOG service piping.

2.2 HANGERS AND SUPPORTS

A. Hangers and supports where shown shall be in accordance with detail drawings. Hangers and supports not shown shall be in accordance with MSS SP 58.

B. Products and Manufacturers: Provide one of the following:

	Type	Description	Manufacturers
1.	Trapeze Hanger	Fig. 70	Anvil International, Inc.
2.	Pipe Stanchion	Fig. 265	Anvil International, Inc.
3.	Concrete Inserts	Fig. 49	Anvil International, Inc.
4.	Hanger Rods	Fig. 146	Anvil International, Inc.
5.	Eye Nut	Fig. 290	Anvil International, Inc.
6.	Expansion Anchor	Kwik Bolt TZ	Hilti
7.	Clevis Hangers	Fig. 260, Fig 590	Anvil International, Inc.
8.	Riser Clamp	Fig. 40	Anvil international, Inc.
9.	Offset Pipe Clamp	Fig. 103	Anvil International, Inc.

b. Or equal.

2.3 ACCESSORIES

A. Hanger rods shall be made from ASTM A 575, with square head nut on top and running thread on bottom end.

B. Concrete Inserts:
1. Concrete inserts shall be MSS SP 58 malleable Type 18.
2. Concrete inserts shall be of the continuous type capable of supporting the load required.
3. Manufacturers: Provide products of one of the following:
   a. Unistrut Corporation, Wayne, Michigan.
   b. Elcan Metal Products, Company, Franklin Park, Illinois.
   c. B-Line.
   d. Anvil International, Inc.
   e. Or equal.

C. Steel Beam Clamps:
1. Steel beam clamps shall be of malleable iron and conform to MSS SP 58 Type 21.

D. Inserts for Pipe Insulation:
1. Insulated pipe, larger than 1-1/2-inches in diameter, shall be supported by a rigid insert to protect the insulation. A steel metal saddle of sufficient gauge to carry the weight of the pipe and its fluid without deforming shall extend

2-inches minimum on each side of the rigid insert. The joints between insert and insulation shall be sealed before saddle is installed. Sizes up to 6-inches IPS shall be MSS SP 58, Type 40, and for sizes over 10-inches shall be MSS SP 58, Type 39.

E. Brackets:
   1. Brackets for wall mounting shall conform to MSS SP 58 Type 31 or Type 33.

F. Pipe Roll:
   1. To provide for pipe expansion, pipe shall be supported on adjustable malleable or steel pipe rolls, Type 41, Type 43, or Type 44.

G. Fabricated Pipe Rack:
   1. Pipes shall be supported and anchored to the fabricated pipe rack as shown. Clamps, rollers, and supports for piping shall conform to the general requirements of MSS SP 69.

2.4 PAINTING

A. Clean and prime ferrous metal surfaces in the shop in accordance with the requirements of Section 09 91 00, Painting.

B. Field painting shall conform to the requirements of Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Locate hangers, supports, and accessories to support piping, valves, and at all concentrated loads.

B. Locate hangers, supports, and accessories within maximum span lengths specified to support continuous pipeline runs unaffected by concentrated loadings.

C. Locate hanger, supports to prevent vibration or swaying and to provide for expansion and contraction.
   1. Temperature differential specified in this Section.
   2. Support piping independently so that equipment is not stressed by piping weight or expansion.
   3. For Uninsulated Copper Pipe or Tubing: Clamps and supports, electroplated copper finish. Instrumentation tubing shall be supported in steel or aluminum troughs with covers. All tubing layout and connections shall be as approved by the manufacturer of the equipment.
   4. Uncoated Hangers, Rods and Supports: Dip in zinc chromate primer before installation.

5. Maximum spacing for horizontal piping:
   a. Steel 1-Inch and Smaller: Seven feet.
   b. Steel 1-1/2-Inch and Larger: Ten feet.
   c. Brass or Copper 3-Inch and Smaller: Seven feet.
   d. Additional supports at:
      1) Change in direction.
      2) Branch piping and runouts over five feet.
      3) Concentrated loads due to valves, strainers or other similar items.
   e. Maximum support spacing for plastic pipe at ambient temperature shall be one-half the above values.
6. Hanger types for horizontal piping, except as noted and shown:
   a. Forged steel adjustable clevis type, rod support for all services.
   b. Slide Bases:
      1) Pipe stand, brackets, trapeze or other equivalent structural support.
      2) For piping 2-inches or larger.
   c. For pipe and covering provide:
      1) Saddles for rollers or slide bases.
      2) Protective shields or saddles for all other types of supports.
   d. Threaded Steel Rods:
      1) Two inch vertical adjustment with two nuts each end for positioning and locking.
      2) Size hanger rods according to the schedule below, unless otherwise noted:

Nominal Pipe (Inches)	Rod Diameter (Inches)
2 and less	3/8
2-1/2 to 3-1/2	1/2
4	5/8
6	3/4
8 through 12	7/8
14 through 18	1
20 through 30	1-1/4

      3) For Double Rod Hangers: One size smaller than above.
      4) Connection to Structure for Piping to 2-Inches: Concrete inserts, or expansion shields in shear into sides of beams.
      5) Connection to Structure for Piping 2-1/2-Inch or Larger: Concrete inserts, beam clamps or suitable bridging.
7. Vertical Piping:
   a. Base Support: Base elbow or welded equivalent.
      1) Bearing plate on structural support.
   b. Guides not to exceed:
      1) 25 feet for piping to 2-inches.
      2) 36 feet for piping 2-1/2-inches or larger.
   c. Top Support:
      1) Special hanger or saddle in horizontal connection.

2) Provisions for expansion.

d. Intermediate Supports: Steel pipe clamp at floor.
   1) Bolted and welded to pipe.
   2) Extension ends bearing on structural steel or bearing plates.

e. For Multiple Pipes: Coordinate guides, bearing plates and accessory steel.

8. Insulated Piping:
   a. Horizontal Pipe Shields at Supports:
      1) Minimum 120 degree arc.
      2) Length equal to diameter of insulation 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.
   b. Vertical Pipe Shields at Guides:
      1) Full 360 degree arc, securely banded.
      2) Length equal to diameter of insulation, 12-inch minimum.
      3) To 6-Inch Pipe Size: No. 18 USSG galvanized steel.

D. Install items to be embedded before concrete placement.

E. Fasten embedded items securely to prevent movement during concrete placement.

F. Install hangers and support units on piping systems in accordance with manufacturer's recommendations.

G. Adjust hangers and supports and place grout for concrete supports to bring pipelines to specified elevations.

H. Bring all pipe systems up to operating pressures and temperatures. Cycle systems to duplicate operating conditions. Correct all support malfunctions.

++ END OF SECTION ++

SECTION 40 05 08

WALL PIPES, FLOOR PIPES, AND PIPE SLEEVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces, and escutcheons to complete the Work.
   2. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified and required to furnish and install all floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons to complete the general construction Work.

B. Coordination:

   1. Review installation procedures under this and other Sections and coordinate with the installation of floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons that must be installed with or within formwork, walls, partitions, ceilings, and panels.
   2. Review installation procedures under other contracts and coordinate with other contractors the installation of floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons that must be installed with or within formwork, walls, partitions, ceilings, and panels constructed by such other contractors.
      a. Provide other contractors with detailed plans or sketches of the locations of the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons as may be required.
      b. Keep informed of the construction where floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons are to be installed. Install the floor pipes, pipe sleeves, wall pipes, other wall pieces and escutcheons in such a manner and within such time periods as will not delay the work of the other contractors.

C. Related Sections:

   1. Section 03 05 00, Concrete.
   2. Section 07 92 00, Joint Sealants.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American National Standards Institute, (ANSI).
      a. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
      b. ANSI B16.4, Gray-Iron Threaded Fittings.
   2. American Water Works Association, (AWWA).
      a. AWWA C104 (ANSI A21.4), Cement-Mortar Lining for Ductile-Iron Pipe and Fittings for Water.
      b. AWWA C110 (ANSI A21.10), Ductile-Iron and Gray-Iron Fittings, for Water.
      c. AWWA C111 (ANSI A21.11), Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings.
      d. AWWA C115 (ANSI A21.15), Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges.
      e. AWWA C151 (ANSI A21.51), Ductile-Iron Pipe, Centrifugally Cast, for Water.
      f. AWWA C200, Steel Water Pipe 6-Inches and Larger.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single wall pipes, floor pipes and pipe sleeves manufacturer.
   2. The wall pipes, floor pipes and pipe sleeves manufacturer to review and approve or to prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the wall pipes, floor pipes and pipe sleeves manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Detailed drawings and data on all wall and floor pipe, and pipe sleeves. Submit and coordinate these with Shop Drawings required for all piping systems.

1.5 DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Wall and Floor Pipes:
   1. Material: Same as specified for the piping connected to wall or floor pipe, unless otherwise approved by ENGINEER.
   2. End Connections: As shown.
   3. Thickness: Same as specified for the piping connected to wall or floor pipe.
   4. Collars: Provide collars at mid-point of wall for anchorage and watertightness.
   5. Pipes ends shall be flush with wall face, unless otherwise shown.
   6. Drill and tap flanged ends and mechanical joint bells for studs. Provide studs of same material as connected piping, except submerged and buried studs shall be of Type 316 stainless steel.

B. Pipe Sleeves:
   1. Ferrous and Plastic Pipe: Use standard weight galvanized steel pipe, unless otherwise shown.
   2. Copper Pipe: Use Type K hard drawn copper pipe, unless otherwise shown.

C. Cast Wall Sleeves:
   1. Material: Ductile iron furnished with integral wall collar.
   2. Dimensions: As required for mechanical joint pipe to pass through sleeve. Length as required.

D. Link Seals: Provide link type mechanical seals suitable for 20 psi working pressure, corrosive service, exposure to hydrocarbons, and accessible from one side, with glass-reinforced nylon pressure plate and stainless steel bolts and nuts.
   1. Products and Manufacturers: Provide one of the following:
      a. Link-Seal, as manufactured by Thunderline Corporation.
      b. Pen Seal, as manufactured by Proco Products, Inc.
      c. Or equal.

E. Wall and Ceiling Plates:
   1. Bare pipes passing through walls and ceilings in finished rooms: Provide escutcheon plates of cast brass or cast-iron nickel plated, clevis or split ring and hinged with set screws.
   2. Provide plated escutcheon plates of 18-gauge steel for insulated pipes passing through walls and ceilings in finished rooms.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall and Floor Pipes: Install as shown and in accordance with approved Shop Drawings.

B. Pipe Sleeves:
   1. Use sleeves wherever pipes pass through walls, partitions, floors, and roofs, unless otherwise shown.
   2. Extend all sleeves through floor slabs a minimum of 2-inches above finished floor.
   3. Anchor sleeves to concrete and masonry walls as shown or otherwise approved.
   4. All sleeves through walls shall be flush with wall face.
   5. All pipe joints and annular spaces in exterior walls or walls subjected to hydrostatic pressure shall be completely watertight.
   6. Use link type seals to seal sleeve against hydrostatic pressure. Size sleeves to provide annular space required to suit the link type mechanical seals that are used.
   7. Do not install sleeves and pipes through structural members, unless specifically shown and approved by ENGINEER.
   8. Size sleeves to provide annular space as follows:

Pipe Size	Sleeve ID Minus Pipe Or Insulation OD
Less than 2-inches	1/2-inches to 3/4-inches
2-inches to 4-inches	3/4 inches to 1-1/4-inches.
6-inches to 12-inches	1-1/4 inches to 2-inches
Over 12-inches	2-inches to 3-inches

C. Install wall and ceiling plates in accordance with the manufacturer's recommendations and approved Shop Drawings.

++ END OF SECTION ++

SECTION 40 05 17

COPPER PROCESS PIPE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This specification provides requirements to furnish and install Pall copper pipe and fittings.
   2. Extent of piping is shown and indicated in the piping schedules in Section 40 05 05, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before copper pipe Work.

C. Related Sections:
   1. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/ASME B16.15, Cast Copper Alloy Threaded Fittings: Classes 125 and 150.
   2. ANSI/ASME B16.18, Cast Copper Alloy Solder Joint Pressure Fittings.
   3. ANSI/ASME B16.22, Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
   4. ANSI/ASME B16.23, Cast Copper Alloy Solder Joint Drainage Fittings: DWV.
   5. ANSI/ASME B16.24, Cast Copper Alloy Pipe Flanges and Flanged Fittings: Classes 150, 300, 600, 900, 1500 and 2500.
   6. ANSI/ASME B16.26, Cast Copper Alloy Fittings for Flared Copper Tubes.
   7. ANSI/ASME B16.29, Wrought Copper and Wrought Copper Alloy Solder Joint Drainage Fittings: DWV
   8. ANSI/ASME B16.39, Malleable Iron Threaded Pipe Unions: Classes 150, 250, and 300.
   9. ANSI/ASME B16.42, Ductile Iron Pipe Flanges and Flanged Fittings: Classes 150 and 300.
   10. ANSI/ASME B16.50, Wrought Copper and Copper Alloy Braze-Joint Pressure Fittings.
   11. ANSI/ASME B18.2.1, Square and Hex Bolts and Screws, Inch Series.
   12. ANSI/ASME B18.2.2, Square and Hex Nuts.
   13. ASTM A194, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure or High Temperature Service, or Both.
   14. ASTM A307, Standard Specification for Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength.

15. ASTM B32, Specification for Solder Metal.
16. ASTM B68, Specification for Seamless Copper Tube, Bright Annealed.
17. ASTM B88, Specification for Seamless Copper Water Tube.
18. ASTM B251, Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube.
19. ASTM B302, Specification for Threadless Copper Pipe, Standard Sizes.
20. ASTM B306, Specification for Copper Drainage Tube (DWV).
21. ASTM D1330, Specification for Rubber Sheet Gaskets.
22. FS WW-U-516, Unions – Brass or Bronze.

1.3 QUALITY ASSURANCE

A. Component Supply and Compatibility:
   1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single copper pipe manufacturer.
   2. Copper pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.

B. Regulatory Requirements:
   1. Pipe and fittings materials and joint types shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under 40 05 05, Exposed Piping Installation:
   1. Shop Drawings:
      a. Detailed layout drawings for pipe, fittings, and appurtenances.
   2. Product Data:
      a. Detailed data on pipe, fittings, and appurtenances.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit certificate signed by manufacturer of each material that material conforms to applicable referenced standards and the Technical Contract Documents.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 40 05 05, Exposed Piping Installation.

B. Maintain ASTM B68 pipe, fittings, and appurtenances free of scale and dirt during transportation, delivery, storage, and handling.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Plant Effluent (W3) Pipe:
   1. Pipe Materials: Comply with ASTM B88.
   2. For exterior, exposed pipe, provide Type K, soft-annealed tube.
   3. Fittings shall be soldered except at valves, which may be flared or flanged joints.

2.2 JOINTS

A. Refer to piping schedules at the end of Section 40 05 05, Exposed Piping Installation for the service and joint type specified for each piping system.

B. Provide type of fittings corresponding to the specified joint type in accordance with Table 40 05 17-A.

TABLE 40 05 17-A
COPPER PIPE JOINT TYPE AND FITTING SCHEDULE

Joint Type	Fitting Type, Applicable Reference Standards
Soldered	ANSI/ASME B16.22, ANSI/ASME B16.29 (DWV)
Flared	ANSI/ASME B16.26
Flanged	ANSI/ASME B16.24

C. When fully developed, the strength of the joint shall be greater than strength of adjoining pipe.

D. Flanged Joints for Water Service: Comply with the following:
   1. Flanges: ANSI/ASME B16.24, Class 150.
   2. Gaskets: Red rubber, ASTM D1330, Grade 1, 1/8-inch thick.
   3. Bolts: ASTM A307, Grade B. Conform to ANSI/ASME B18.2.1.
   4. Nuts: ASTM A194, Grade 2H, Heavy hex. Comply with ANSI/ASME B18.2.2.

E. Unions for Water Service: Shall be bronze, 250-pound class, conforming to FS WW-U-516.

2.3 MARKING

A. Mark or label all materials with the following:
   1. Metal or alloy designation.
   2. Temper.
   3. Size and schedule.
   4. ASTM reference standard number.
   5. Name and location of manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Section 40 05 05, Exposed Piping Installation, for exposed piping installation, disinfection, testing and cleaning.

+ + END OF SECTION + +

SECTION 40 05 19

DUCTILE IRON PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish ductile iron pipe and fittings.
   2. Extent of piping is shown on the Drawings. Piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, specify pipe service, diameter, material, lining, coating, pressure rating, joint type, and testing required.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before ductile iron pipe Work.

C. Related Sections:
   1. Section 09 91 00, Painting.
   2. Section 33 05 05, Buried Piping Installation.
   3. Section 40 05 05, Exposed Piping Installation.
   4. Section 40 05 06, Couplers, Adapters, and Specials for Process Piping.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI B18.2.1, Square and Hex Bolts and Screws Inch Series.
   2. ANSI B18.2.2, Square and Hex Nuts. (Inch Series).
   3. ASTM A193, Alloy Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   4. ASTM A194, Specification for Carbon Steel and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
   5. ASTM A307, Specification for Carbon Steel Bolts and Studs, 60,000 psi Tensile Strength.
   6. ASTM A354, Specification for Quenched and Tempered Alloy Steel Bolts, Studs and Other Externally Threaded Fasteners.
   7. ASTM A563, Specification for Carbon and Alloy Steel Nuts.
   8. ASTM B117, Practice for Operating Salt Spray (Fog) Apparatus.
   9. ASTM C283, Test Methods for Resistance of Porcelain Enameled Utensils to Boiling Acid.
   10. ASTM D714, Test Method for Evaluating Degree of Blistering of Paints.
   11. ASTM D792, Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.

12. ASTM D5162, Discontinuity (Holiday) Testing of Non-Conductive Protective Coating on Metallic Substrates.
13. ASTM E96, Test Methods for Water Vapor Transmission of Materials.
14. ASTM G14, Test Method for Impact Resistance of Pipeline Coatings (Falling Weight Test).
15. ASTM G62, Test Methods for Holiday Detection in Pipeline Coatings.
16. ASTM G95, Test Methods for Cathodic Disbondment Test of Pipeline Coatings (Attached Cell Method).
17. ANSI/AWWA C104, Cement-Mortar Lining for Ductile Iron Pipe and Fittings for Water.
18. ANSI/AWWA C110, Ductile Iron and Gray Iron Fittings for Water.
19. ANSI/AWWA C111, Rubber-Gasket Joints for Ductile Iron Pressure Pipe and Fittings.
20. ANSI/AWWA C115, Flanged Ductile Iron Pipe with Ductile Iron or Gray Iron Threaded Flanges.
21. ANSI/AWWA C116, Protective Fusion-Bonded Epoxy Coatings for the Interior and Exterior Surfaces of Ductile Iron and Gray Iron Fittings for Water Service.
22. ANSI/AWWA C151, Ductile Iron Pipe, Centrifugally Cast, for Water.
23. ANSI/AWWA C153, Ductile Iron Compact Fittings, 3 inch through 24 inch and 54 inch through 64 inch for Water Service.
24. ANSI/AWWA C606, Grooved and Shouldered Type Joints.
25. European Standard (EN), EN 598: Ductile Iron Pipe, Fittings, Accessories and Their Joints for Sewerage Applications.
26. MSS-SP 60, Connecting Flange Joint Between Tapping Sleeves and Tapping Valves.
27. NACE RP0188, Discontinuity (Holiday) Testing of New Protective Coatings on Conductive Substrates.
28. NAPF 500-03, Surface Preparation Standard for Ductile Iron Pipe and Fittings Receiving Special External Coatings and/or Special Internal Linings.
29. NSF/ANSI 61, Drinking Water System Components - Health Effects.
30. SSPC PA 2, Measurement of Dry Coating Thickness with Magnetic Gages.
31. SSPC Painting Manual, Volume 1, Para. XIV.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer:
      a. Manufacturer shall have a minimum of five years successful experience producing ductile iron pipe and fittings and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.
      b. Lining and coating products shall be manufactured by a firm with a minimum of five years successful experience in protecting pipelines exposed to the specified service conditions , and shall be able to show evidence of at least five installations in satisfactory operation in the United States that are similar applications to the specified service.

c. When not applied by the manufacturer, lining and coating Subcontractor shall have a minimum of five years successful experience in the application of the specified linings and coatings for similar applications for the specified service, and shall be able to show evidence of at least five installations in satisfactory operation in the United States.

B. Supply and Compatibility:
1. Unless otherwise approved, obtain all pipe, fittings, and appurtenances included in this Section from a single ductile iron pipe manufacturer.
2. Ductile iron pipe manufacturer shall review and approve or prepare all Shop Drawings and other submittals for pipe, fittings, and appurtenances furnished under this Section.
3. Pipe, fittings, and appurtenances shall be suitable for the specified service and shall be integrated into overall piping system by ductile iron pipe manufacturer.
4. Ductile iron pipe manufacturer shall be responsible for all products and all factory-applied linings and coatings, whether installed at pipe manufacturer's facility or at manufacturer's Supplier's facility.

C. Regulatory Requirements:
1. Pipe and fittings, including linings and coatings, that will convey potable water or water that will be treated to become potable, shall be certified by an accredited organization in accordance with NSF/ANSI 61 as being suitable for contact with potable water, and shall comply with requirements of authorities having jurisdiction at Site.

1.4 SUBMITTALS

A. Action Submittals: Submit the following with Shop Drawings required under Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation:
1. Shop Drawings:
a. Detailed drawings and data for pipe, fittings, gaskets, appurtenances, linings, and coatings.

B. Informational Submittals: Submit the following:
1. Certificates:
a. Submit certificate signed by manufacturer of each product that product conforms to applicable referenced standards and the Contract Documents.
2. Source Quality Control Submittals:
a. Submit results of specified shop tests for pipe, fittings, linings, and coatings.
b. Lining and coating test coupons.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed

Piping Installation.

PART 2 – PRODUCTS

2.1 MATERIALS

A. General:
   1. Piping systems shall be suitable for their intended use.
   2. Joints shall be as specified in Section 33 05 05, Buried Piping Installation and Section 40 05 05, Exposed Piping Installation. If not specified, provide flanged joints for exposed piping and push-on or mechanical joints for buried piping. Provide couplings on pipe with plain or grooved ends where shown or where approved by ENGINEER.

B. Ductile Iron Pipe, Joints, and Fittings:
   1. Flanged Pipe: Fabricate in accordance with ANSI/AWWA C115.
      a. Pressure Rating: As specified in piping schedule in Section 40 05 05, Exposed Piping Installation. If not otherwise specified, use Special Thickness Class 53 for three-inch to 54-inch diameter pipe and Pressure Class 350 for 60-inch and 64-inch diameter pipe.
   2. Non-Flanged Pipe: Conform to ANSI/AWWA C151 for material, pressure, dimensions, tolerances, tests, markings, and other requirements.
   3. Pipe Joints:
      a. Flanged Joints: Conform to ANSI/AWWA C110 and ANSI/AWWA C111 capable of meeting the pressure rating or special thickness class, and test pressure specified in piping schedule in Section 40 05 05, Exposed Piping Installation.
         1) Gaskets: Unless otherwise specified, gaskets shall be at least 1/8-inch thick, ring or full-face as required for the pipe, of synthetic rubber compound containing not less than 50 percent by volume nitrile or neoprene, and shall be free from factice, reclaimed rubber, and other deleterious substances. Gaskets shall be suitable for the service conditions specified, specifically designed for use with ductile iron pipe and fittings.
         2) Bolts: Comply with ANSI B18.2.1.
            a) Exposed: ASTM A307, Grade B.
            b) Buried or Submerged: ASTM A193, Grade B8M, Class 2, Heavy hex, Type 316 stainless steel.
         3) Nuts: Comply with ANSI B18.2.2.
            a) Exposed: ASTM A563, Grade A, Heavy hex.
            b) Buried or Submerged: ASTM A194, Grade B8M, Heavy hex, Type 316 stainless steel.
      b. Mechanical Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure rating or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
         1) Glands: Ductile iron.

2) Gaskets: Plain tip.
3) Bolts and Nuts: High strength, low alloy steel.
4) Manufacturers: Provide products of one of the following:
   a) Clow Water Systems Company
   b) Atlantic States Cast Iron Pipe Company
   c) Canada Pipe Company, Ltd.
   d) McWane Cast Iron Pipe Company
   e) Pacific States Cast Iron Pipe Company
   f) Griffin Pipe Products Co.
   g) American Cast Iron Pipe Co.
   h) U.S. Pipe and Foundry Co.
   i) Or approved equal.

c. Push-On Joints: Comply with ANSI/AWWA C111 and ANSI/AWWA C151, capable of meeting pressure class or special thickness class, and test pressure specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   1) Gaskets: Vulcanized SBR, unless otherwise specified.
   2) Stripes: Each plain end shall be painted with a circular stripe to provide a guide for visual check that joint is properly assembled.
   3) Products and Manufacturers: Provide one of the following:
      a) Tyton or Fastite Joint by Clow Water Systems, Atlantic States Cast Iron Pipe Company, Canada Pipe Company, Ltd., McWane Cast Iron Pipe Company, Pacific States Cast Iron Pipe Company, and Griffin Pipe Products Company.
      b) Fastite Joint by American Cast Iron Pipe Company.
      c) Tyton Joint by U.S. Pipe and Foundry Company.
      d) Or approved equal.

d. Restrained Joints: Restrained push-on joints shall be capable of being deflected after full assembly. Field cuts of restrained pipe are not allowed without approval of ENGINEER.
   1) Products and Manufacturers: Provide restrained joints for mechanical joint piping by one of the following:
      a) Megalug, Series 1100, by EBBA Iron Sales, Inc.
      b) MJ Coupled Joint, by American Cast Iron Pipe Co.
      c) MJ Field Lok, by U.S. Pipe and Foundry Co.
      d) Or approved equal.
   2) Products and Manufacturers: Provide restrained joints for push-on joint piping by one of the following:
      a) Super-Lock Joint Pipe, by Clow Water Systems, a division of McWane, Inc.
      b) Lok-Ring Joint, or Flex-Ring Joint, by American Cast-Iron Pipe Company.
      c) TR Flex Joint, by U.S. Pipe and Foundry Company.
      d) Snap-Lok, by Griffin Pipe Products Company.
      e) Or approved equal.

4. Flanged and Push-On Joint Fittings: Comply with ANSI/AWWA C110 and ANSI/AWWA C111.

a. Material: Ductile iron.
b. Pressure rating, gaskets, bolts, and nuts shall be as specified for flanged joints. Pressure rating of fittings shall meet, but not exceed, specified pressure rating or special thickness class of the connected pipe.

C. Interior Glass Lining:
1. General:
a. Where specified in piping schedules included with Section 33 05 05, Buried Piping, provide interior glass lining for pipe and fittings.
b. Mechanical Joint and Push-on Joint Pipe and Fittings: Factory-cut lengths of pipes as required and provide complete end-to-end glass lining in pipes and fittings.
c. Longitudinal warping or change in roundness of pipe and fittings resulting from glass lining shall not exceed:
1) Buried Pipe and Fittings, with Wall Thickness Equal To or Less Than Class 52 Pipe: 0.025 inches per foot of length. For pipe thicker than Class 52, lining applicator shall submit recommended tolerances to ENGINEER for approval.
d. Submit glass lining test results of pipe and fittings tested for Project.
e. Failure of tests on glass lining in pipe and fittings will result in rejection of all glass-lined pipe and fittings.
2. Mechanical and Physical Properties:
a. Total Lining Thickness:
1) Pipe: 0.01 to 0.03 inch.
2) Fittings: 0.01 to 0.04 inch.
b. Hardness: Five to six on Mohs scale, minimum.
c. Density: 2.5 to 3.0 grams per cubic centimeter when measured in accordance with ASTM D792.
d. Flexibility: Glass lining shall withstand metal yield point of 0.001-inch per inch (yield point of base metal) without damage to glass lining.
e. Continuity of Glass Lining: When tested with a low voltage wet sponge holiday detection unit, with a test voltage of 67.5 volts, number of pinholes detected shall not exceed:

Fitting Diameter	Maximum Pinholes per Fitting
3-inch through 8-inch	3 to 5
Note: Allowable pinholes in pipe or fitting shall be located no closer than three inches to one another in any direction. Total surface area of the pinholes shall not exceed 0.01 percent an individual length of pipe or fitting. Visible pinholes that expose the base metal are not acceptable	

f. Thermal Shock: Glass lining shall withstand an instantaneous thermal shock at differential temperature of 350 degrees F without cracking, crazing, or spalling.
3. Corrosion Resistance:
a. Glass lining shall be resistant to corrosion when exposed to solutions at pH of 3 through 10, at 125 degrees F, for period of one hour.

b. Surface gloss shall be maintained when immersed in eight percent sulfuric acid solution at 148 degrees F for ten minutes.
c. Weight loss shall not exceed three mg/sq. in. when tested in boiling citric acid solution in accordance with ASTM C283.

4. Glass Lining Material and Application:
   a. Material: Vitreous and inorganic glass frit suspended in water.
   b. Application: Apply glass lining utilizing a method recommended by lining manufacturer that complies with requirements of this Section.
5. Initial Shop Testing of Glass Lined Test Specimens:
   a. Glass line two, 3-inch by three-inch test specimens and one, 8-inch diameter by 12-inch long test specimen, of material and wall thickness similar to that of pipes and fittings for Project.
   b. Surface preparation and glass lining procedure shall be similar for test specimens and Project pipe and fittings.
   c. Perform following tests:
      1) Thickness.
      2) Hardness.
      3) Density.
      4) Flexibility.
      5) Continuity.
      6) Thermal Shock Resistance.
      7) Surface gloss.
      8) Corrosion resistance.
      9) Weight loss.
6. Final Source Quality Control Testing of Glass Lined Pipes and Fittings:
   a. After application of glass lining, perform the following tests on Project pipe and fittings:
      1) Check thickness of glass lining in each pipe and fitting, at minimum of two locations at each end of each pipe and fitting, 180 degrees apart.
      2) Test hardness of glass lining in every tenth pipe and fitting. If total quantity is less than ten, test minimum of one each.
      3) Test continuity of glass lining in each pipe and fitting.
      4) Cut two test coupons, each approximately three-inch by three-inch in size, from two 6-inch or eight-inch diameter pipes and fittings, picked at random, and perform thermal shock resistance tests.
   b. Provide permanent sticker inside each pipe and fitting indicating tested thickness of glass lining and number of pinholes, signed by manufacturer's inspector.
7. Initial and Final Source Quality Control Procedures:
   a. Calibrate test instruments prior to starting tests.
   b. Thickness: Test with magnetic gauge, Mikra Test IV FM Automatic, zero to 40 mils scale, made by Electro Physik or approved equal.
   c. Hardness: Use Mohs test kit consisting of nine elements of varying hardness. Glass lining shall show no mark when No. 5 element, Apatite, is scraped over surface of glass lining.
   d. Density: Comply with ASTM D792.

e. Flexibility: Place sample piece of eight-inch or 12-inch diameter glass-lined pipe in an arbor press or similar device. Measure outside diameter of pipe prior to applying pressure. Apply pressure at two points, 180 degrees apart from each another on exterior surface of sample until pipe is deformed by 0.025 inches from initial measurement. When visually inspected, glass lining shall show no cracking, crazing, or spalling.

f. Continuity:
   1) Comply with ASTM D5162 Test Method A - Low Voltage Wet Sponge Testing.
   2) Test Unit: Tinker and Rasor Model M/1 Holiday Detector, or equal.
   3) Apply 67.5-volt potential across surface of glass. Move wetted sponge over glass lining. Pinholes or discontinuity in glass surface due to moisture from sponge shall close the circuit and produce an audible signal.

g. Thermal Shock Resistance: Heat test specimens to 400 degrees F and instantly drop into water at 50 degrees F. Maintain temperature differential of 350 degrees F between the specimen temperature and the water temperature during testing. Visual inspection of glass lining shall reveal no crazing, blistering, or spalling.

h. Surface Gloss: Immerse test specimen in an eight-percent sulfuric acid solution at 148 degrees F for ten minutes. Glass lining shall show no loss of surface gloss.

i. Corrosion Resistance:
   1) Immerse test specimen in a solution of sulfuric acid and distilled water with pH of three and temperature of 125 degrees F for one hour.
   2) Immerse test specimen in solution of sodium hydroxide and distilled water with pH of ten and a temperature of 125 degrees F for one hour.
   3) Glass lining shall show no change in surface gloss, roughening of surface, or visible deterioration.

j. Weight Loss Test: Test in boiling citric acid solution in accordance with ASTM C283.

8. Manufacturers of Glass Lining: Provide products of one of the following:
   a. Vitco Industries, Inc.
   b. Or approved equal.

D. Couplings:
   1. Refer to Section 40 05 06, Couplings, Adapters, and Specials for Process Piping.

2.2 MARKING FOR IDENTIFICATION

A. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify push-on joint and mechanical joint pipe with:
   1. Name or trademark of manufacturer.
   2. Weight, class or nominal thickness, and casting period.
   3. Country where cast.

4. Year the pipe was produced.
5. Letters “DI” or “Ductile” shall be cast or metal stamped

B. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify flanged pipe with:
   1. Flange manufacturer’s mark, size, and letters “DI” cast or stamped on the flanges.
   2. Fabricator’s mark if other than flange manufacturer.
   3. Length and weight.

C. In addition to identification markings specified in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation, also stamp, mark, and identify fittings with:
   1. Manufacturer’s identification.
   2. Pressure rating.
   3. Nominal diameters of openings.
   4. Country where cast.
   5. Number of degrees or fraction of the circle on bends.
   6. Letters “DI” or “Ductile” cast on them.

2.3 EXTERIOR SURFACE PREPARATION AND COATINGS

A. General Coating Requirements:
   1. Coating types are specified in piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 3 – EXECUTION

3.1 INSPECTION

A. Inspect piping to assure that piping is free from defects in material and workmanship. Verify compatibility of pipe, fittings, gaskets, linings, and coatings.

3.2 INSTALLATION AND FIELD QUALITY CONTROL

A. For buried piping installation and testing, refer to Section 33 05 05.
B. For exposed piping Installation and testing, refer to Section 40 05 05.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 40 05 23.23

STAINLESS STEEL PROCESS PIPE FOR LIQUID SERVICE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install stainless steel pipe and fittings for liquid service.
   2. Extent of piping is shown and shall be in accordance with piping schedules in Section 40 05 05, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before stainless steel piping Work.

C. Related Sections:

   1. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section include:
   1. ANSI B36.19, Stainless Steel Pipe (ASME B36.19M).
   2. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
   3. ASTM A276, Specification for Stainless Steel Bars and Shapes.
   4. ASTM A312/A 312M, Specification for Seamless and Welded Austenitic Stainless Steel Pipes.
   5. ASTM A320/A320M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for Low-Temperature Service.
   6. ASTM A774/A774M, Specification for As-Welded Wrought Austenitic Stainless Steel Fittings for General Corrosive Service at Low and Moderate Temperatures.
   7. ASTM A778, Specification for Welded, Unannealed Austenitic Stainless Steel Tubular Products.
   8. ASTM F593, Specification for Stainless Steel Bolts, Hex Cap Screws, and Studs
   9. AWS D1.6/D1.6M, Structural Welding Code – Stainless Steel.

10. AWWA C606, Grooved and Shouldered Joints.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer's Qualifications: Manufacturer shall have a minimum of five years experience producing stainless steel pipe and fittings for liquid service substantively similar to the materials specified, and shall be able to provide documentation of satisfactory service in at least five completed installations.
   2. Welders shall be qualified in accordance with AWS D1.6.

B. Component Supply and Compatibility:
   1. Obtain all materials included in this Section, regardless of component Supplier, from a single stainless steel pipe manufacturer.
   2. Stainless steel pipe manufacturer shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
   3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by stainless steel pipe Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Piping layout Shop Drawings in accordance with Section 40 05 05, Exposed Piping Installation.
   2. Product Data:
      a. Product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificate of compliance standards referenced in this Section.
   2. Qualifications Statements:
      a. Manufacturer's qualifications when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 40 05 05, Exposed Piping Installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Provide products of one of the following:
   1. Alaskan Copper & Brass Company.

2. Felker Brothers Corporation.
3. Douglas Brothers Division, Robert Mitchell Co., Inc.
4. Or approved equal.

2.2 STAINLESS STEEL PIPE AND FITTINGS

A. Fabricated Stainless Steel Pipe:
1. Pipe:
   a. Type: Pipe and fittings may be electrically welded or seamless. Spiral welded pipe is not acceptable.
   b. Material: ASTM A240/A240M, Type 316L stainless steel.
   c. Diameter: Pipe diameters as shown and specified shall mean nominal outside diameter of pipe, except for pipes specified with schedule numbers for wall thickness. Pipes specified with schedule numbers for wall thickness shall conform to ANSI B36.19.
   d. Wall Design Criteria:
      1) Provide a piping that meets fabrication, installation, and service conditions as shown and specified.
      2) Based on internal design pressure indicated for test pressure in Section 40 05 05, Exposed Piping Installation.
      3) Minimum Wall Thickness: Schedule 40.
   e. Fabrication of stainless steel pipe shall be in accordance with ASTM A312 and ASTM A778, where applicable.
      1) Longitudinal Seams: Maximum of two per section of pipe.
      2) Girth Seams: Not less than six feet apart, except at fittings and specials.
      3) Pipe Ends: Perpendicular to longitudinal axis.
      4) Roundness: Tolerance of 1/16-inch.
      5) Straightness: Tolerance of 1/8-inch in ten feet.
      6) Edges: Joint-edges shall be true so as to not leave shoulder on inside of pipe.
   f. Welding:
      1) Longitudinal Welds: Tungsten Inert Gas or Metal Inert Gas.
      2) Circumferential Welds: Heliarc or metallic air process.
      3) Grinding: Interior welds shall be ground smooth to provide internal bead of 1/16-inch or less.
   g. Factory Finish:
      1) Pipe and fittings shall be pickled after manufacture by immersing in acid bath until weld discoloration and iron pickup is removed.
      2) Passivate piping welds after fabrication.
      3) Thoroughly wash pipe and fittings with clear water after pickling.

2. Fittings:
   a. Type: Welded, flanged, or grooved end shouldered coupling as shown, all stainless steel.
   b. Construction:

1) Stainless steel fittings, 2.5-inch diameter and smaller, shall be ASTM A403/A403M, of same material and pressure rating as associate pipe, threaded, long-radius with dimensions conforming to ANSI B16.11.
2) Unless otherwise specified, stainless steel fittings three-inch diameter and larger shall be of same material and same thicknesses as associated pipe. Long-radius elbows up to 24-inch diameter shall be smooth flow. Short-radius, special-radius, and reducing bends, and long-radius bends greater than 24-inch diameter, shall be mitered construction. Reducers shall be tapered, cone type. Tees, crosses, laterals, and wyes shall be shop-fabricated pipe.
3) For general corrosive service at low and moderate temperatures, comply with ASTM A774/A774M.

c. Wall Thickness: Conform to wall thickness specified in Section 40 05 05, Exposed Piping Installation, but in no case less than pipe wall thickness.
d. Base Fitting: Provide Type 316 stainless steel.

3. Threaded Connections: Threaded pipe, gage, or instrument connections shall be made using stainless steel, 150-pound, threaded half-couplings conforming to ASTM A182/A182M or ASTM A276, shop welded to pipe at locations specified or shown.

B. Welding of Pipe:
1. Welding performed under this Section shall be completed in shop. Field welding is not allowed. Welding shall conform to AWS D1.6.
2. Stainless steel joining welds shall be made using fully automatic, inert gas process. Before welding longitudinal butt seal, starting and run-off tabs shall be heliarc spot welded to each end of pipe. Ends shall be checked for trueness to axis. Rigid jigs and fixtures shall be used for holding parts in proper alignment during welding.
3. During welding, joint shall be backed up from opposite side with chill bar. Chill bar shall have series of holes running its entire length through which gas is introduced to assure shielding to interior of joint. Welding of joint shall be by automatic arc, inert gas method. Gas shield shall be utilized top and bottom to assure that weld is made in completely inert atmosphere.
4. Filler wire shall be added to all gauges of material to provide cross section of weld metal equal to or greater than parent metal. Filler wire shall be at least one grade higher than parent metal and always of extra low carbon grade. Filler wire shall be automatically fed to weld with rate of travel of automatic welding machine. Use non-consumable tungsten electrode, with shielding gas being either argon or helium.
5. Welds shall be fully penetrated, sound, and of uniform bead. Circumferential welds shall be made using tungsten shielded arc process. Welds shall have full penetration to interior surface of pipe. Provide gas shielding to interior of joint as well as to exterior, to assure that weld is made in completely inert atmosphere.
6. Welds shall have surface finish equal to smoothness of 2D sheet finish. Interior weld beads shall be smooth, evenly distributed, with interior projection

not exceeding 1/16-inch beyond inside diameter of pipe or fitting. Ripples or unevenness shall be finely ground to meet above requirements. Major grinding of interior seams to remove excess projection of welds or severe unevenness is not allowed.

7. Outside weld area shall be wire brushed. Brushes shall be of stainless steel and used only on stainless steel material. Exterior discoloration and deposits left by welding shall be removed mechanically with wire brushes or non-metallic abrasives.

C. Grooving of Pipes and Fittings:
   1. Groove stainless steel pipe and fittings in accordance with grooved end coupling manufacturer recommendations.
   2. Grooves shall be cut using a Victaulic VG cut grooving tool or equal.

2.3 JOINTS

A. General:
   1. Comply with Section 40 05 05, Exposed Piping Installation.
   2. Provide flanged joints at connections to valves, equipment, and instruments.
   3. Provide grooved end couplings for field assembly of exposed piping.
   4. Joints shall be shop welded, unless otherwise shown or specified.
   5. Welding shall comply with the requirements of Paragraph 2.2.B of this Section.
   6. Stainless steel pipe fabricated into spool pieces shall have shop-welded circumferential butt-welded joints or flanges.

B. Flanged Joints:
   1. Two-part flange:
      a. Slip-on rolled angle face rings of 1/8-inch stainless steel for pipe less than 16-inch diameter, and 3/16-inch thick for pipe 16-inch diameter and larger. Angle face ring thickness shall be equal to or greater than wall of pipe or fitting to which angle face ring is welded, and continuously weld angle face ring to pipe or fitting on both sides. Angle leg shall not interfere with flange bolt holes.
   2. Pressure Rating: 150 psig minimum.
   3. Gaskets:
      a. Comply with stainless steel pipe manufacturer's recommendations for service conditions shown and as specified.
   4. Bolts and Nuts:
      a. Provide stainless steel bolts complete with washers complying with ASTM F593, AISI Type 316 and with nitrided stainless nuts.
      b. For low-temperature service, comply with ASTM A320/A320M.
   5. Specials:
      a. Taps:
         1). Provide taps as shown or required for small pipe and instrument connections.

2) Connections shall be welded, forged threaded Type 316L stainless steel boss.
3). Products and Manufacturers: Provide the following:
a) Thredolet by Grinnell Company.
b) Or equal.

b. Pipe Adapters: Where necessary to join pipe of different type, provide necessary adapters. Ends shall conform to the Specifications for appropriate type joint.

2.3 FINAL CLEANING

A. After fabrication, mechanically clean accessible weld surfaces with wire brushes or non-metallic abrasives.

B. Pipe, fittings, and flanges shall be free of iron particulates and other foreign material.

2.4 IDENTIFICATION

A. Pipe and fitting materials shall be stamped, marked, or identified with the following:
1. Name of manufacturer.
2. Date of manufacture.
3. Operating design pressure at operating design temperature.
4. Type of service.
5. Manufacturer's part number.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

A. For exposed piping installation and testing, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

SECTION 40 05 31

THERMOPLASTIC PROCESS PIPE

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install thermoplastic piping and fittings.
   2. Extent of piping is shown and shall be in accordance with piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate installation of items to be installed with or before thermoplastic piping Work.

C. Related Sections:
   1. Section 33 05 05, Buried Piping Installation.
   2. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ASTM D1784, Specification for Rigid Poly (Vinyl Chloride) (PVC) Compounds and Chlorinated Poly (Vinyl Chloride) (CPVC) Compounds.
   3. ASTM D1785, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80 and 120.
   4. ASTM D2464, Specification for Threaded Poly (Vinyl Chlorinated) (PVC) Plastic Pipe Fittings, Schedule 80.
   5. ASTM D2466, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
   6. ASTM D2467, Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
   7. ASTM D2513, Specification for Thermoplastic Gas Pressure Pipe, Tubing, and Fittings.
   8. ASTM D2564, Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
   9. ASTM D2665, Specification for Poly (Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings.
   10. ASTM D683, Specification for Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.

11. ASTM D3034, Specification for Type PSM Poly (Vinyl Chloride) (PVC) Sewer Pipe and Fittings.
12. ASTM D3035, Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
13. ASTM D3139, Specification for Joints for Plastic Pressure Pipes Using Flexible Elastomeric Seals.
14. ASTM D3212, Specification for Joints for Drain and Sewer Plastic Pipes Using Flexible Elastomeric Seals.
15. ASTM D3222, Unmodified Poly (Vinylidene Fluoride) (PVDF) Molding Extrusion and Coating Materials.
16. ASTM D3261, Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
17. ASTM D3311, Specification for Drain, Waste and Vent (DWV) Plastic Fittings Patterns.
18. ASTM D3350, Specification for Polyethylene Plastic Pipe and Fittings Materials.
19. ASTM D4101, Specification for Polypropylene Injection and Extrusion Materials.
20. ASTM F437, Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
21. ASTM F438, Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40.
22. ASTM F439, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80.
23. ASTM F441/F441M, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80.
24. ASTM F442/F442M, Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR).
25. ASTM F477, Specification for Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
26. ASTM F656, Specification for Primers for Use in Solvent Cement Joints of Poly (Vinyl Chloride) (PVC) Plastic Pipe and Fittings.
27. ASTM F679, Specification for Poly (Vinyl Chloride) (PVC) Large-Diameter Plastic Gravity Sewer Pipe and Fittings.
28. ASTM F714, Specification for Polyethylene (PE) Plastic Pipe (SDR-PR) Based on Outside Diameter.
29. ASTM F1055, Specification for Electrofusion Type Polyethylene Fittings for Outside Diameter Controlled Polyethylene Pipe and Tubing.
30. ASTM F1336, Specification for Poly (Vinyl Chloride) (PVC) Gasketed Sewer Fittings.
31. ASTM F1674, Standard Test Method for Joint Restraint Products for Use with PVC Pipe.
32. ASTM F1760, Specification for Coextruded Poly (Vinyl Chloride) (PVC) Non-Pressure Plastic Pipe Having Reprocessed-Recycled Content.

33. AWWA C900, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 In.-12 In. (100 mm-300 mm), for Water Transmission and Distribution
34. AWWA C901, Polyethylene (PE) Pressure Pipe and Tubing, 1/2 In. (13 mm) Through 3 In. (76 mm), for Water Service.
35. AWWA C905, Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 14 In.-48 In. (350 mm-1,200 mm).
36. AWWA C906, Polyethylene (PE) Pressure Pipe and Fittings, 4 In. (100 mm) Through 63 In. (1,600 mm), for Water Distribution and Transmission.
37. AWWA C907, Injection-Molded Polyvinyl Chloride (PVC) Pressure Fittings, 4 In. Through 12 In. (100 mm Through 300 mm).
38. NSF 14, Plastic Piping Systems Components and Related Material.
39. ANSI/NSF 61, Drinking Water System Components - Health Effects.
40. Standards of U.S. Food and Drug Administration.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Shall have a minimum of five years experience producing thermoplastic pipe and fittings substantively similar to the materials specified, and shall be able to submit documentation of satisfactory service in at least five completed installations in operation for at least five years each.
   2. Installer:
      a. Engage a single pipe installer who shall be responsible for all thermoplastic pipe Work, and who shall employ only tradesmen with specific skills and experience in the type of Work required.
      b. Installer shall have a minimum of five years experience installing thermoplastic pipe and fittings substantively similar to the materials specified and substantively similar to or larger than the scope of thermoplastic piping Work on the Project, and shall be able to submit documentation of satisfactory experience in at least five completed installations in operation for at least five years each.

B. Component Supply and Compatibility:
   1. Obtain all materials included in this Section, regardless of component Supplier, from a single thermoplastic pipe Supplier. All pipe of each material type shall be furnished by the same manufacturer.
   2. Thermoplastic pipe Supplier shall review and approve to prepare all Shop Drawings and other submittals for all materials furnished under this Section.
   3. Materials shall be suitable for specified service conditions and shall be integrated into overall assembly by thermoplastic pipe Supplier.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:

a. Submit piping layout Shop Drawings in accordance with Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

2. Product Data:
   a. Submit product data on pipe, fittings, gaskets, hardware, and appurtenances sufficient to demonstrate compliance with the Contract Documents.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Submit manufacturer's certificate of compliance standards referenced in this Section.
   2. Source Quality Control Submittals:
      a. When requested by ENGINEER, submit results of source quality control tests.
   3. Qualifications Statements:
      a. Submit qualifications of manufacturer when requested by ENGINEER.
      b. Submit qualifications of installer when requested by ENGINEER.

1.5 DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

PART 2 – PRODUCTS

2.1 SERVICE CONDITIONS

A. General:
   1. Pipe materials shall be suitable for services intended. Refer to piping schedules in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.
   2. Pipe shall be homogeneous throughout and free of visible cracks, holes, foreign inclusions, and other defects. Unless otherwise shown or indicated, pipe shall be uniform in color, opacity, density, and other physical properties.
   3. Comply with NSF 14.
   4. Buried pipe shall be capable of withstanding external live load, including impact, equal to AASHTO H-20 loading, with cover shown or indicated on the Drawings.

2.2 POLYVINYL CHLORIDE (PVC) PIPING

A. PVC Pipe – General Applications: Unless otherwise shown or indicated, PVC pipe shall comply with the following:
   1. Manufacturers: Provide products of one of the following:
      a. Ipex, Inc.

b. Spears Manufacturing Company.
c. Or approved equal.

2. Material: Unless otherwise specified, comply with the following:
   a. Type and Grade: Type 1, Grade 1.
   b. Wall Thickness: Schedule 40 complying with ASTM D1784 and ASTM D1785, and US Product Service PS 21-70 as having same outside diameter dimension as cast-iron pipe.
   c. Temperature Rating: Rated for temperature to 140 degrees F.
   d. Color: White, Gray.
3. Fittings: Type, grade, schedule, and color of fitting shall match the associated pipe.
   a. Solvent Weld: Comply with ASTM D2466
4. Joints:
   a. Solvent Weld: Use primer and solvent cement recommended by PVC pipe manufacturer for the application. Primer shall be in accordance with ASTM F656, and solvent cement shall be in accordance with ASTM D2564.

B. Buried PVC Gravity Drainage Pipe.
1. Manufacturers: Provide products of one of the following:
   a. JM Eagle.
   b. Ipex, Inc.
   c. Diamond Plastics Corp.
   d. Or approved equal.
2. Material:
   a. Pipe shall comply with ASTM D3034.
   b. Wall Thickness and Pipe Stiffness: Pipe stiffness shall be determined in accordance with test methods in ASTM D3034.
      1) Main Line: SDR 35, with minimum ring stiffness of 46 psi.
3. Fittings:
   a. Injection-molded, gasketed fittings shall comply with ASTM F1336, and ASTM D3034.
   b. Fabricated fittings shall comply with ASTM F1336.
   c. Unless otherwise shown or indicated, saddle wyes are unacceptable.
4. Joints:
   a. Provide bell and spigot joints. Bell shall consist of an integral wall section to hold securely in place (and prevent displacement during assembly of joint) elastomeric O-ring gasket.
   b. Jointing lubricant shall be as recommended by pipe manufacturer.
   c. Provide elastomeric gaskets complying with ASTM F477, and ASTM D3139 or ASTM D3212.

2.3 CHLORINATED POLYVINYL CHLORIDE (CPVC) PIPING

A. CPVC Pipe – General Applications: Unless otherwise shown or indicated, CPVC pipe shall comply with the following:
   1. Manufacturers: Provide products of one of the following:
      a. Ipex, Inc.
      b. Spears Manufacturing Company.
      c. Or approved equal.
   2. Material: Comply with ASTM F441/F441M and US Product Standard PS 21-70 as having same outside diameter as iron pipe. Comply with the following:
      a. Type and Grade: Type IV, Grade 1.
      b. Minimum Wall Thickness: Schedule 40, unless otherwise specified.
      c. Temperature Rating: Rated to 210 degrees F.
      d. Color: Gray.
      e. Manufacture pipe and fittings with minimum of two percent of titanium oxide for ultraviolet protection.
   3. Fittings: Type, grade, schedule, and color of fittings shall match the associated pipe.
      a. Solvent Welded: Fittings shall comply with ASTM F438 for socket type.
   4. Joints:
      a. Solvent Welded: Use primer and solvent cement recommended by CPVC pipe manufacturer. Primer shall be in accordance with ASTM F656, and solvent cement shall be in accordance with ASTM D2564.

2.7 IDENTIFICATION

A. Pipe material identification requirements are in Section 33 05 05, Buried Piping Installation, and Section 40 05 05, Exposed Piping Installation.

2.8 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Pipe manufacturer shall maintain continuous quality control program.
   2. Where applicable and when requested by ENGINEER, submit results of source quality control tests specified in reference standards.
   3. CPVC plastic molding materials used for manufacturing pipe and fittings under this Section shall be tested for compliance with ASTM D1784.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspect pipe materials for defects in material and workmanship. Verify compatibility of pipe and fittings.

3.2 INSTALLATION

A. For buried piping installation, refer to Section 33 05 05, Buried Piping Installation.

B. For exposed piping installation, refer to Section 40 05 05, Exposed Piping Installation.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 40 05 53

PROCESS VALVES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish and install process valves and appurtenances, complete and operational.
   2. All valves are for liquid service.

B. Coordination:

   1. Review installation procedures under this and other Sections and coordinate installation of items that must be installed with or before process valves Work.

C. Related Sections:
   1. Section 05 05 33, Anchor Systems.
   2. Section 09 91 00, Painting.
   3. Section 40 05 05, Exposed Piping Installation.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. ANSI B16.1, Cast-Iron Pipe Flanges and Flanged Fittings.
   2. ANSI B16.34, Valves-Flanged, Threaded and Welding end. (ASME B16.34).
   4. API STD 594, Check Valves, Flanged Lug, Wafer and Butt-Welding.
   5. API STD 598, Valve Inspection and Testing.
   6. API STD 609, Butterfly Valves: Double Flanged, Lug-Type and Wafer-Type.
   7. ASTM A126, Specification for Gray Iron Castings for Valves, Flanges and Pipe Fittings.
   8. ASTM A193/A193M, Specification for Alloy-Steel and Stainless Steel Bolting Materials for High-Temperature Service.
   9. ASTM A194/A194M, Specification for Carbon and Alloy Steel Nuts for Bolts for High Pressure and High Temperature Service, or Both.

10. ASTM A240/A240M, Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
11. ASTM A276, Specification for Stainless Steel Bars and Shapes.
12. ASTM A351/A351M, Specification for Castings, Austenitic, Austenitic-Ferritic (Duplex), for Pressure-Containing Parts.
13. ASTM A380, Practice for Cleaning, Descaling and Passivation of Stainless Steel Parts, Equipment and Systems.
14. ASTM A536, Specification for Ductile Iron Castings.
15. ASTM A564/A564M, Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes.
16. ASTM A743/A743 M, Specification for Castings, Iron-Chromium, Iron-Chromium-Nickel, Corrosion Resistant, for General Application.
17. ASTM B62, Specification for Composition Bronze or Ounce Metal Castings.
18. ASTM B98/B98M, Specification for Copper-Silicon Alloy Rod, Bar, and Shapes.
19. ASTM B138/B138M, Specification for Manganese Bronze Rod, Bar and Shapes.
20. ASTM B1000-15, Standard Practices for Casting Preparation and Test Procedure of Porcelain Enamel-lined Pipe, Fittings, and Valves for Use in the Municipal Wastewater, Sewage, and Water Treatment Industry
21. ASTM D429, Test Methods for Rubber Property - Adhesion to Rigid Substrates.
22. AWWA C500, Metal-Seated Gate Valves for Water Supply Service.
24. AWWA C502, Dry-Barrel Fire Hydrants.
25. AWWA C504, Rubber-Seated Butterfly Valves.
26. AWWA C508, Swing-Check Valves for Waterworks Service, 2-inch through 24-inch NPS.
27. AWWA C515, Reduced Wall, Resilient-Seated Gate Valves for Water Supply Service.
28. AWWA C520, Knife Gate Valves, Sizes 2-inch through 96-inch.
30. AWWA C550, Protective Interior Coatings for Valves and Hydrants.
31. FS TT-C-494, Coating Compound, Bituminous, Solvent Type, Acid-Resistant.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have minimum of five years of experience producing substantially similar materials and equipment to that required and be able to provide evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:

1. Obtain each type of equipment and appurtenances included in this Section, regardless of the component manufacturer, from a single manufacturer of the type of process valve. For each type of valve, do not furnish valves of more than one manufacturer.
2. Supplier of each type of equipment specified shall review and approve or prepare all Shop Drawings and other submittals for all components associated with the type of process valve Supplier is furnishing.
3. Components shall be suitable for use in the specified service conditions. Components shall be integrated into the overall assembly by the process valve manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Installation drawings showing orientation of valve in both plan and elevation view. Drawings shall clearly identify valve and its appurtenances, including controls, actuators, valve stems, and other components. Show dimensions of valves and appurtenances in relation to piping and structural and architectural components, where applicable.
      b. Calculations for sizing of operating mechanism with extension stems.
   2. Product Data:
      a. Product data sheets.
      b. Complete catalog information, including dimensions, weight, specifications, and identification of materials of construction of all parts.
      c. Corrosion resistance information to confirm suitability of valve materials for the application. Furnish information on chemical resistance of elastomers from elastomer manufacturer.
   3. Samples:
      a. If requested by ENGINEER, furnish one foot of chain for chainwheel-operated valves.
   4. Testing Plans:
      a. Submit plan for shop testing of each valve for which shop testing is specified, including testing plan's and test facility's limitations proposed.

B. Informational Submittals: Submit the following:
   1. Certificates:
      a. Certificates of compliance with referenced standards, where applicable, including those of AWWA, NSF, and others required by ENGINEER.
   2. Manufacturer Instructions:
      a. Submit manufacturer's instructions for handling, storing, and installing valves and appurtenances. Provide templates and setting drawings for

valves and appurtenances that require anchor bolts or similar anchorages.

4. Source Quality Control Submittals:
   a. Submit copies of shop test results and inspection data, certified by manufacturer.
5. Field Quality Control Submittals:
   a. Submit results of field tests required.
6. Supplier's Reports:
   a. When requested by ENGINEER, submit written report of results of each visit to Site by Supplier's serviceman, including purpose and time of visit, tasks performed and results obtained.
7. Qualifications Statements:
   a. When requested by ENGINEER, submit manufacturer's qualifications demonstrating compliance with the Specifications, including list of existing installations with contact names and telephone number(s) for each.

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Furnish operation and maintenance manuals in accordance with Section 01 78 23, Operations and Maintenance Data.
      b. Furnish in operations and maintenance manuals complete nameplate data for each valve and electric actuator.

D. Maintenance Material Submittals: Submit the following:
   1. Spare Parts, Extra Stock Materials, and Tools:
      a. Spare Parts and Extra Stock Materials: Furnish as specified for each valve type.
      b. Tools: Furnish two sets of special tools (excluding metric tools, if applicable) for each size and type of valve furnished.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling, and Unloading:
   1. Deliver materials and equipment to Site to ensure uninterrupted progress of the Work. Deliver anchorage products that are to be embedded in concrete in ample time to prevent delaying the Work.
   2. Inspect boxes, crates, and packages upon delivery to Site and notify ENGINEER in writing of los or damage to materials and equipment. Promptly remedy loss and damage to new condition in accordance with manufacturer's instructions.
   3. Conform to Section 01 65 00, Product Delivery Requirements.

B. Storage and Protection:
   1. Keep products off ground using pallets, platforms, or other supports. Store equipment in covered storage and prevent condensation and damage by

extreme temperatures. Store in accordance with manufacturer's recommendations. Protect steel, packaged materials, and electronics from corrosion and deterioration.

2. Conform to Section 01 66 00, Product Storage and Handling Requirements.

PART 2 - PRODUCTS

2.1 GENERAL

A. Valves, General:
   1. Provide each valve with manufacturer's name and rated pressure cast in raised letters on valve body.
   2. Provide valves with brass or Type 316 stainless steel nameplate attached with Type 316 stainless steel screws. Nameplates shall have engraved letters displaying the following minimum information:
      a. Valve size.
      b. Pressure and temperature ratings.
      c. Application (other than water and wastewater).
      d. Date of manufacture.
      e. Manufacturer's name.
   3. Provide valves to turn clockwise to close, unless otherwise specified.
   4. Provide valves with permanent markings for direction to open.
   5. Manually operated valves, with or without extension stems, shall require not more than 40-pound pull on manual operator to open or close valve against specified criteria. Gear actuator and valve components shall be able to withstand minimum pull of 200 pounds on manual operator and input torque of 300-foot pounds to actuator nut. Manual operators include handwheel, chainwheel, crank, lever, and T-handle wrench.

B. Valve Materials:
   1. Valve materials shall be suitable for the associated valve's service or application, as shown.
   2. Protect wetted parts from galvanic corrosion caused by contact of different metals.
   3. Clean and descale fabricated stainless steel items in accordance with ASTM A380 and the following:
      a. Passivate all stainless steel welded fabricated items after manufacture by immersing in pickling solution of six percent nitric acid and three percent hydrofluoric acid. Temperature and detention time shall be sufficient for removing oxidation and ferrous contamination without etching surface. Perform complete neutralizing operation by immersing in trisodium phosphate rinse followed by clean water wash.
      b. Scrub welds with same pickling solution or pickling paste and clean with stainless steel wire brushes or by grinding with non-metallic abrasive tools to remove weld discoloration, and then neutralize and wash clean.

C. Valve Joints:
   1. Exposed Valves: Unless otherwise specified, provide with flanged ends conforming to ANSI B16.1. Pressure class of flanges shall be equal to or greater than specified pressure rating of the associated valve.
   2. For stainless steel bolting, except where nitrided nuts are required, use graphite-free anti-seize compound to prevent galling. Strength of joint shall not be affected by using anti-seize compound.

2.2 METAL-SEATED KNIFE GATE VALVES

A. Manufacturers: Provide products of one of the following:
   1. Henry Pratt Company.
   2. Orbinox Valves International.
   3. Wey Valve, Inc.
   4. Or approved equal.

B. General:
   1. Provide valves conforming to AWWA C520 and as specified in this Section.
   2. Type:
      a. Provide Outside Screw and Yoke (OS&Y) rising-stem valves for exposed service unless specified otherwise.
   3. Minimum Rated Working Pressure: 150 psig.
   4. Maximum Fluid Temperature: 160 degrees F.

C. Materials of Construction: Materials of construction shall conform to AWWA C520 and shall be as follows:
   1. Valve Body: Ductile iron or Carbon steel.
   2. Gate: Type 316 stainless steel.
   3. Seat: Type 316 stainless steel
   3. Packing: Lubricated Teflon or equal.
   4. Body Flanges, Exterior Stiffeners, Packing Gland and Yoke: Carbon steel.
   5. Stem and Clevis: Type 304 stainless steel.
   6. Stem Nut: Bronze or Brass.
   7. Internal and external bolting and other hardware, including pins, set screws, studs, bolts, nuts, and washers, shall be Type 316 stainless steel.
   8. Rubber Items: Buna-N or other synthetic rubber suitable for application.

E. Testing:
   1. Test valves in valve manufacturer's shop in conformance with AWWA C520.

F. Gear Actuators for Manually operated Valves:
   1. Provide gear actuators for valves, in accordance with AWWA C520.
   2. Size gear actuators for a 150 psig maximum differential pressure across the closed valve.

2.3 RUBBER FLAPPER SWING CHECK VALVES

A. Manufacturers: Provide products of one of the following:
   1. DeZurik APCO series.
   2. Or equal.

B. General:
   1. Provide valves conforming to AWWA C508 and as specified herein.
   2. Type: Resilient-seated.
   3. Minimum Rated Working Pressure: 250 psig.
   4. Maximum Fluid Temperature: 160 degrees F.
   5. Provide valves suitable for horizontal or vertical mounting.
   6. Check valves shall have unobstructed flow path with full-open area equal to nominal pipe size.
   7. Provide check valves with bolted access cover to enable access to valve disk without removal of valve from service line.
   8. Valve flapper disc shall be mechanically attached and shall be field replaceable.
   9. Valve flapper disc shall travel 35 degrees from fully open to fully closed.

C. Materials of Construction: All materials of construction shall conform to AWWA C508 and shall be as follows:
   1. Body and Cover: Ductile iron.
   2. Flapper disc: NBR reinforced with carbon steel.
   3. Gaskets: Buna-N or equal
   4. Internal and external bolting and other hardware; including cover bolts, nuts, and washers shall be Type 316 stainless steel.

D. Interior Coating:
   1. Steel, cast-iron, and ductile iron surfaces, except machined surfaces, shall be coated inside. Refer to Manual Valve Schedule at the end of this Section for valve Coatings and Linings.

E. Testing:
   1. Test each valve in manufacturer's shop in accordance with AWWA C508.
   2. Allowable Leakage at Rated Pressures: Zero.

2.4 BALL VALVES

A. Manufacturers: Provide products of one of the following:
   1. Nibco, Incorporated.
   2. Lunkenheimer Company.
   3. Or equal.

B. General

1. Provide a full port valve with a port diameter equal to the nominal valve diameter.
2. Valves 3-inch in diameter and smaller shall have lever operators unless otherwise noted on the Contract Drawings.
3. Minimum Rated Service Pressure: 150 psig.

C. Materials of Construction: Materials of construction shall be as follows:
1. Body and Ball: Type 316 stainless steel.
2. Stem: Type 316 stainless steel. Stem gland shall be adjustable and independent of the lever to compensate for wear. Bottom loaded stems shall be designed to be blow-out proof.
3. Seats and Seals: Tetrafluoroetylene or equal.
4. Levers shall be stainless steel covered with a vinyl grip and attached with a stainless steel nut.
5. Elastomers shall be EPDM and suitable for the intended service.

2.5 PRESSURE RELIEF VALVE (BREATHING VALVE)

A. Manufacturers: Provide products of one of the following:
1. Groth Pressure/Vacuum relief valve model 1200A
2. Or equal.

B. General:
1. Inlet flange size: 2-in
2. Set point pressure: 6 in WC
3. Set point vacuum: - 4 in WC
4. Airflow capacity at 100% overpressure: 1,980scfm at 60degF

C. Materials of Construction:
1. Fiberglass reinforced plastic

2.6 APPURTENANCES FOR EXPOSED METALLIC VALVES

A. General:
1. For valves located less than five feet above operating floor, provide levers on four-inch diameter quarter-turn valves, and provide handwheels on all other valves, unless otherwise shown or specified.

B. Handwheels:
1. Conform to applicable AWWA standards.
2. Material of Construction: Ductile iron, or cast aluminum.
3. Arrow indicating direction of opening and word “OPEN” shall be cast on trim of handwheel.
4. Maximum Handwheel Diameter: 2.5 feet.

C. Crank Operator:
1. Crank operator shall be removable and fitted with rotating handle.

2. Maximum Radius of Crank: 15 inches.
3. Materials:
   a. Crank: Cast-iron or ductile iron.
   b. Handle: Type 304 stainless steel.
   c. Hardware: Type 304 stainless steel.

2.7 ANCHORAGES AND MOUNTING HARDWARE

A. General:
1. Comply with Section 05 05 33, Anchor Systems, except as modified in this Section.
2. Obtain bolts, nuts, and washers for connection of valve and appurtenances to concrete structure or other structural members from valve Supplier.
3. Bolts, nuts, and washers shall be of ample size and strength for purpose intended. Anchorages in concrete shall be at least 5/8-inch diameter.
4. Provide stem guide anchorages of required strength to prevent twisting and sagging of guides under load.
5. Materials: Provide bolts and washers of Type 316 stainless steel and nitrided nuts. Bolts shall have rolled threads. Bolts and nuts shall be electropolished to remove burrs.

2.8 TOOLS, LUBRICANTS, AND SPARE PARTS

A. Lubricants: For valves, actuators, and appurtenances requiring lubricants, provide suitable lubricants for initial operation and for first year of use following Substantial Completion.

B. Tools, spare parts, and maintenance materials shall conform with Section 01 78 43, Spare Parts and Extra Materials.

2.9 PAINTING OF EXPOSED VALVES AND APPURTENANCES

A. Exterior steel, cast-iron, and ductile iron surfaces, except machined surfaces of exposed valves and appurtenances, shall be finish painted in manufacturer's shop. Surface preparation, priming, finish painting, and field touch-up painting shall conform to Section 09 91 00, Painting.

PART 3 - EXECUTION

3.1 INSPECTION

A. Examine conditions under which materials and equipment are to be installed and notify ENGINEER in writing of conditions detrimental to proper and timely

completion of the Work. Do not proceed with the Work until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. General:
   1. Install valves and appurtenances in accordance with:
      a. Supplier's instructions and the Contract Documents.
      b. Requirements of applicable AWWA standards.
      c. Applicable requirements of Section 40 05 05, Exposed Piping Installation.
   2. Install valves plumb and level. Install all valves to be free from distortion and strain caused by misaligned piping, equipment, and other causes.
   3. Position swing check valves and butterfly valves so that, when valve is fully open, valve disc does not conflict with piping system elements upstream and downstream of valve.

B. Exposed Valves:
   1. Provide supports for large or heavy valves and appurtenances as shown or required to prevent strain on adjoining piping.
   2. Operators:
      a. Install valves so that operating handwheels or levers can be conveniently turned from operating floor without interfering with access to other valves, piping, structure, and equipment, and as approved by ENGINEER.
      b. Avoid placing operators at angles to floors or walls.
   3. Floor Stands and Stems:
      a. Install floor stands as shown and as recommended by manufacturer.
      b. Provide lateral restraints for extension bonnets and extension stems as shown and as recommended by manufacturer.

3.3 FIELD QUALITY CONTROL

A. Field Tests:
   1. Adjust all parts and components as required to provide correct operation of valves.
   2. Conduct functional field test on each valve in presence of ENGINEER to demonstrate that each valve operates correctly.
   3. Verify satisfactory operation and controls of motor operated valves.
   4. Demonstrate satisfactory opening and closing of valves at specified criteria requiring not more than 40 pounds effort on manual actuators.
   5. Test ten percent of valves of each type by applying 200 pounds effort on manual operators. There shall be no damage to gear actuator or valve.

B. Supplier's Services:

1. Training: Furnish services of Supplier's qualified factory trained specialists to instruct OWNER's operations and maintenance personnel in recommended operation and maintenance of equipment. Training requirements, duration of instruction and qualifications shall be in accordance with Section 01 79 23, Instruction of Operations and Maintenance Personnel.
2. All costs, including expenses for travel, lodging, meals and incidentals, and cost of travel time, for visits to the Site shall be included in the Contract Price.

3.4 SUPPLEMENTS

A. The supplements listed below, following "End of Section" designation, are a part of this Specification Section:
   1. Table 40 05 53-A, Schedule of Manually Actuated Valves.

+ + END OF SECTION + +

TABLE 40 05 53-A, SCHEDULE OF MANUALLY ACTUATED VALVES

Service	Type	Valve Size (in)	Lining	Specification Paragraph
FOG	KV-MS	3 - 6	-	2.2
FOG	RFCV	3 - 4	FBE	2.3
W3	BV	¾ to 2	-	2.4
VENT	PRV	2	-	2.5

Note: Fusion bonded epoxy coating shall be applied in accordance with AWWA C550.

The following abbreviations are used in Table 40 05 53-A.

A. Valve Type Abbreviations

Valve Type	Abbrev		Valve Type	Abbrev.
Metal-seated Knife Gate Valve	KV-MS		Ball Valve	BV
Rubber Flapper Swing Check Valve	RFCV			
Pressure Relief Valve	PRV			

C. Lining Abbreviations

Lining Type	Abbrev
Fusion Bonded Epoxy	FBE

C. Service Abbreviations

Service	Abbrev
Fat, Oils and Grease	FOG
Plant Effluent	W3
Vent	V

SECTION 40 05 93

COMMON MOTOR REQUIREMENTS FOR PROCESS EQUIPMENT

PART 1 – GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Electric motors and accessories to be furnished under other equipment Sections shall comply with this Section, unless specified otherwise in the Section for the associated driven equipment.
   2. Motor horsepower and voltage ratings, speed, enclosure type, service conditions and testing requirements shall be as specified in the Sections for the associated driven equipment.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/NETA ATS, Acceptance Testing Specifications for Electrical Power Equipment and Systems.
   2. IEEE 43 - Recommended Practice for Testing Insulation Resistance of Rotating Machinery.
   3. IEEE 112 - Test Procedure for Polyphase Induction Motors and Generators.
   4. IEEE 429 - Standard Test Procedure for the Evaluation of Sealed Insulation Systems for AC Electric Machinery Employing Form-wound Stator Coils.
   5. IEEE 522 - Guide for Testing Turn-to-Turn Insulation on Form-Wound Stator Coils for Alternating Current Electric Machines.
   6. IEEE 1043, Recommended Practice for Voltage Endurance Testing of Form-Wound Bars and Coils.
   7. NEMA MG-1 - Motors and Generators.
   8. NEMA MG-2 - Safety Standard for Construction and Guide for Selection, Installation and Use of Electric Motors and Generators.
   9. NFPA 70 – National Electrical Code (NEC).
   10. UL 1004, Electric Motors.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer shall have not less than five years' experience producing equipment substantially similar to that required and shall be able to submit documentation of at least five installations in satisfactory operation for at least five years each.
   2. Motor manufacturer shall be one of the following:
      a. TECO – Westinghouse.
      b. US Motors.

c. General Electric.
d. Or Approved Equal.

3. Manufacturers listed are not guaranteed acceptance of a product that is proposed for this project. The motor supplied under this Section is required to meet all requirements stated in the Specifications.
4. Motor Compatibility: Manufacturer shall provide confirmation that motor provided is compatible with driven equipment and complies with this Specification.

1.4 SUBMITTALS

A. The following information shall be provided for each motor in accordance with the requirements of this Section.
1. Datasheets including motor outline, dimensions, and weight.
2. Motor nameplate drawing.
3. Manufacturer's general descriptive information relative to motor features.
4. Datasheets and wiring diagrams of motor heaters, winding thermal protection, lubrication equipment and other accessories.
5. Copies of motor characteristic curves including speed-torque curve, motor thermal damage curve, and power factor vs. speed curve during startup.
6. Alarm and trip setpoints for thermal and vibration protection devices.
7. Data input for programming motor protection relays when required.
8. Motor test data:
   a. Submit preliminary testing datasheets for proposed motor(s) prior to fabrication. Values indicated on testing datasheets shall be from tests of a previously manufactured, electrically duplicate motor or calculated data. Mark each test data sheet to indicate the Project motor application location, manufacturer, type, frame size, horsepower, voltage, speed, bearing type, lubrication medium and enclosure type. Test datasheet shall also include:
      1) Winding resistances.
      2) Torque values.
      3) Efficiency at 100, 75, and 50 percent of full load.
      4) Power factor at 100, 75, and 50 percent of full load.
      5) Slip.
      6) Full load amperes.
      7) Locked rotor and no load amperes.
      8) Nameplate temperature and results of dielectric tests.
   b. Submit results of required shop testing specified herein. Shop test reports shall be dated and signed by motor manufacturer.
   c. Submit results of required field testing and inspections specified herein. Field testing reports shall be dated and signed by CONTRACTOR.
9. Testing Plans and Procedures:
   a. When witnessed source quality control testing is required in the Section for associated driven equipment, submit description of proposed factory testing methods, procedures, and testing apparatus with calibration dates, together with proposed testing schedule and proposed travel and

logistical plans for testing.

10. Manufacturer's Instructions:
    a. Instructions and recommendations for handling, storing, protecting the motors.
    b. Installation data for motors, including setting drawings, templates, and directions and tolerances for installing anchorage devices.
11. Qualifications Statements:
    a. Submit manufacturer's qualifications data when requested by ENGINEER.
12. Applicable operation and maintenance information specified in Section 01 78 23, Operations and Maintenance Data. Provided overhaul instructions for the motor.

1.5 DELIVERY, STORAGE AND HANDLING

A. Delivery, storage, and handling shall comply with manufacturer's recommendations.

B. Ship motors with all enclosure openings sealed.

C. Protect materials and equipment from corrosion and deterioration. Store equipment in a clean, dry location with controls for uniform temperature and humidity. Protect equipment with coverings and maintain environmental controls.

D. Provide and maintain temporary power for space heater operation during storage and prior to energization once installed in permanent location. Failure to energize space heaters during storage shall dictate that motors are subject to rejection as determined by the ENGINEER or OWNER pending any inspection or testing. All expenses for inspection, testing, returning motor to factory, and shipping replacement motor to the site shall be solely the responsibility of the CONTRACTOR.

E. Fill bearing oil reservoirs and bearing grease cavities to confirm bearings are properly lubricated and to prevent ingress of moisture during storage. Rotate motor shaft during storage in intervals recommended by the manufacturer.

1.6 WARRANTY

A. The manufacturer shall provide a single warranty against faults and defects in material and workmanship for a period of 24 months of operation from the date of successful commissioning. Warranty shall provide for free replacement or repair of parts during that time period including all necessary labor. Warranty shall be administered by the manufacturer or its authorized service representative.

PART 2 – PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. Equipment Description:
   1. Comply with motor requirements specified in the Sections for the associated driven equipment.
   2. Motors shall be suitable for continuous operation at an elevation of up to 3,300 feet above mean sea level, at ambient temperatures ranging from -25 degrees C to 40 degrees C, unless specified otherwise in the Section for the associated driven equipment.

2.2 POWER REQUIREMENTS

A. Motor power supply shall be as shown on the Drawings or as specified in Section of the associated driven equipment.

B. Motors for Use with Variable Frequency Drives:
   1. Motors shall be inverter duty type and shall be compatible with characteristics of the intended variable frequency inverters.
   2. Motors shall comply with the performance standards of NEMA MG 1-31.

C. Motors shall successfully operate under power supply variations in accordance with NEMA MG 1-14.30 and NEMA MG 1-20.14.

D. Motor current imbalance shall not exceed 10% when the motor is operating at any load within its service factor rating and is supplied by a balanced voltage system. Imbalance criteria shall be based upon the lowest current value measured.

2.3 CONSTRUCTION – GENERAL

A. Unless specified otherwise in Section of the associated driven equipment, motors shall have the following features of construction and operation:
   1. NEMA Design B with torque and starting currents in accordance with NEMA MG 1, except in special high-torque applications, as specified in the Section for the associated driven equipment, which may require NEMA Design C.
   2. Motors shall operate within their full load rating without applying the service factor, unless specified otherwise in Section for the associated driven equipment.
   3. Speed and horsepower specified or required to properly operate the associated driven equipment and torque characteristics required by the drive load and suitable for direct coupling or V-belt drive, as specified in the Section for the associated driven equipment.
   4. Constructed for full-voltage starting.
   5. Fabricated steel or cast-iron frames with integrally cast feet or bases, cast-iron end bells, cast iron or steel conduit boxes and covers and bases with precision machined bearing fits, ASTM A48/A48M, Class 25 or better. For each TEFC motor, provide UL-approved automatic stainless steel breather drains in lowest part of front and back brackets to allow drainage of condensation.
   6. Stator core assembly shall consist of stacked lamination made from specially selected electrical sheet silicon steel.

7. Rotor cages shall be fabricated copper or copper alloy. Shafts shall be carbon steel unless specified otherwise in this Section or in the Section on the associated driven equipment.
8. Rotors on frames 213T and larger shall be keyed shrunk or welded to shaft and rotating assembly, dynamically balanced to NEMA limits. Use rivets to secure balance weights, if required, to rotor resistance ring or fan blades. Machine screws and nuts are unacceptable. Coat entire rotating assembly between bearing inner caps with corrosion-resistant epoxy.
9. Bolt and cap screws shall be high-strength, SAE Grade 5 zinc-plated and chromatic steel. Screwdriver slot fasteners are unacceptable.
10. Motors shall be factory-painted at the motor fabrication facility. Finish coat shall be the same color as the associated driven equipment. Final paint finish shall be corrosive resistant and capable of passing ASTM B117 250-hour salt spray test. Motors that will be located outdoors shall have coating resistant to degradation or chalking in sunlight.

2.4 SINGLE-PHASE AC MOTORS

A. Motors shall be rated 115-, 200-, or 230-volt, 60 Hertz.

B. Bearings shall be grease-lubricated ball type with grease fittings or with lubrication for 10 years of normal operation.

C. Motors shall be totally enclosed except fractional-horsepower motors may be open type if motor is suitably protected from moisture, dripping water, and airborne particulates accumulation. Motor features shall be in accordance with the following:
   1. Open motors shall be split-phase or capacitor start in accordance with torque requirements, with service factor of not less than 1.25, 40 degrees C ambient rating, and Class B insulation.
   2. Enclosed motors shall be capacitor start, with service factor of not less than 1.15, 40 degrees C ambient rating, and Class F insulation. Motors shall be fan-cooled or non-ventilated.
   3. Severe duty type motors shall be designed to withstand chemical corrosion and equipped with cast iron end shields, neoprene gaskets, stainless steel shaft, heavy pressed steel fan cover and provision for threaded conduit connection.
   4. Provide direct drive fan motors with conduit fittings and leads to allow external connection.
   5. Explosion-proof motors shall comply with UL 674.

2.5 THREE-PHASE AC MOTORS

A. General: Unless specified otherwise in the Sections for the associated driven equipment, provide three-phase motors with the following features:
   1. NEMA Premium Efficient construction complying with NEMA MG 1.
   2. Motor efficiency determined in accordance with NEMA MG 1-12.58.
   3. Minimum and nominal full-load efficiencies not less than those listed in: NEMA MG 1 Table 12-12 for motors rated 600 volts and smaller, and NEMA

MG 1 Table 12-13 for motors rated larger than 600 volts and equal to or less than 5,000 volts.

4. Motors shall be constructed for operation on three-phase, 60 Hertz, alternating current system. Motor voltage and variable frequency operation, where required, shall be as specified in the Sections for the associated driven equipment. Voltage ratings shall be 200 volts for operation on 208-volt systems, 230 volts for 240-volt systems, 460 volts for 480-volt systems, 2300 volts for 2400-volt systems, and 4000 volts for 4160-volt systems.
5. Unless otherwise required by the load, motors shall be NEMA Design B, normal starting torque. Locked rotor KVA/HP shall not exceed NEMA Code Letter G for motors 20 hp and larger.
6. Motor frame shall be a rigid structure, constructed to maintain the lamination in correct alignment, and shall not depend on lamination or bolts for rigidity.
7. Severe-duty totally-enclosed motors shall comply with IEEE 841.

B. Bearings:

1. Provide horizontal motors with rolling element (anti-friction) or sliding element (sleeve) type bearings. Use anti-friction type bearings for NEMA frame motors. Use sleeve type bearings when specified in the Section for the associated driven equipment.
2. Insulate the bearings for motors larger than 200 hp and for inverter-duty motors 100 hp and larger, to prevent shaft currents and related bearing damage.
3. Bearings for open drip-proof, TEFC, and explosion-proof motors shall be grease lubricated, ball type, unless specified otherwise in the Section for the associated driven equipment. Bearings shall have inlet fittings and outlet plugs. Protect bearings and grease reservoirs from entry of contaminants. Provide suitable fittings to allow convenient positive purging of old grease during re-greasing.
4. For horizontal motors with ratings up to and including 500 hp, or for motors with speeds up to and including 3600 rpm, anti-friction bearings furnished shall have a minimum L-10 bearing life of 100,000 hours as defined by the ABMA for direct-connected motors. Anti-friction bearings shall have a minimum L-10 bearing life of 50,000 hours for belted motors.
5. Sleeve bearings shall be ring-oiled with adequate, integral self-cooled oil reservoir. Bearing sleeves shall be lined with high tin content babbitt to minimize oil contamination. Close running shaft seals shall prevent oil leakage as well as prevent entrance of foreign material such as water and dirt into the bearing area. Provide oil level sight gauges with permanently-marked easily-discernible oil level. Provide inspection openings to observe the oil rings.
6. When specified in Section for the associated driven equipment or required by motor speed and bearing size, provision shall be made for forced lubrication. Provide oil rings and an adequate oil reservoir in bearing housings to allow orderly shutdown of motor in the event of failure of forced feed lubrication system.
7. Motors driven by VFDs shall be provided with a shaft grounding ring to prevent shaft frame voltages and currents that can damage motor bearings.

Provide shaft grounding ring on the drive end with an insulated bearing on the non-drive end of the motor.

C. Insulation:
1. Insulation systems shall be rated Class F, with a service factor of 1.15 times motor's nameplate horsepower rating when operated on a sine wave power supply, and a service factor of 1.00 on an adjustable frequency power supply. Temperature rise shall be limited to Class B insulation system when motor is operated continuously at rated horsepower with ambient temperature not exceeding 40 degrees C, unless specified otherwise in the Section for the associated driven equipment.
2. Windings shall be epoxy-coated. Treat windings with insulating compound suitable for protecting against moisture, salt air, and slightly acidic and alkaline conditions. Insulation system for enclosed motors shall be upgraded to increase moisture resistance.
3. Motors for outdoor service and all motors larger than 200 hp shall have vacuum/pressure-impregnated epoxy insulation (VPI) for moisture resistance. Motors shall be preheated before VPI and baked in temperature-controlled oven.
4. Stator windings and end turn connections shall be fully brazed to withstand full voltage starting, regardless of the starting method indicated in the Section for the associated driven equipment. Bracing system shall essentially eliminate coil vibration under the high-current conditions of starting as well as during normal operation. When a tied system is used, system shall be such that no tie depends on the integrity of another tie within the system.

D. Enclosures:
1. Enclosure types shall be the following:
   a. Totally enclosed fan cooled (TEFC) and totally enclosed non-ventilated motors (TENV) shall have cast-iron frame, cast-iron end brackets, and cast-iron conduit box. Provide drain holes on each end of motor.
2. Motor Terminal Box:
   a. Box shall be split from top to bottom and shall be capable of being rotated to four positions 90 degrees apart.
   b. Box shall be gasketed with rubber-like gaskets between frame and conduit box and between conduit box and conduit box cover.
   c. Provide box or opening in motor housing with conduit hub type fitting to allow threaded conduit connections.
   d. Minimum terminal box sizes shall be in accordance with NEMA MG-1 requirements and shall accommodate all requirements specified herein.
   e. Protective and auxiliary devices shall terminate in auxiliary conduit boxes.
   f. Terminal leads shall be flexible and of sufficient length to extend for distance of not less than ten inches beyond face of terminal box. Terminal leads shall be fitted with solderless lugs suitable for attachment to lugs installed on external wiring. Leads shall be sealed with non-wicking, non-hygroscopic insulating material, or insulating “wrap-cap”

as manufactured by Ideal Industries, or equal.

g. Provide motor frame grounding stud inside conduit box. Stud shall include a drilled and tapped hole.

E. Lifting Eyes: Motors weighing more than 50 pounds shall include at least one lifting eye or lifting lug. Construct motor and lifting eyes or lifting lugs to bear motor's full weight.

2.6 ACCESSORIES

A. Space Heater:

1. Provide space heaters within motor for condensation prevention. Space heater wattage shall maintain motor interior above dew point temperature at all times. Space heaters shall be low-density type for low surface temperature and long service life. Space heaters shall operate on 120 volts, single phase power.

B. Winding Thermostats:

1. Provide thermostat type winding thermal protection for motors. Thermostats shall be bi-metal disk or rod type embedded in the stator windings. Thermostat contacts shall be normally-closed opening on excessive temperature, automatic-reset type, rated 120 VAC, five amps minimum. Provide each motor with one thermostat in each phase and wired to the motor junction box.

2.7 NAMEPLATES

A. Nameplates shall be stainless steel with engraved or embossed lettering and shall be fastened to the motor frame with Type 316 stainless steel pins. Nameplates shall contain the following information:

1. Motor manufacturer’s name.
2. Motor manufacturer type designation.
3. Serial number.
4. Frame designation.
5. Enclosure.
6. Voltage.
7. Phase.
8 Hertz.
9. RPM.
10. Maximum Ambient Temperature.
11. Duty.
12. Insulation class.
13. Horsepower.
14. Full load (FL) amps.
15. Service factor (SF) amps.
16. NEMA nominal efficiency.
17. Guaranteed efficiency.
18. NEMA design letter.
19. NEMA code letter.

20. Nominal power factor.
21. FL Kilowatt.
22. Max Capacitor KVAR.
23. FL torque.

B. Dual-voltage motor nameplates shall include connection diagrams.

2.8 SOURCE QUALITY CONTROL

A. Factory Tests:
1. Perform factory testing on the specific motors provided for this project at the manufacturer's facility. Factory testing shall be in accordance with NEMA MG-1 and IEEE Standard 112 and shall demonstrate that the motors tested comply with the Contract Documents.
2. Submit factory test reports identifying tests performed and results obtained.
3. Motors shall be given a Routine Test in accordance with NEMA MG 1 and IEEE Standard 112 that consists of the following:
   a. Measurement of winding resistance.
   b. No-load readings of current and speed at normal voltage and frequency.
   c. Current input at rated frequency with rotor at standstill for squirrel-cage motors (locked rotor amperes).
   d. High potential test.
   e. Bearing inspection.
   f. Sound level measurements under load conditions.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General:
1. Install motors in accordance with the Contract Documents and manufacturer's instructions and recommendations. Obtain written interpretation from ENGINEER in the event of conflict between manufacturer's instructions and recommendations and the Contract Documents.
2. Install in accordance with Laws and Regulations.
3. Do not modify structures to facilitate installation of motors, unless approved in writing by ENGINEER.
4. Carefully and properly align motors with the driven equipment.
5. Secure motors to mounting surfaces with anchorage devices complying with manufacturer's recommendations that are of sufficient size and quantity to secure motor to equipment.
6. Until start-up and operation, tightly cover and protect motors from dirt, water, and chemical and mechanical damage.

3.2 FIELD QUALITY CONTROL

A. Site Tests:
   1. Inspect motors prior to supplying electricity to (energizing) equipment. Do not energize equipment without ENGINEER's permission. Inspections shall include the following:
      a. Inspect motor and equipment for physical damage.
      b. Inspect motor for proper anchorage, mounting, grounding, connection, and lubrication.
      c. Check for unusual noise and indications of overheating during initial or test operation.

+ + END OF SECTION + +

SECTION 40 42 00

INSULATION OF PROCESS PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, material, equipment and incidentals as shown, specified and required to furnish and install insulation for the process piping systems indicated below:
      a. FOG piping.
      b. Plant Service Water piping.
      c. All unions, valves and fittings as indicated in the drawings.
   2. Systems above will be also heat traced according to Section 26 51 00 – Heat Tracing.

B. Coordination:

   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the insulation of process piping Work.

C. Related Sections:

   1. Section 26 51 00 – Heat Tracing.
   2. Division 40, Applicable Sections on Pipe Valves

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Society for Testing and Materials, (ASTM).
   2. Federal Specifications, (FS).
      a. FS HH-1-558B, Insulation Blocks, Boards, Blankets, Felts, Sleeving, Pipe Fitting Covering.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience of producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:

1. Obtain all components included in this Section, regardless of the component manufacturer, from a single insulation of process piping manufacturer.
2. The insulation of process piping manufacturer shall review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the insulation of process piping manufacturer.

C. Regulatory Requirements: Comply with applicable provisions and recommendations of the following, except as otherwise shown or specified.
1. National Fire Protection Association, (NFPA).
2. Underwriters' Laboratories, Inc., (UL). Fire hazard ratings to be verified by Underwriters' Laboratories, Inc. label or listing or a certified test report from an approved independent testing laboratory.
3. Local and State Building Codes and Ordinances:
   a. Uniform Building Code
   b. Uniform Mechanical Code.
   c. Model Energy Code.
4. Permits: CONTRACTOR shall obtain and pay for all required permits, fees, inspections and approvals by authorities having jurisdiction.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
1. Product Data:
   a. Manufacturers' catalog literature, specifications, and illustrations with the following information:
   b. Thermal properties.
   c. Physical properties.
   d. Fire hazard ratings.
   e. Facing information.
   f. Installation instructions.

2. Samples:
   a. Fiberglass insulation.
   b. Weatherproof insulation.

B. Informational Submittals: Submit the following:
1. Supplier Instructions:
   a. Fabrication instructions for pipe fittings and valve insulation and coatings.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
1. Deliver materials to the Site to ensure uninterrupted progress of the Work.

Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

2. Material shall be packed and shipped in corrugated carton.

B. Storage and Protection:
1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.
2. Store all materials in covered storage off the ground and prevent condensation and in accordance with the manufacturer's recommendations for long-term storage.
3. Store material in clean, dry area, out of the weather.
4. Material shall be tightly covered to protect against dirt, water, mechanical injury or chemical damage.
5. Material shall remain in original cartons until time of installation.

C. Acceptance at Site:
1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 DESIGN CRITERIA

A. Insulation systems including covering, mastics, adhesives, sealers and facings shall have the following fire hazard classifications:
1. Flame Spread: 25 maximum.
2. Fuel Contributed: 50 maximum.
3. Smoke Developed: 50 maximum.

2.2 MATERIALS

A. Fiberglass Insulation:
1. Type: Heavy-density sectional pipe insulation with vapor barrier and self-sealing lap.
2. Density: Four pounds per cubic foot.
3. R-Value Minimum: 4.0 hr.-ft^2-°F/BTU.
4. Fittings: Molded fiberglass.
5. Jointing Materials: Manufacturer’s recommended adhesives and tape.
6. Valve Insulation: Miter cut nesting size covering segments of same thickness as pipeline, for insulation of valves.
7. Products and Manufacturers: Provide one of the following:
   a. Owens Corning Fiberglass Corporation, Fiberglass 25ASJ/SSL.
   b. Certain-Teed Products Corporation, Certain Teed snap-on ASJ-SSL.

c. Or equal.

B. Weatherproof Insulation Jacket (for insulated pipes located outdoor exposed to outside ambient conditions):
1. Type: Smooth embossed aluminum metal jacket.
2. Thickness: 0.016-inches.
3. Moisture Barrier: Polycraft.
4. Fastening: Pre-formed "Z"-lock seam with 2-inch butt strap with sealant.
5. Bands: 1/2-inch aluminum bands with wing seals.
6. Fittings:
   a. Type: Pre-fabricated aluminum fittings.
   b. Thickness: 0.016-inches.
7. Manufacturers: Provide products of one of the following:
   a. Certain-Teed Products Corporation.
   b. Childers Products Company, Lock-On and Slip-On.
   c. Or equal.

2.3 SOURCE QUALITY CONTROL

A. Source Quality Control: Perform the following tests and inspections at the factory:
1. Flame spread.
2. Smoke developed.
3. Fuel contributed.

PART 3 - EXECUTION

3.1 INSPECTION

A. Ensure that surfaces of all pipes, valves, and fittings are clean and dry before applying insulation.

3.2 PREPARATION

A. Ensure that piping has been tested, inspected and released for application of insulation.

3.3 INSTALLATION

A. Pipe insulation shall be continuous through walls and floor openings.

B. Where hangers are in direct contact with piping the hanger and supporting rod shall be wrapped with foil-faced blanket insulation and vapor sealed. Hanger rod insulation and vapor barrier shall extend up to the rod a minimum distance equal to the diameter of the pipe.

C. Install insulation so as to make surfaces smooth, even, and substantially flush with adjacent insulation.

D. Follow manufacturer's application instructions for all materials used.

E. Provide insulation protection shields for insulated piping supported by pipe hangers.

F. Install and coat insulation in accordance with the manufacturer's recommendations.

G. Weatherproofing for Outdoor Pipe Insulation:
   1. Piping: Apply field applied jacket with moisture barrier around pipe or equipment and slip edge into preformed Z lock position to shed water. Butt next jacket section leaving approximately 3/8-inch gap. Place preformed 2-inch butt strap with sealant over the seam and secure with 1/2-inch aluminum band and wing seal.
   2. Fittings: Apply prefabricated metal fittings identical in composition to pipe jacketing.

3.4 FIELD QUALITY CONTROL

A. Ensure that insulation is dry when installed, and before and during application of any finish.

B. Protection:
   1. All material applied in one day shall have the vapor barrier applied the same day and any exposed ends shall be temporarily protected with a moisture barrier and sealed to the pipe.

3.5 SCHEDULE

A. Refer to Schedule below for minimum thickness of pipe insulation:

Pipe Size (inches)	Minimum Insulation Thickness (inches)
1/2 thru 1:	1 with weatherproof jacket
1-1/4 thru 4:	1-1/2 with weatherproof jacket

+ + END OF SECTION + +

SECTION 40 61 13

PROCESS CONTROL SYSTEM GENERAL PROVISIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment, and incidentals as shown, specified, and required to furnish, install, calibrate, test, start-up and place in satisfactory operation a complete process control system (PCS).
   2. The process instrumentation and control Work includes, but is not limited to, the following:
      a. Panels and panel-mounted instruments and devices.
      b. Field-mounted instruments and devices.
      c. Programmable logic controller (PLC) hardware and wiring within existing control panel.

B. PCS shall monitor, store, display, and log process and equipment operating information; perform various process control functions; and generate various reports.

C. The Contract Documents describe the required PCS and PCS functions and operational requirements.

D. Coordination:
   1. Process Controls:
      a. An existing Rockwell Automation CompactLogix PLC currently controls nearby processes (DCU-9A). This PLC shall be modified as part of this Contract to control the FOG system. Instruments and controls (I&C) Work under this Contract shall, as part of the Work, be interfaced with PLC. Programming of control logic and configuration of the human machine interface (HMI) software is part of the Work. Process control description of process system and its associated equipment is included in Section 40 61 96, Process Control Descriptions.
      b. Coordinate with Suppliers of panels and equipment to provide fully functional system complying with the Contract Documents and that interfaces with the existing PLC.
      c. PLC input/output list identifies inputs and outputs required and is part of this Division. Use input/output list for coordinating signals between equipment provided under this and other contracts. Include Work for

CONTRACTOR-furnished control options not on the input/output list at no additional cost to OWNER.

1. To centralize responsibility, I&C materials and equipment provided under this Contact shall be furnished by a single Supplier.
2. With CONTRACTOR, Supplier shall assume the responsibility for adequacy and performance of materials and equipment provided under this Section.
3. Modifications to the existing PLC control section, DCU-9A, shall be performed by the City's selected integrator. This includes modifications to the PLC program and SCADA screens and database configuration. **Currently, this City's selected integrator is Prime Controls, 972-221-4849**.
4. Supplier's Responsibilities:
   a. Preparing all process control equipment submittals in accordance with the Contract Documents.
   b. Proper interfacing of instrumentation and control equipment with field equipment, instruments, devices, and panels, including required interfacing with packaged control systems furnished by other equipment Suppliers, and required interfacing with the Site's electrical system.
   c. Review and coordination with manufacturers, other Suppliers, and other contracts of Shop Drawings and other CONTRACTOR submittals for equipment, valves, piping, and appurtenances for ensuring proper interfacing of hardware, and locations and installation requirements of inline devices and instrument taps.
   d. Direct, detailed oversight of installation of instruments, panels, consoles, cabinets, wiring and other components, and related wiring and piping connections.
   e. Calibrating, source quality control, field quality control, and start-up of the system.
   f. Responsibility for correction period obligations for the PCS.
   g. Training operations and maintenance personnel in operation and maintenance (including calibration and troubleshooting) of the PCS.

E. Related Sections:
1. Section 01 75 11 Checkout and Startup Procedures
2. Section 01 79 23 Instructions of Operations and Maintenance Personnel
3. Section 40 61 23, Process Control System Start-up and Field Testing
4. Section 40 61 26, Process Control System Training.
5. Section 40 61 93, Process Control System Input-Output List.
6. Section 40 61 96, Process Control Descriptions
7. Section 40 64 00, Programmable Logic Controllers.
8. Section 40 67 17, Process Control Panels and Enclosures.
9. Section 40 70 05, Primary Sensors and Field Instruments
10. Section 40 78 00, Panel Mounted Instruments and Devices.

1.2 REFERENCES

A. Standards referenced in this Section are:
   1. ANSI/ASQ Z1.4, Sampling Procedures and Tables For Inspection By Attributes.
   2. ISA 5.4, Instrument Loop Diagrams.
   3. ISA 20, Specification Forms for Process Measurement & Control Instruments, Primary Elements & Control Valves.
   4. NFPA 79, Electrical Standard for Industrial Machinery.

1.3 QUALITY ASSURANCE

A. Qualifications:
   1. Supplier:
      a. Shall be financially sound with at least five years of continuous experience in designing, implementing, supplying, and supporting process control systems for municipal wastewater treatment facilities comparable to PCS required for the Project, relative to hardware, software, cost, and complexity.
      b. Shall have record of successful process control system equipment installations. Upon ENGINEER's request, submit record of experience for at least five projects, each with the following information: project name, owner name and contact information, name and contact information for contractor, name and contact information for engineer or architect, approximate and contract value of process control systems Work for which Supplier was responsible,
      c. Shall have at time of Bid experienced engineering and technical staff capable of designing, supplying, implementing, and supporting the instrument and control system and complying with submittal and training requirements of the Contract Documents.
      d. Shall be capable of training operations and maintenance personnel in PCS applications, and in operating, programming, and maintaining the control system and equipment.
      e. Shall have UL-approved panel shop.
      f. Supply and support system hardware components and software packages of fully developed and field-proven standardized designs that are not a highly unique, custom, or one-of-a-kind systems.
      g. Possess a thorough, working knowledge of wastewater treatment processes and control philosophy in accordance with standard practices of the wastewater treatment industry.
      h. Possess and maintain a documented program of failure analysis.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Shop Drawings:
      a. Field Instruments:
         1) Manufacturer's product name and complete model number of devices proposed for use, including manufacturer's name and address.
         2) Instrument tag number in accordance with the Contract Documents.
         3) Data sheets and manufacturer's catalog literature. Provide data sheets in accordance with ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets using a format similar to ISA 20.
         4) Description of construction features.
         5) Performance and operation data.
         6) Installation, mounting, and calibration details; instructions and recommendations.
         7) Service requirements.
         8) Dimensions of instruments and details of mating flanges and locations of closed tanks, pipe sizes for insertion instruments, and upstream/downstream straight run pipe lengths required.
         9) Range of each device and calibration information
         10) Descriptions of materials of construction and listing of NEMA/UL Type ratings for equipment.
      b. Panels, Consoles, and Cabinets:
         Layout drawings that include:
            a) Front, rear, and internal panel views to scale.
            b) Tag number and functional name of components mounted in and on panel, console, or cabinet, as applicable.
            c) Product information on panel components.
            d) Nameplate location and legend including text, letter size and colors to be used.
            e) Location of anchorage connections.
            f) Location of external wiring and piping connections.
            g) Mounting and installation details, coordinated with actual application.
            h) Proposed layouts and sizes of operator interface graphic display panels and alarm annunciator panels.
            i) Calculations substantiating panel heating and cooling provisions proposed.
            j) Subpanel layouts and mounting details for items located inside control panels.
         2) Product information on panel components including:

a) Manufacturer's product name and complete model number of devices being provided, including manufacturer's name and address.
b) Instrument tag number in accordance with the Contract Documents.
c) Data sheets and catalog literature. Submit data sheets as shown in ISA 20 and annotated for features proposed for use. For instruments not included in ISA 20, submit data sheets with format similar to ISA 20.
d) Description of construction features.
e) Performance and operation data.
f) Installation, mounting, and calibration details; instructions and recommendations.
g) Service requirements

3) Wiring and piping diagrams, including the following:
a) Name of each panel, console, or cabinet.
b) Wire sizes and types.
c) Pipe sizes and types.
d) Terminal strip and terminal numbers.
e) Wire color coding.
f) Functional name and manufacturer's designation for components to which wiring and piping are connected.
g) Lightning and surge protection grounding.

4) Electrical control schematics in accordance with NFPA 79. Control schematics shall be in accordance with convention indicated in Annex D of NFPA 79. Standardized wiring diagrams that do not accurately reflect actual wiring to be furnished are unacceptable. Tables or charts for describing wire numbers are unacceptable.

5) Stock list or bill of materials for each panel including tag number, functional name, manufacturer's name, model number and quantity for components mounted in or on the panel or enclosure.

6) Detail showing anchorage plan of wire bundles between subpanels and front panel mounted devices.

c. Field wiring and piping diagrams, include the following:
1) Wire and pipe sizes and types.
2) Terminal numbers at field devices and in panels.
3) Color coding.
4) Conduit numbers in which wiring will be located.
5) Locations, functional names, and manufacturer's designations of items to which wiring or piping are connected.

d. Supervisory Control and Data Acquisition System:
1) Submit the following general information:
a) Control and failure modes.

b) Input/Output Information:
   (1) Input/output (I/O) point listing with I/O module cross-reference identification.
   (2) I/O module cross-reference identification based on I/O address list developed by I&C Subcontractor.
c) Database listing, including all I/O points.
d) Suggested detailed format and configuration of log reports, alarm summaries, printer outputs, displays, and graphics.

2) Hardware: (Not Applicable)
3) Software: (Not Applicable)
4) System I/O Loop Wiring Diagrams (modified):
   a) Rack numbers, module type and slot number, and module terminal point numbers. Include location and identification of intermediate panel and field terminal blocks and terminal numbers to which I/O wiring and power supply wiring is connected. Identify power supply circuits with designation numbers and ratings.
   b) Wiring types, wire numbers, and color coding.
   c) Designation of conduits in which field I/O wiring will be installed.
   d) Location, functional name, tag numbers and manufacturer's module numbers of panel and field devices and instruments to which I/O wiring will be connected.
   e) Prepare loop wiring diagrams in accordance with ISA 5.4.

e. Complete point-to-point interconnection wiring diagrams of field wiring associated with the system. Diagrams shall include the following:
   1) Field wiring between each equipment item, panel, instruments, and other devices, and wiring to control stations, panelboards, and motor starters. Some of this equipment may be specified in other Divisions. CONTRACTOR is responsible for providing complete point-to-point interconnection wiring diagrams for control and monitoring of that equipment.
   2) Numbered terminal block and terminal identification for each wire termination.
   3) Identification of assigned wire numbers for interconnections. Assign each wire a unique number.
   4) Schedule showing the wiring numbers and the conduit number in which the numbered wire is installed.
   5) Junction and pull boxes through which wiring will be routed.
   6) Identification of equipment in accordance with the Contract Documents.

2. Product Data:

a. Product data for field instruments in accordance with requirements for Shop Drawings in this Section.
b. Product data for panels, consoles, and cabinets in accordance with requirements for Shop Drawings in this Section.
c. Product data for field wiring and piping provided for instrumentation and control service and not included under other Sections or contracts.

3. Samples:
   a. Color charts for finish paint for metallic panels. Provide full range of paint manufacturer's standard and custom colors. Color selection will be by ENGINEER.
   b. Color charts for fiberglass-reinforced panels. Provide full range of panel manufacturer's standard and custom colors. Color selection will be by ENGINEER.

B. Factory Acceptance Test Procedure: (Not Applicable)

C. Closeout Submittals: Submit the following:
   1. Operations and Maintenance Data:
      a. Submit in accordance with Section 01 78 23, Operation and Maintenance Data.
      b. Include complete up-to-date system software documentation. Provide hardcopy and electronic copies.
   2. Record Documentation:
      a. Prepare and submit record documents in accordance with Section 01 78 39, Project Record Documents.
      b. Revise all PCS Shop Drawings to reflect as-built conditions in accordance with the following.
         1) Use "as-built" updates of approved Shop Drawings and submittals in operation and maintenance manuals.
         2) Half-size black line prints of wiring diagrams applicable to each control panel shall be placed in clear plastic envelopes inside a suitable print pocket or container inside each control panel.
         3) Submit drawings of the point-to-point interconnection wiring diagrams updated to reflect final as-built equipment information and as-installed field installation information.

D. Maintenance Materials Submittals: Submit the following:
   1. Spare Parts and Test Equipment
      a. General
         1) Furnish the spare parts and test equipment in accordance with the Contract Documents, identical to and interchangeable with similar materials and equipment provided for the PCS under the Contract.
         2) Provide source quality control for spare parts as part of factory testing prior to shipment of process control system equipment.

3) For process sensors and other analog instruments, Supplier shall submit a separate quotation for recommended list of spare parts and test equipment. Separately list and price each item recommended. Spare parts quotation shall include a statement that prices quoted are valid for a period of one year from date of equipment installation and that Supplier understands that OWNER reserves the right to purchase none, any, or all parts quoted. Upon request, Supplier shall submit documentation that stock of spare parts and test equipment is obtainable within 48 hours of receipt of OWNER's order.

b. Furnish the following spare parts:

1) Twelve of each type and size of fuse used in instruments.

2. Furnish the following test equipment: (Not Applicable)
3. Software:

a. Submit copies of programming and configuration files developed specifically for the Project in accordance with Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Prior to packaging, each manufacturer or Supplier shall securely attach tag number and instructions for proper field handling and installation to each instrument.

PART 2 - PRODUCTS

2.1 PCS – GENERAL PROVISIONS FOR PRODUCTS

A. General:

1. All electrically-powered equipment and devices shall be suitable for operation on 115-volt plus-or-minus 10 percent, 60 Hertz plus-or-minus two Hertz power, unless otherwise indicated on the P&ID Drawings. If different voltage or closer regulation is required, provide suitable regulator or transformer.
2. Provide appropriate power supplies for all two-wire transmitters, loops for monitoring discrete inputs and necessary outputs. Install power supplies mounted in enclosures, and install in appropriate control room or field panel.
3. Power supplies shall be suitable for minimum of 130 percent of the maximum simultaneous current draw.
4. Provide power on-off switch or air circuit breaker for each item requiring electrical power.
5. Provide isolation transformers, line voltage regulators and power distribution panels for the distributed digital portions of the PCS to eliminate electrical noise and/or transients entering on the primary power line.

6. Unless otherwise shown or indicated in the Contract Documents, control system shall be furnished to use 4 to 20 mADC analog signals.
7. Provide signal converters and repeaters where required. Analog inputs to distributed control system shall be through appropriate repeaters to provide signal isolation where series-looped with other devices and to allow loop to maintain integrity even when distributed control system is out of service. Power supplies shall adequate for signal converter and repeater loads.
8. Signals shall be isolated from ground.
9. Signals shall not have a transient DC voltage exceeding 300 volts over one millisecond nor a DC component over 300 volts.
10. PCS and associated input/output wiring will be used in a facility environment where there can be high-energy AC fields, DC control pulses, and varying ground potentials between the sensors/transducers or input contact locations and PCS components. PCS shall be adequate to provide proper protection against interferences from all such possible situations.
11. Instrumentation and PCS components shall be heavy-duty types, suitable for continuous service in a municipal wastewater treatment plant environment. Furnish products that are currently in production at the time products are shipped from the factory. All equipment furnished shall be of modular construction and be capable of field expansion through installation of plug-in circuit cards and additional cabinets as necessary. Logic and control loops shall be fail-safe.
12. Instrumentation and other PCS components shall return automatically to accurate measurement within 15 seconds upon restoration of power after a power failure, and when transferred to standby power supply.
13. Provide surge protection for instruments and all other PCS components that could be damaged by electrical surges.
14. Field-mounted instruments and PCS components shall be suitable for installation in humid and corrosive service conditions. Field-mounted instrument enclosures, junction boxes, and appurtenances shall comply with NEMA 4X requirements, unless otherwise shown or specified.
15. Relays with interconnections to field devices shall be wired through terminal blocks. Terminals as part of the relay base are unacceptable.
16. Panel mounted instruments, switches, and other devices shall be selected and arranged to present a pleasing coordinated appearance. Front-of-panel-mounted devices shall be of the same manufacturer and model line.
17. All components furnished, including field-mounted and rear-of-panel instruments, shall be tagged with the item number and nomenclature as shown and the instrument index in the Contract Documents or, as applicable, the "data sheets" that are part of the Contract Documents.
18. Ranges and scales specified in the Contract Documents shall be coordinated to suit equipment actually furnished. Range, scale, and set point values specified in other Sections of Division 40 are for initial setting and configuration.

Coordinate specified values with actual equipment furnished to implement proper and stable process action as systems are placed in operation.

19. Field-mounted devices shall be treated with an anti-fungus spray.
20. Field-mounted devices shall be protected from exposure to freezing temperatures.

B. Environmental Conditions:
   1. PCS and its components shall be designed and constructed for continuous operation under the following temperature and humidity conditions:
      a. Equipment and Devices Installed in Control Rooms:
         1) Ambient Temperature: 60°F to 80°F normal range; and 40°F to 105°F occasional maximum extremes.
         2) Relative Humidity: 80 percent, normal; 95 percent maximum.
      b. Equipment and devices installed at indoor locations (other than control rooms) for digital processing equipment hardware, control panels, and instruments:
         1) Ambient Temperature: 40°F to 120°F.
         2) Relative Humidity: 98 percent maximum.
      c. Equipment and Devices Installed Outdoors:
         1) Ambient Temperature: -10°F to 120°F.
         2) Relative Humidity: 100 percent maximum.

C. Refer to Sections 40 61 13 through 40 78 00 for product requirements for materials and equipment that are part of the PCS.

PART 3 - EXECUTION

3.1 PCS – GENERAL PROVISIONS FOR EXECUTION

A. Refer to Sections 40 61 13 through 40 78 00 for execution requirements for the PCS.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 40 61 23

PLANT MONITORING AND CONTROL SYSTEM START-UP AND FIELD TESTING

PART 1 - GENERAL

1.1 SYSTEM CHECK-OUT AND START-UP RESPONSIBILITIES

A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install all equipment and coordinate all activities necessary to perform check-out and start-up of the equipment.

B. CONTRACTOR shall retain the services of the Supplier to supervise and/or perform check-out and start-up of all system components. As part of these services, the system Supplier shall include for those equipment items not manufactured by him the services of an authorized manufacturers' representative to check the equipment installation and place the equipment in operation. The manufacturers' representative shall be thoroughly knowledgeable about the installation, operation and maintenance of the equipment.

1.2 SYSTEM CHECKOUT AND START-UP

A. CONTRACTOR, under the supervision of the PCS Supplier, and other instrument suppliers as applicable, shall perform the following:
   1. Check and approve the installation of all PCS components and all cable and wiring connections between the various system components prior to placing the various processes and equipment into operation.
   2. Conduct a complete system checkout and adjustment, including calibration of all instruments, tuning of control loops, checking operation functions, and testing of final control actions. When there are future operational functions included in this work, they should be included in the system checkout. All problems encountered shall be promptly corrected to prevent any delays in start-up of the various unit processes.

B. CONTRACTOR shall provide all test equipment necessary to perform the testing during system checkout and start-up.

C. CONTRACTOR and Supplier shall be responsible for initial operation of monitoring and control system and shall make any required changes, adjustment or replacements for operation, monitoring and control of the various processes and equipment necessary to perform the functions intended.

D. CONTRACTOR shall furnish to the ENGINEER certified calibration reports for field instruments and devices specified in Section 40 70 05, Primary Sensors and Field Instruments, and panel mounted devices specified in Section 40 78 00, Panel-Mounted Instruments and Devices, as soon as calibration is completed.

E. CONTRACTOR shall furnish ENGINEER an installation inspection report certifying that all equipment has been installed correctly and is operating properly. The report shall be signed by authorized representatives of both CONTRACTOR and the Supplier.

1.3 INTEGRATED SYSTEM FIELD TEST

A. Following the PCS checkout and initial operation, CONTRACTOR, under the supervision of the Supplier, shall perform a complete system test to verify that all equipment and programmed software is operating properly as a fully integrated system, and that the intended monitoring and control functions are fully implemented and operational. Any defects or problems found during the test shall be corrected by CONTRACTOR and then retested to demonstrate proper operation.

B. Following demonstration of all system functions, the PCS including field sensors/transducers and instruments shall be running and fully operational for a continuous 48 hour period. The Operational Availability Demonstration specified below shall not begin until the continuous 48 hour integrated system test has been successfully completed and OWNER and ENGINEER agree that the Operation Availability Demonstration can begin.

1.4 OPERATIONAL AVAILABILITY DEMONSTRATION

A. Operational Availability Demonstration (OAD) shall begin following completion of the integrated system field test as specified above and shall continue until a time frame has been achieved wherein the system (both hardware and software) availability meets or exceeds 99.7 percent for 30 consecutive days and no system failures have occurred which result in starting the OAD over again. During the OAD the system shall be available to plant operating personnel for use in normal operation of the plant.

B. For the purpose of the OAD, the system will be defined as consisting of the following systems and components:
   1. Programmable Logic Controller (PLC) and Human Machine Interface (HMI).

C. The conditions listed below shall constitute system failures which are considered critical to the operability and maintainability of the system. The OAD shall be

terminated if one or more of these conditions occur. Following correction of the problem, a new 60 consecutive day OAD shall begin.

1. Failure to repair a hardware or software problem within 120 consecutive hours from the time of notification of a system failure.
2. Recurrent hardware or software problems: if the same type of problem occurs three times or more.
3. Software problem causing a processor to halt execution.

D. The following conditions shall constitute a system failure in determining the system availability based on the equation specified in Paragraph 1.4.E., below:

1. Failure of Programmable Logic Controller (PLC) and Human Machine Interface (HMI).
2. Loss of communications between devices on the communications network.
3. Failure of one or more input/output components.
4. Failures of any type affecting ten or more input/output points simultaneously.
5. Failure of any type affecting one or more regulatory control loops or sequential control strategies thereby causing a loss of the automatic control of the process variable or process sequence operation.
6. Failure of power supply. Where redundant power supplies are provided, failure of one power supply shall not constitute a system failure provided the backup power supply operates properly and maintains supply power. Failure of the backup supply to operate properly and maintain supply power shall constitute a system failure.
7. Failure of three or more primary sensors/transducers or field instruments simultaneously.

E. The system availability shall be calculated based on the following equation:

$$A = \frac{TTO}{TTO + TTR} \times 100 \text{ percent}$$

where, A = system availability in percent

TTO = total time in operation
TTR = total time to repair

F. Time to repair shall be the period between the time that CONTRACTOR is notified of a system failure and the time that the system has been restored to proper operation in terms of hours with an allowance for the following dead times which shall not be counted as part of the time to repair period.

1. Actual travel time for service personnel to get to the Site up to six hours per incident from the time CONTRACTOR is notified of a system failure.
2. Time for receipt of spare parts to the plant site once requested up to 24 hours per incident. No work shall be done on the system while waiting for delivery of spare parts.
3. Dead time shall not be counted as part of the system available period. The dead time shall be logged and the duration of the OAD extended for an amount of time equal to the total dead time.

G. Completion of a 60 consecutive day period without any restarts of the OAD and with a system availability in excess of 99.7 percent will constitute acceptance of the PCS by OWNER.

H. All parts and maintenance materials required to repair the system prior to completion of the OAD shall be supplied by CONTRACTOR at no additional cost to OWNER. If parts are obtained from the required plant spare parts inventory, they shall be replaced to provide a full complement of parts as specified.

I. A Plant Control System Malfunction/Repair Reporting Form shall be completed by the plant personnel and ENGINEER to document system failures, to record CONTRACTOR notification, arrival and repair times and CONTRACTOR repair actions. Format of the form shall be developed and agreed upon prior to the start of the OAD.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 40 61 26

PROCESS CONTROL SYSTEM TRAINING

PART 1 - GENERAL

1.1 REQUIREMENTS AND RESPONSIBILITIES

A. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to perform and coordinate all required training at times acceptable to OWNER and ENGINEER.

B. CONTRACTOR shall retain the services of the Supplier to provide operation and maintenance training for all PCS equipment as specified herein.

C. For equipment items not manufactured by the Supplier, the Supplier shall provide for on-site training by an authorized representative of the equipment manufacturer as part of the Supplier's services. The manufacturer's representative shall be fully knowledgeable in the operation and maintenance of the equipment.

D. CONTRACTOR shall be responsible for all costs, including cost of travel, meals and lodging, if required, associated with training, both on-site and at the suppliers facilities, and shall provide all required materials, texts and required supplies. A total of five (5) will be attending training courses at the Supplier's facility.

E. All training shall be conducted in the normal eight-hour working days until conclusion of the training course. For training at the Supplier's facility, the course instructor shall be assigned full time and shall not perform other duties throughout the period of the course.

1.2 SUBMITTALS

A. Within 21 days of the effective date of the Notice to Proceed, CONTRACTOR shall submit his plan for training conforming to the requirements of Section 01 79 23, Instruction of Operations and Maintenance Personnel. Included in the plan shall be course outlines and schedules for training to be provided at the Supplier's facilities.

1.3 ON-SITE TRAINING

A. Primary Sensors/Transducers and Field Instruments:
   1. Provide on-site operation and maintenance training by Supplier and the equipment manufacturer representatives prior to placing the equipment in continuous operation, conforming to the requirements of Section 01 79 23, Instruction of Operations and Maintenance Personnel. The qualified equipment manufacturer’s representatives shall provide, as a minimum, the following operation and maintenance training:

a. Level Transmitter – Radar Type: Two (2) hours.
b. Coriolis Flow Meter: Two (2) hours.
c. Pressure Gauge: One (1) hour.
d. Pressure Switch: One (1) hour.

2. Training shall accomplish the following:
   a. Provide instruction covering use and operation of the equipment to perform the intended functions.
   b. Provide instruction covering procedures for routine, preventive and troubleshooting maintenance including equipment calibration.
   c. Explain procedures for placing the equipment in and out of operation and explain necessary actions and precautions to be taken regarding the overall plant monitoring and control system.

B. Training covering the control equipment:
   1. During the first thirty (30) days of continuous operation of the control panels, retain qualified representatives of the Supplier and equipment manufacturer to instruct on-site Owner personnel. The qualified representatives of the Supplier and equipment manufacturer shall provide, as a minimum, the following control panel training (including OITs where installed):
      a. Control Panels: 1 hour for each panel.
   2. Operator and maintenance training shall accomplish the following:
      a. Provide instruction covering the use and operation of the control panels and all items contained on or within the control panels.
      b. Provide instruction covering procedures for routine, preventative, and troubleshooting maintenance including device calibration.
      c. Explain procedures for placing the control panels in and out of operation.

C. PLC Training: (Not Applicable)

D. Training following two months of regular system operations: (Not Applicable)

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

+ + END OF SECTION + +

SECTION 40 61 93

PROCESS CONTROL SYSTEM INPUT/OUTPUT LIST

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. This Section describes the system input/output (I/O) list, which follows this Section and requirements for configuring the control system database.

B. Related Sections:
   1. Section 40 64 00, Programmable Logic Controllers.

C. The I/O list information is available from the ENGINEER on diskette. Allow 30 days from request to deliver this diskette.

1.2 SUBMITTALS

A. For each I/O attribute listed in the I/O list that cannot be used exactly as listed, submit an explanation of the reason for the deviation and propose a method to modify the I/O list information. Do not proceed with any configuration until a method of resolving deviations is accepted by the ENGINEER.

B. Include the control system I/O database information in the PLC specific submittals for Section 40 64 00, Programmable Logic Controllers.

1.3 I/O POINT LIST DESCRIPTION

A. The I/O point list contains the information necessary to configure the PLC I/O interface hardware and to indicate range conversion or signal functions.

B. “POINT NUMBER” is an alphanumeric character string.

C. “DESCRIPTION” is an alphanumeric character string up to 40 positions in length. Points described as “SPARE” denote pre-wired I/O.

D. “SIGNAL TYPE” is one of the following:
   1. AI designates an analog input.
   2. DI designates a discrete input.
   3. PI designates a pulse input.
   4. AO designates an analog output.
   5. DO designates a momentary, maintained or latched discrete output.

E. "DATA FIELD 1" and "DATA FIELD 2" describes the function or signal characteristics. These are further defined under each signal type.

F. "RELAY" is used only for discrete outputs to indicate the action of the contacts:
   1. "MO" designates momentary action.
   2. "MA" designates maintained action.

G. "ALARM" is used only for discrete inputs to distinguish between status inputs and alarm inputs.

1.4 SIGNAL TYPE DESCRIPTION

A. Analog Input:
   1. "DATA FIELD 1" is the electrical input signal range and units.
   2. "DATA FIELD 2" is the process parameter range and engineering unit.

B. Discrete Input:
   1. "DATA FIELD 1" is the condition that exists when a field contact is closed.
   2. "DATA FIELD 2" is the condition that exists when a field contact is open.

C. Pulse Input:
   1. "DATA FIELD 1" is the pulse frequency range.
   2. "DATA FIELD 2" is the process parameter range and engineering unit.

D. Analog Output:
   1. "DATA FIELD 1" is the electrical output signal and units.
   2. "DATA FIELD 2" is the range of the controlled variable and engineering units.

E. Discrete Output:
   1. Discrete outputs can be momentary or maintained.
   2. "DATA FIELD 1" is the contact closed function.
   3. "DATA FIELD 2" is the contact open function.

PART 2 - PRODUCTS (NOT USED)

PART 3 – EXECUTION

3.1 I/O CONFIGURATION

A. Implement the control system database fields in a consistent manner by using the following procedures:

1. Use abbreviations and acronyms already established in the Contract Documents. In particular, use the information in the I/O Point List.
2. Use only abbreviation or acronym for a word or group of words, respectively.
3. Use the same subject and word order within data fields.
4. Use the same term (either phrase, word or acronym) to denote the same meaning. Do not use multiple terms for a single meaning.
5. Use the point names, descriptions, logic state descriptions, ranges and units of measurement exactly the same wherever the point is referenced.
6. Show point names and descriptions for all point references on documentation.
7. Spell correctly.
8. Maintain lists of acronyms and abbreviations used.

3.2 I/O HARDWARE CONFIGURATION

A. Partition the I/O among cards within an I/O enclosure to provide control loop integrity.
   1. Put all inputs of the same I/O type associated with a device (e.g. pump, blower, clarifier or other piece of equipment) on the same card.
   2. Put all inputs of the same I/O type for devices arranged in process trains (e.g. a pump, its inlet valve and its outlet valve, or a pump and its associated macerator) on the same card or cards if more than one card is required to accommodate the points.
   3. Put all outputs of the same I/O type associated with a device or group of devices in a process train on the same card or cards if more than one card is required to accommodate the points.
   4. Where the preceding requirements specified in this paragraph would cause more than 20 percent spare points on a card, points for a device or process train may be split between two consecutive cards.
   5. Make unused terminals resulting from partitioning the I/O into pre-wired spares. Provide pre-wired spare points with all cabling and termination internal to the DCU as done for other I/O points.

3.3 POINT DATA FIELDS

A. I/O point data fields may be subject to review and modification by the ENGINEER during the Shop Drawing review phase. Incorporate changes directed by the ENGINEER completely into the entire system, at no additional cost to OWNER, subject to the following limitations:
   1. Limit the total number of modifications to 20 percent of the total number of I/O points.
   2. Each unique change will count as one modification. For example, modifying the description, range, and engineering unit on an analog input count as three modifications.
   3. Analog input alarm limit definition will not be counted as a modification.

3.4 INPUT/OUTPUT TAGGING

A. Each tag number shall be written as identified on P&ID Drawings.

+ + END OF SECTION + +

Tag No	Description	P&ID Ref	RIO	Rack	Slot	Point No.	WRF	CARD	Term. Block	Term. Block
	CONTROLLER		DCU-9A	0	0			AB 1756-L73		
	ETHERNET		DCU-9A	0	1			AB 1756-EN2T		
MXSLDG_MX8060_YA	BLENDING TANK MIXER FAIL		DCU-9A	0	2	0		AB 1756-IA16		
MXSLDG_M8060_ON	BLENDING TANK MIXER RUNNING		DCU-9A	0	2	1		AB 1756-IA16		
MXSLDG_M8011_PSL	DIGESTER FEED PUMP #1 LOW SUCTION PRESSURE		DCU-9A	0	2	2		AB 1756-IA16		
MXSLDG_M8011_PSH	DIGESTER FEED PUMP #1 HIGH DISCHARGE PRESSURE		DCU-9A	0	2	3		AB 1756-IA16		
MXSLDG_M8011-TSH	DIGESTER FEED PUMP #1 HIGH TEMP		DCU-9A	0	2	4		AB 1756-IA16		
MXSLDG_M8011_YA	DIGESTER FEED PUMP #1 FAIL		DCU-9A	0	2	5		AB 1756-IA16		
MXSLDG_M8011_ON	DIGESTER FEED PUMP #1		DCU-9A	0	2	6		AB 1756-IA16		
MXSLDG_M8021_PSL	DIGESTER FEED PUMP #2 LOW SUCTION PRESSURE		DCU-9A	0	2	7		AB 1756-IA16		
MXSLDG_M8021_PSH	DIGESTER FEED PUMP #2 HIGH DISCHARGE PRESSURE		DCU-9A	0	2	8		AB 1756-IA16		
MXSLDG_M8021_TSH	DIGESTER FEED PUMP #2 HIGH TEMP		DCU-9A	0	2	9		AB 1756-IA16		
MXSLDG_M8021_YA	DIGESTER FEED PUMP #2 FAIL		DCU-9A	0	2	10		AB 1756-IA16		
MXSLDG_M8021_ON	DIGESTER FEED PUMP #2 RUNNING		DCU-9A	0	2	11		AB 1756-IA16		
MXSLDG_M8031_PSL	DIGESTER FEED PUMP #3 LOW SUCTION PRESSURE		DCU-9A	0	2	12		AB 1756-IA16		
MXSLDG_M8031_PSH	DIGESTER FEED PUMP #3 HIGH DISCHARGE PRESSURE		DCU-9A	0	2	13		AB 1756-IA16		
MXSLDG_M8031_TSH	DIGESTER FEED PUMP #3 HIGH TEMP		DCU-9A	0	2	14		AB 1756-IA16		
MXSLDG_M8031_YA	DIGESTER FEED PUMP #3 FAIL		DCU-9A	0	2	15		AB 1756-IA16		
MXSLDG_M8031_ON	DIGESTER FEED PUMP #3 RUNNING		DCU-9A	0	3	0		AB 1756-IA16		
MXSLDG_M8041_PSL	DIGESTER FEED PUMP #4 LOW SUCTION PRESSURE		DCU-9A	0	3	1		AB 1756-IA16		
MXSLDG_M8041_PSH	DIGESTER FEED PUMP #4 HIGH DISCHARGE PRESSURE		DCU-9A	0	3	2		AB 1756-IA16		
MXSLDG_M8041-TSH	DIGESTER FEED PUMP #4 HIGH TEMP		DCU-9A	0	3	3		AB 1756-IA16		
MXSLDG_M8041_YA	DIGESTER FEED PUMP #4 FAIL		DCU-9A	0	3	4		AB 1756-IA16		
MXSLDG_M8041_ON	DIGESTER FEED PUMP #4 RUNNING		DCU-9A	0	3	5		AB 1756-IA16		
MXSLDG_CMP8075_ALM	INSTRUMENT AIR LOW COMPRESSOR FAIL		DCU-9A	0	3	6		AB 1756-IA16		
MXSLDG_871_PSL	INSTRUMENT AIR LOW PRESSURE		DCU-9A	0	3	7		AB 1756-IA16		
	GRINDER RUNNING	I-03	DCU-9A	0	3	8		AB 1756-IA16		
	GRINDER FAULT	I-03	DCU-9A	0	3	9		AB 1756-IA16		
	GRINDER MOTOR HIGH TEMP	I-03	DCU-9A	0	3	10		AB 1756-IA16		
	FOG RECEIVING TANK LEVEL ALARM HIGH-HIGH	I-03	DCU-9A	0	3	11		AB 1756-IA16		
	FOG RECEIVING TANK LEVEL ALARM LOW-LOW	I-03	DCU-9A	0	3	12		AB 1756-IA16		
	GRINDER JAM	I-03	DCU-9A	0	3	13		AB 1756-IA16		
	SPARE		DCU-9A	0	3	14		AB 1756-IA16		
	UNLOAD/MIX PUMP NO.1 MOTOR HIGH TEMPERATURE	I-03	DCU-9A	0	3	15		AB 1756-IA16		
	UNLOAD/MIX PUMP NO.1 RUNNING	I-03	DCU-9A	0	4	0		AB 1756-IA16		
	UNLOAD/MIX PUMP NO.1 OVERLOAD	I-03	DCU-9A	0	4	1		AB 1756-IA16		
	UNLOAD/MIX PUMP NO.1 HIGH PRESSURE	I-03	DCU-9A	0	4	2		AB 1756-IA16		
	UNLOAD/MIX PUMP NO.1 IN REMOTE	I-03	DCU-9A	0	4	3		AB 1756-IA16		
	UNLOAD/MIX PUMP NO.1 ESTOP	I-03	DCU-9A	0	4	4		AB 1756-IA16		

Tag No	Description	P&ID Ref	RIO	Rack	Slot	Point No.	WRF	CARD	Term. Block	Term. Block
	METERING PUMP NO.1 RUNNING	I-04	DCU-9A	0	4	5		AB 1756-IA16		
	METERING PUMP NO.1 VFD FAULT	I-04	DCU-9A	0	4	6		AB 1756-IA16		
	METERING PUMP NO.1 HIGH PRESSURE	I-04	DCU-9A	0	4	7		AB 1756-IA16		
	METERING PUMP NO.1 IN REMOTE	I-04	DCU-9A	0	4	8		AB 1756-IA16		
	METERING PUMP NO.1 ESTOP	I-04	DCU-9A	0	4	9		AB 1756-IA16		
DCU9A_INTRUSTION	ENCLOSURE DOOR OPEN		DCU-9A	0	4	10		AB 1756-IA16		
DC9A_LINE_PWR	NOT ON UPS POWER ALARM		DCU-9A	0	4	11		AB 1756-IA16		
DCU09A_PWR_FAIL	UPS ON BATTERY		DCU-9A	0	4	12		AB 1756-IA16		
DCU09_UPS_LOBATT	UPS LOW BATTERY		DCU-9A	0	4	13		AB 1756-IA16		
DCU09A_UPS_OL	UPS OVERLOADED		DCU-9A	0	4	14		AB 1756-IA16		
DCU09A_UPS_YA	UPS FAULT		DCU-9A	0	4	15		AB 1756-IA16		
	UNLOAD/MIX PUMP NO.2 RUNNING	I-03	**DCU-9A**	**0**	**5**	**0**		**AB 1756-IA16**		
	UNLOAD/MIX PUMP NO.2 OVERLOAD	I-03	**DCU-9A**	**0**	**5**	**1**		**AB 1756-IA16**		
	UNLOAD/MIX PUMP NO.2 HIGH PRESSURE	I-03	**DCU-9A**	**0**	**5**	**2**		**AB 1756-IA16**		
	UNLOAD/MIX PUMP NO.2 IN REMOTE	I-03	**DCU-9A**	**0**	**5**	**3**		**AB 1756-IA16**		
	UNLOAD/MIX PUMP NO.2 ESTOP	I-03	**DCU-9A**	**0**	**5**	**4**		**AB 1756-IA16**		
	UNLOAD/MIX PUMP NO.2 MOTOR HIGH TEMPERATURE	I-03	**DCU-9A**	**0**	**5**	**5**		**AB 1756-IA16**		
	METERING PUMP NO.2 RUNNING	I-04	**DCU-9A**	**0**	**5**	**6**		**AB 1756-IA16**		
	METERING PUMP NO.2 VFD FAULT	I-04	**DCU-9A**	**0**	**5**	**7**		**AB 1756-IA16**		
	METERING PUMP NO.2 HIGH PRESSURE	I-04	**DCU-9A**	**0**	**5**	**8**		**AB 1756-IA16**		
	METERING PUMP NO.2 IN REMOTE	I-04	**DCU-9A**	**0**	**5**	**9**		**AB 1756-IA16**		
	METERING PUMP NO.2 ESTOP	I-04	**DCU-9A**	**0**	**5**	**10**		**AB 1756-IA16**		
	METERING PUMP NO.2 MOTOR HIGH TEMPERATURE	I-04	**DCU-9A**	**0**	**5**	**11**		**AB 1756-IA16**		
	METERING PUMP NO.1 MOTOR HIGH TEMPERATURE	I-04	**DCU-9A**	**0**	**5**	**12**		**AB 1756-IA16**		
	SPARE		**DCU-9A**	**0**	**5**	**13**		**AB 1756-IA16**		
	SPARE		**DCU-9A**	**0**	**5**	**14**		**AB 1756-IA16**		
	SPARE		**DCU-9A**	**0**	**5**	**15**		**AB 1756-IA16**		
MXSLDG_M8011_CMD	DIGESTER FEED PUMP #1 START-STOP COMMAND		DCU-9A	0	6	0		AB 1756-OA16		
MXSLDG_M8021_CMD	DIGESTER FEED PUMP #2 START-STOP COMMAND		DCU-9A	0	6	1		AB 1756-OA16		
MXSLDG_M8031_CMD	DIGESTER FEED PUMP #3 START-STOP COMMAND		DCU-9A	0	6	2		AB 1756-OA16		
MXSLDG_M8041_CMD	DIGESTER FEED PUMP #4 START-STOP COMMAND		DCU-9A	0	6	3		AB 1756-OA16		
	UNLOADING/MIX PUMP NO.1 START/STOP COMMAND	I-03	DCU-9A	0	6	4		AB 1756-OA16		
	UNLOADING/MIX PUMP NO.2 START/STOP COMMAND	I-03	DCU-9A	0	6	5		AB 1756-OA16		
	METERING PUMP NO.1 START/STOP COMMAND	I-04	DCU-9A	0	6	6		AB 1756-OA16		

Tag No	Description	P&ID Ref	RIO	Rack	Slot	Point No.	WRF	CARD	Term. Block	Term. Block
	METERING PUMP NO.2 START/STOP COMMAND	I-04	DCU-9A	0	6	7		AB 1756-OA16		
	SLUDGE TANK HIGH LEVEL ALARM TO VFD-021	I-04	DCU-9A	0	6	8		AB 1756-OA16		
	SLUDGE TANK HIGH LEVEL ALARM TO VFD-022	I-04	DCU-9A	0	6	9		AB 1756-OA16		
	SPARE		DCU-9A	0	6	10		AB 1756-OA16		
	SPARE		DCU-9A	0	6	11		AB 1756-OA16		
	SPARE		DCU-9A	0	6	12		AB 1756-OA16		
	SPARE		DCU-9A	0	6	13		AB 1756-OA16		
	SPARE		DCU-9A	0	6	14		AB 1756-OA16		
	SPARE		DCU-9A	0	6	15		AB 1756-OA16		
	EMPTY		DCU-9A	0	7			EMPTY		
MXSLDG_LIT_801	MS BLENDING TANK LEVEL		DCU-9A	0	8	0		AB 1756-IF16		
MXSLDG_DIT_802	MIXED SLUDGE DENSITY		DCU-9A	0	8	1		AB 1756-IF16		
MXSLDG_FIT_813	DIGESTER FEED PUMP #1 DISCHARGE FLOW		DCU-9A	0	8	2		AB 1756-IF16		
MXSLDG_M8011_SI	DIGESTER FEED PUMP #1 SPEED INDICATION		DCU-9A	0	8	3		AB 1756-IF16		
MXSLDG_FIT_814	DIGESTER FEED PUMP #2 DISCHARGE FLOW		DCU-9A	0	8	4		AB 1756-IF16		
MXSLDG_M8021_SI	DIGESTER FEED PUMP #2 SPEED INDICATION		DCU-9A	0	8	5		AB 1756-IF16		
MXSLDG_FIT_815	DIGESTER FEED PUMP #3 DISCHARGE FLOW		DCU-9A	0	8	6		AB 1756-IF16		
MXSLDG_M8031_SI	DIGESTER FEED PUMP #3 SPEED INDICATION		DCU-9A	0	8	7		AB 1756-IF16		
MXSLDG_FIT_816	DIGESTER FEED PUMP #4 DISCHARGE FLOW		DCU-9A	0	8	8		AB 1756-IF16		
MXSLDG_M8041_SI	DIGESTER FEED PUMP #4 SPEED INDICATION		DCU-9A	0	8	9		AB 1756-IF16		
	FOG RECEIVING TANK LEVEL	I-03	DCU-9A	0	8	10		AB 1756-IF16		
	METERING PUMP NO.1 SPEED FEEDBACK	I-04	DCU-9A	0	8	11		AB 1756-IF16		
	METERING PUMP NO.2 SPEED FEEDBACK	I-04	DCU-9A	0	8	12		AB 1756-IF16		
	FOG METERING FLOW RATE (FIT-001)	I-04	DCU-9A	0	8	13		AB 1756-IF16		
	UNLOADING FLOW RATE (FIT-002)	I-03	DCU-9A	0	8	14		AB 1756-IF16		
	SPARE		DCU-9A	0	8	15		AB 1756-IF16		
	EMPTY		DCU-9A	0	9			EMPTY		
MXSLDG_M0811_SP	DIGESTER FEED PUMP #1 SPEED SET POINT		DCU-9A	0	10	0		AB 1756-OF08		
MXSLDG_M0821_SP	DIGESTER FEED PUMP #2 SPEED SET POINT		DCU-9A	0	10	1		AB 1756-OF08		
MXSLDG_M0831_SP	DIGESTER FEED PUMP #3 SPEED SET POINT		DCU-9A	0	10	2		AB 1756-OF08		
MXSLDG_M0841_SP	DIGESTER FEED PUMP #4 SPEED SET POINT		DCU-9A	0	10	3		AB 1756-OF08		
	METERING PUMP NO.1 SPEED REFERENCE	I-04	DCU-9A	0	10	4		AB 1756-OF08		
	METERING PUMP NO.2 SPEED REFERENCE	I-04	DCU-9A	0	10	5		AB 1756-OF08		
	SPARE		DCU-9A	0	10	6		AB 1756-OF08		
	SPARE		DCU-9A	0	10	7		AB 1756-OF08		
	EMPTY		DCU-9A	0	11	0		EMPTY		
	EMPTY		DCU-9A	0	12	0		EMPTY		
	EMPTY		DCU-9A	0	13	0		EMPTY		
	EMPTY		DCU-9A	0	14	0		EMPTY		
	EMPTY		DCU-9A	0	15	0		EMPTY		
	EMPTY		DCU-9A	0	16	0		EMPTY		

SECTION 40 61 96

PROCESS CONTROL DESCRIPTIONS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. PLC and SCADA HMI programming services for the existing DCU-9A PLC and SCADA HMI screens will be provided by a single Systems Integrator as part of the CONTRACTOR's project responsibility.
   2. Packaged Equipment Vendors shall provide PLC & OIT programming and configuring for the associated PLC-based control panel.

B. Related Sections:
   1. Section 40 61 13, Process Control System General Provisions.
   2. Section 46 24 23, Inline Grinder and Rock Trap.

C. The control descriptions are generally divided by the PLC that will include the described control logic.

D. The loop descriptions are broken into a hierarchical layer concept. There may be one layer or multiple layers per loop, depending upon that loop. The lowest layer of control, local control, is at that piece of equipment. The second layer of control is at an intermediate control panel between the equipment and the Plant Control System (PCS) I/O or vendor's panel. The third layer would be at the vendor's panel. The highest layer of control is by the Plant Control System (PCS) with its associated operator workstations (OWS) in the control room. The PCS/OWS refers to both the existing PLC DCU-9A, which does the actual monitoring and control logic for the process equipment and the OWS, which are computers that have graphical software that interface to the PLC software for monitoring and implementing all operator-required tasks to control that process equipment.

E. Process Control Functions:
   1. Process control function shall be structured to permit the realization of all control strategy requirements. In addition, each control function shall be designed so that bumpless, balance free transfers are obtained during operating mode changeover and initialization. Where applicable, user-changeable parameters shall be automatically defaulted to a preset value if a specific value is not given during system generation.
   2. The P&IDs represent the required process monitoring and control. The required control for the system is a combination of the representation on the P&IDs and the requirements specified herein. The P&IDs do not show all the required

internal diagnostic indications. In addition, to the indications shown on the P&IDs the following, at a minimum shall be provided:

a. Indication of bad quality on any hardwired input/output point (such as zero milliamps on a 4 to 20 mADC circuit).
b. Individual PLC fault indications.
c. Indication of a communications failure.
d. For all motor start and stop commands check for run feedback after adjustable time delay (0 to 30 seconds). Provide a "FAIL TO START" and "FAIL TO STOP" alarm if unit fails to run or stop. Use the bad start or stop bit to remove the run command from the control logic.
e. For analog control loops, when control of field equipment is not in "REMOTE," the associated PID controller output shall track the position feedback.
f. Runtimes shall be provided for all pieces of equipment.
g. Provide the following alarm indications for analog signals (as required):
    1) "High-high."
    2) "High."
    3) "Low."
    4) "Low-low."
    5) "High and low rate of change."

3. In addition to the indications shown on the P&IDs, the following shall be provided at a minimum:
    a. Analog Data Scaling: This control function shall scale all analog inputs to a common span and shall normalize the digital representation of each analog input to a percent of the operating span. The processed value shall be expressed as a binary number that specifies the analog input's position on a straight line lying between zero and full scale as defined for a given input by the zero span values in the data base.
    b. Amplitude Limit Check: This control function shall perform dual level, high/low amplitude limit checking and shall identify a limit violation every time a measured or virtual variable goes out-of-limits and returns back into limits. The control function shall determine the time at which each limit excursion occurred. A deadband shall be provided on each limit and shall be expressed as a percentage of span or in engineering units. Low and high limiting default values will be set-up for each measured or calculated variables used in the process control loops.
    c. Engineering Unit Conversion: This control function shall convert scaled analog data to engineering units by means of the following equation:

$$Y = (H - L)(D/DH) + L$$

where:

Y = Value in engineering units.
H = High value of span, expressed in engineering units.
L = Low value of span, expressed in engineering units.
D = Digitized scaled input value in counts.
DH = Full scale digitized value in counts.

d. Manual Control: It shall be possible for Operator or Plant Engineer to interrupt any sequence, loop or automatic operation and operate the same manually through the Operator Workstation.
e. Verification of Digital Outputs: This control function shall verify that the equipment has responded to the digital commands before proceeding to next step during automatic operation. If any discrepancy is detected, an alarm will be annunciated.

F. Configuration: All set points, tuning parameters and engineering scales etc. shall be documented for each control point and each control strategy on configuration sheets or similar documents. These documents shall be updated during Factory Testing and finally during start-up.

G. All scales, configuration values, mathematical constants, equations and set points given in the control strategies are adjustable over a wide range. The values given are initial and may change during shop drawing review and may have to be readjusted during start-up.

H. Definitions and Terminology:
1. The following defines terminology repeatedly used throughout the control descriptions:
a. COMMON DISPLAY ALARMS: Conditions that generate an alarm display “A” on the PCS HMI screens near the graphic display of device. Operator must go to the Alarm Summary Screen to see the individual alarms that set off the Common Display Alarm.
b. HARD-CODED SETPOINTS: Variables within the PLC programming that shall be adjusted by a programmer during start up and testing of the system. These variables will not be available to operations staff at the HMI.
c. HARD-WIRED CONTROL: Refers to devices that have physical conductors wired to devices and independent of PLC control. Signals can either be discrete or analog.
d. HMI: (Human Machine Interface). Computer monitoring screen with graphical and numerical displays that allows an Operator to control devices and view information.
e. LOCAL: Lights, push-buttons, alarms, and other devices that the Operator interfaces with outside of the PCS HMI.
f. LOCAL CONTROL: Any device controls that is locally available to the Operator.
g. LOCAL INTERLOCKS: Any interlock that prevents an Operator from running a device from the local push-button or switch.
h. LOCAL SETPOINTS and CONFIGURATION: Any setpoint which the Operator manipulates outside of the PCS HMI and through the use of push-button, switches, keypads, or local OITs.
i. MANUAL: Refers to removing PLC automatic control from device and allows Operator to manual control device.

j. OIT: (Operator Interface Terminal). Local panel-mount monitoring screen with graphical and numerical displays that allows an Operator to control devices and view information.
k. OPERATOR-ADJUSTABLE SETPOINTS: Variables that may be adjusted by Operators at the HMI.
l. PID: (Proportional Integral Derivative): Computer logic subroutine in PLC that can control a process by monitoring a process variable analog input and controlling a process analog output to maintain setpoint. The PID has several adjustable parameters that will control how fast or slow the PID will control process output and determine how much it will overshoot or undershoot the setpoint.
m. REMOTE: Shall refer to displays and controls physically away from the LOCAL location of the device. Usually refers to the main control room's HMI or PLC.
n. REMOTE AUTO CONTROL: Automatically controlling the devices from the PLC, based on process parameters and Operator entered setpoints.
o. REMOTE MANUAL CONTROL: Manually operating a device using the graphic buttons on the HMI screen. Software interlocks can automatically stop a running device and override the remote manual control.
p. SOFTWARE INTERLOCKS: Conditions that prevent and/or stop equipment operation when the equipment is placed in either Remote Manual or Remote Automatic at the HMI Auto/Manual Station.

1.2 SUBMITTALS

A. The control strategies are written descriptions of the basic configuration and/or programming required to implement regulatory and sequential control of the unit processes as shown on the P&IDs. They do not describe the process characteristics fully in all cases. Finalizing and tuning of strategies, as required, by process characteristic's shall be accomplished during start-up. Control strategies shall fully reside in the memory of the designated PLC. The process inputs/outputs referred to in the Control Strategies are shown on the P&IDs and Process Control System Input/Output list. Any additional I/O (Maximum 20 percent) required shall be added during Shop Drawing review. It shall be provided at no additional cost to the OWNER.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GRINDER AND ROCK TRAP

A. General:
   1. Process and Instrumentation Diagrams: I-03.
   2. Loop Numbers: 001.

B. Overview:
   1. A grinder will be installed after the rock trap. This arrangement will allow Haskell WWTP operators the option to receive loads from waste haulers other than LES in the future that may not perform a rigorous pre-screening process. There will be a manual bypass for the rock trap/grinder system that can be operated when loads received are high quality material that have already been pre-screened. While the material is being unloaded into the tank, both routes converge into a single pipe where a Coriolis flow meter will record the flow rate and totalize in the PLC per batch.

C. Monitoring and Control:
   1. There is no automatic control of the grinder.
   2. The following signals are sent from the Grinder Control Panel to the existing PLC DCU-9A and OWS:
      a. Grinder Running
      b. Grinder Fault
      c. High Temperature
      d. Grinder Jam
   3. The following signals are sent from the field to the existing PLC DCU-9A and OWS:
      a. Unloading Flow Rate

Equipment	Local Control Station Location	Process Panel Location	Motor Controller Location
Grinder	N/A	Near Grinder	N/A

D. Local Control:
   1. Grinder: The grinder can be controlled locally, from the packaged Grinder Control Panel (MCP-001) located near the grinder. By placing the starter mounted "ON/OFF " selector switch (HS 001A) in the "ON" position, the grinder will start and run continuously regardless of the unloading/mixing FOG pumps status. The grinder can also be stopped using the "EMERGENCY STOP" mushroom-head pushbutton (HSS 001) located on MCP-001. Load sensing and other vendor panel provided controls as described in Specification Section 46 24 23 may remain active.

E. Remote Manual: (Not Applicable)

F. Auto Control: (Not Applicable)

G. Interlocks and I/O from other process areas:

Interlock / I/O	Tag	Loop #	Response	Local / CCS
FOG Receiving Tank High-High level	LAHH	001	Stop Grinder after 5 second timer.	Local

H. CCS generated alarms and indications:

Alarm / Indication	Priority	Comment
Grinder Fault	Medium	
Grinder Jam	Medium	
Grinder High Temperature	Medium	

I. Set points / data to be entered by the operator at the CCS:

Set point	Range / Typical Value
N/A	N/A

J. Historical Database and Trends:

Description	Tag	Historical Database
Unloading Flow rate	FI-001	YES
Unloading Flow rate totalized	FQI-001	N/A

3.2 UNLOADING/MIXING PUMPS

A. General:
   1. Process and Instrumentation Diagrams: I-03.
   3. Loop Numbers: 011, 012.

B. Overview:
   1. The FOG unloading/mixing pump will keep the FOG material in constant circulation to prevent solidification and the formation of a scum layer. The pipe arrangement will allow for the mixing pump to work as an offloading

pump if required for trucks not equipped with vacuum pumps but will not be sized for rapid truck unloading.

2. The recirculation line connected to the FOG receiving tank (TNK-001) will be electrically heat traced to keep the FOG material warm and at lower viscosity levels within the tank and piping.
3. The FOG product will be delivered to the plant by tanker trucks with capacity of 5,500 gallons. Only one or two trucks per weekday are expected to be received at Haskell WWTP.
4. The FOG will be transferred from the hauler's trucks into the receiving tank using vacuum pumps that are equipped onto the trucks. When this occurs, the unloading/mixing pumps will be turned off and manual valve configurations changed to allow the transfer. If the hauler's truck does not have an operational vacuum pumps, the unloading/mixing pump can be used to transfer FOG from the truck to FOG receiving tank.

C. Monitoring and Control:

1. The typical strategy of the unloading/mixing pump is to provide mixing of the FOG within the FOG receiving tank (TNK-001). There are two unloading/mixing pumps (PMP-011 and PMP-012) that are operated in a duty/standby configuration. These pumps are alternated every 8 hours. The alternation time cycle should be operator adjustable from OWS.
2. When a FOG hauler truck arrives, the unloading/mixing pumps will be stopped and valves manually configured to allow transfer of screened FOG directly into the receiving tank, bypassing the rock screen and grinder pump. The vacuum pump on the hauler's truck will be used to transfer the screened FOG. When FOG transfer is complete, valves will be manually configured for FOG tank mixing to resume.
3. If a hauler truck arrives with a vacuum pump that is not operational, the unloading/mixing pumps will be stopped and valves manually configured to allow transfer of screened FOG via unloading/mixing pumps, bypassing or utilizing the rock screen and grinder pump. The unloading/mixing pump will be used to transfer the screened FOG from the hauler's truck into the FOG tank (TNK-001). When FOG transfer is complete, valves will be manually configured for FOG tank mixing.
4. The mixing system will be operated in Local Control or REMOTE Manual Mode, as described below.
5. The following signals are sent between each mixing/unloading pump starter and the existing PLC DCU-9A and OWS:
   a. Unloading/Mixing Pump No.1/2 Running
   b. Unloading/Mixing Pump No.1/2 Overload
   c. Unloading/Mixing Pump No.1/2 High Pressure
   d. Unloading/Mixing Pump No.1/2 In Remote
   e. Unloading/Mixing Pump No.1/2 E-Stopped
   f. Unloading/Mixing Pump No.1/2 Start/Stop Command
   g. Unloading/Mixing Pump No.1/2 High Temperature

Equipment	Local Control Station Location	Process Panel Location	Motor Controller Location
Unloading/Mixing Pump No.1 and 2 (Duty/Standby)	Near Unloading/Mixing Pump No.1	N/A	Mixed Sludge Pump Station Control Room (MCC-20)

D. Local Control:
   1. Unloading/Mixing Pumps: Each pump can be controlled locally, from the respective local control station local near the unloading/mixing pump station. This is accomplished by placing the applicable "LOCAL/OFF/ REMOTE" selector switch (HS 011/012) in the "LOCAL" position. When in "LOCAL," the operator can start and stop the pump from the local control station mounted near the pump. Each pump can also be stopped using the "EMERGENCY STOP" mushroom-head pushbutton (HSS 011/012) located at the pump.

E. REMOTE Manual Control: Mixing pumps must be in "REMOTE" at the "LOCAL/ OFF/REMOTE" selector switch and Manual at the respective OSW screen for REMOTE Manual control. The steps for operating equipment in REMOTE Manual are similar to operating in "LOCAL," with the exception that the controls will be initiated from the OWS screen.

F. REMOTE Automatic Control: There is no REMOTE automatic control of the mixing/unloading pumps.

Interlocks:
   1. If any of the following conditions exist the unloading/mixing pump will not start, or will stop if running regardless of control mode and will notify SCADA:

      a. Fog Tank High-High Level Alarm (LAHH 001).
      b. High Discharge Pressure (PAH/PSH 011/012).
      c. Pump Motor Overload (IAH 011/012).
      d. E-Stopped (HSS 011/012).
   2. If any of the following conditions exist the unloading/mixing pump will not start unless the “LOCAL/OFF/REMOTE” selector switch is set to LOCAL and use the local start to prevent running the pumps dry from an empty tank but allowing operators to unload a truck into an empty tank:
      a. Fog Tank Low Level Alarm (LALL 001).

G. Interlocks and I/O from other process areas:

Interlock / I/O	Tag	Loop #	Response	Local / CCS
Fog Tank High-High Level Alarm	LAHH 001	001	Immediately stop the Unloading/Mixing pumps	N/A
Fog Tank Low-Low Level Alarm	LALL 001	001	Immediately stop the Unloading/Mixing pumps	N/A

H. PLC generated alarms and indications:

Alarm / Indication	Priority	Comment
Mixing/Unloading Pump No.1 Failed-To-Run	Low	
Mixing/Unloading Pump No.1 High Temperature	Medium	
Mixing/Unloading Pump No.1 Overload	Medium	
Mixing/Unloading Pump No.1 High Pressure	High	
Mixing/Unloading Pump No.1 E-Stop	High	
Mixing/Unloading Pump No.2 Failed-To-Run	Low	
Mixing/Unloading Pump No.2 High Temperature	Medium	
Mixing/Unloading Pump No.2 Overload	Medium	
Mixing/Unloading Pump No.2 High Pressure	High	
Mixing/Unloading Pump No.2 E-Stop	High	

I. Set points / data to be entered by the operator at the OWS screen:

Set point	Range / Typical Value
N/A	N/A

J. Historical Database and Trends:

Description	Tag	Historical Database
Mixing/Unloading Pump No.1 runtime hours	KIQ-011	
Mixing/Unloading Pump No.2 runtime hours	KIQ-012	

3.3 FOG RECEIVING TANK

A. General:
   1. Process and Instrumentation Diagrams: I-03.
   2. Loop Numbers: 001.

B. Overview:
   1. The receiving tank is a repurposed polymer tank with 18,000 gallon capacity. This capacity is enough to provide for at least two days of detention time at peak FOG daily volume deliveries.
   2. FOG product levels in the tank will be measured with a radar type of sensor installed at the top of the tank. The level signal will be sent to PLC DCU-9A and a local control panel with digital process meter. The process meter will display tank level and provide a high-high level alarm signal to interlock the mixing/unloading pumps and grinder.
   3. The tank vent currently has a tap that will be connected to a carbon canister for odor control.

C. Monitoring and Control:
   1. The following signals are sent from the FOG Tank Level Control Panel to the existing PLC DCU-9A and OWS:
      a. Fog Tank Level (4-20mA)
      b. Fog Tank High-High Level Alarm (LAHH 001)
      c. Fog Tank Low-Low Level Alarm (LALL 001).

Equipment	Local Panel Location	Process Panel Location	MCC Location
Level Transmitter Radar Type	Near truck unloading	Existing DCU-9A	N/A

D. Local Control: (Not Applicable)

E. FOG Mode REMOTE Manual Control: (Not Applicable)

F. REMOTE Automatic Control: (Not Applicable)

G. Interlocks and I/O from other process areas: (Not Applicable)

Interlock / I/O	Tag	Loop #	Response	Local / OWS

H. CCS Generated Alarms and Conditions:

Alarm / Indication	Priority	Comment
Low Level Warning	Medium	Alarm sustained until reset at the OWS but does not affect pumping cycle.
Low-Low Level Alarm	High	Alarm sustained until reset at the OWS.
High Level Warning	Medium	Alarm sustained until reset at the OWS but does not affect pumping cycle.
High-High Level Alarm	High	Alarm sustained until reset at the OWS.

I. Set Points/Data to be entered by the operator at the OWS:

Set point	Range / Typical Value
Low Level Warning	2 ft
High Level Warning	15 ft

J. Historical Database and Trends:

Description	Tag	Historical Database
FOG Tank Level	LI 001	

3.4 METERING PUMPS

A. General:
   1. Process and Instrumentation Diagrams: I-04.
   2. Loop Numbers: 021, 022.

B. Overview:
   1. This control description is for the metering pumps and associated equipment. The purpose of this equipment is to transfer FOG product out of the FOG receiving tank at a lower rate and to meter the FOG product into the existing sludge mixing tank.
   2. The FOG transfer rate out of the FOG receiving tank will be at a lower flow rate than the intake and will be conducted under 24/7 operations to provide a feed to the digesters that is as consistent as possible. Flowrates are projected to be in the order of 20-70gpm. Pumping will be intermittent, occurring for a few minutes every hour. The existing submersible paddle mixer within the sludge mixing tank will be used to blend and homogenize the FOG with the sludge and avoid the formation of an upper layer of grease in the tank.

C. Monitoring and Control:
   1. The overall strategy of the FOG metering pumping system is to transport FOG product to the sludge mixing tank without automatic adjustment of the pumps speed. The VFD will be used to manually experiment and define the optimal pumping rate for the system – as steady as possible without creating clogging issues in discharge piping.
   2. Pumping will be intermittent. Pumping intervals will be defined manually considering the pumping rates being adopted and the amount of FOG received into the FOG receiving tank.
   3. In addition to the normal REMOTE Automatic Control, the system may also be operated in the Local Control and REMOTE Manual Mode, as described below. All operator setpoints for automatic control are defined in Paragraph 3.4.I.
   4. The following signals are sent between each metering pump VFD cabinet and the existing PLC DCU-9A and OWS:
      a. Metering Pump No.1/2 Running
      b. Metering Pump No.1/2 VFD Fault
      c. Metering Pump No.1/2 High Pressure
      d. Metering Pump No.1/2 In Remote
      e. Metering Pump No.1/2 E-Stopped
      f. Metering Pump No.1/2 Start/Stop Command
      g. Metering Pump No.1/2 Speed Reference
      h. Metering Pump No.1/2 Speed Feedback
      i. Metering Pump No.1/2 High Temperature

Equipment	Local Panel Location	Process Panel Location	MCC Location
Metering Pump No. 1 and 2 (Duty/Standby)	Near the respective metering pump	Existing DCU-9A	Mixed Sludge Pump Station Control Room (MCC-20)

D. Local Control:
   1. Metering Pumps: Each metering pump can be controlled locally, from the respective local control station, by placing the applicable "LOCAL/OFF/ REMOTE" selector switch (HS 021/022) in the "HAND" position. When in "HAND," the operator can start, stop and control the speed of the pump from the local control station. Each pump can also be stopped using the "EMERGENCY STOP" mushroom head switch (HSS 021/022) located at the pump.

E. REMOTE Manual Control: Metering pump equipment must be in "REMOTE" at the "LOCAL/OFF/REMOTE" selector switch and Manual at the respective OWS screen for REMOTE Manual control. The steps for operating equipment in REMOTE Manual are similar to operating in "LOCAL," with the exception that the controls will be initiated from the OWS screen.

F. REMOTE Automatic Control: The "LOCAL/OFF/REMOTE" selector switches for the metering pumps must be in the "REMOTE" position to place the pumps in REMOTE Automatic mode at the OWS screen. In this mode the equipment will operate automatically as described below:
   1. Metering pump shall operate to maintain desired flowrate setpoint.

Interlocks:
   1. If any of the following conditions exist the metering pump will not start, or will stop if running regardless of control mode:
      a. High Discharge Pressure (PAH/PSH 021/022).
      b. Fog Tank Low-Low Level Alarm (LALL 001).
      d. VFD Fail (UA 021/022).
      e. E-Stopped (HSS 021/022).

G. Interlocks and I/O from other process areas:

Interlock / I/O	Tag	Loop #	Response	Local /CCS
Fog Tank Low-Low Level Alarm	LALL 001	001	Immediately stop the Metering pumps	N/A
Sludge Blending Tank High Level Alarm (MXSLD_LIT _801_H)	MXSL D_LIT_ 801_H	801	Immediately stop the Metering pumps	N/A

H. CCS Generated Alarms and Conditions:

Alarm / Indication	Priority	Comment
Zero FOG Flow	Medium	Metering pump running but pump flow reading (FIT 001) is at or below zero after a time delay (0 to 60 seconds set at start-up).
Metering Pump No.1 VFD fault.	Medium	Metering pump No. 1 VFD fault.
Metering Pump No.2 VFD fault.	Medium	Metering pump No. 2 VFD fault.

I. Set Points/Data to be entered by the operator at the CCS:

Set point	Range / Typical Value
Metering Pump Discharge Flowrate	20-70 gpm
Metering Pump Average Flowrate	20-70 gpm

J. Historical Database and Trends:

Description	Tag	Historical Database
Metering Pump Discharge Flow	FIT 001	Yes
Metering Pump No.1 runtime hours	YI-021	
Metering Pump No.2 runtime hours	YI-022	

+ + END OF SECTION + +

SECTION 40 64 00

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Provide all labor, materials, and components, and shall provide all design, assembly, testing, and start-up services required to provide modifications to the existing programmable controller (PLC) system as specified and shown on the Drawings. The system includes, but is not necessarily limited to the following:
   1. PLC I/O modules.
   2. Modifications to the existing control section within MCC-20 (DCU-9A). Modifications to the PCS include detailed design, assembly, installation, testing, and start-up services.

B. Modifications to the existing PLC (DCU-9A) shall be as shown on the Drawings and specified herein.

C. The Process and Instrumentation Diagrams (P&ID's) and the specifications of this Section and the other Division 40 Sections generally illustrate and describe the overall PLC System requirements.

D. All equipment shall be constructed specifically for the demanding requirements of real-time process management and control on a continuous basis for use in a municipal water treatment plant.

1.2 SUBMITTALS

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

1.3 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

1.4 EQUIPMENT DELIVERY, HANDLING, AND STORAGE.

A. Comply with the requirements of 40 61 13, Process Control System General Provisions.

PART 2 - PRODUCTS

2.1 PLC SYSTEM GENERAL REQUIREMENTS

A. All materials and equipment furnished shall be new, free from defects, and of first quality, produced by manufacturers who have been regularly engaged in the manufacture of these products.

B. All materials furnished under this Contract shall be determined safe by either Underwriters Laboratories, Inc., or Factory Mutual and all material shall be labeled, certified, or listed by the testing agency.

C. Provide PLC processors, communication modules, local and remote I/O components, and other hardware and system components required for a complete functioning PLC System to meet the intent of the configuration drawing and as listed in the PLC System I/O Schedule at the end of this section. The PLC shall be configured to perform the functions shown on the Contract Drawings and specified herein.

D. The PLC components shall be designed, constructed and tested in conformance to NEMA Standard ICS 3-304 for programmable controllers, and shall be suitable for use under the following environmental conditions:
   1. Operating Temperature: 32° to 140° F.
   2. Relative Humidity: 5% to 95% non-condensing.
   3. Shock: 30 G peak acceleration for 11ms duration.
   4. Vibration: 10 to 500 Hz, 2.0g maximum peak acceleration.

E. The existing PLC is a Allen Bradley ControlLogix PLC platform.

F. Provide sixteen-point discrete input modules which accept an input of 115 VAC, 60 Hz. The discrete input modules shall be Allen Bradley Model 1756-IA16.

2.2 WIRING ACCESSORIES

A. Provide wiring accessories including but not limited to connectors, taps, terminator lugs, and screw clamp blocks as recommended by the manufacturer for a complete PLC system installation.

2.3 INPUT/OUTPUT SCHEDULE

A. An Input/Output (I/O) schedule for the programmable controller system is included in Section 40 61 93, Input-Output List. CONTRACTOR shall provide

the input/output capacity necessary to facilitate the system functional requirements as specified and shown on the Drawings.

2.4 SPARE PARTS AND EXPENDABLE MATERIALS

A. The following spare parts and expendable materials shall be provided as a minimum, for the PLC System:
   1. One (1) of each type of input module.
   2. Ten (10) of each type of fuse supplied for this project.

B. All spare parts shall be individually packaged for protection against impact, moisture, and dirt. Each package shall be clearly labeled as to its contents with a description and part number.

C. All spare parts shall become the property of the OWNER. The CONTRACTOR shall maintain the spare parts inventory as listed above, and replace, at no additional cost, all spare parts consumed during the one-year warranty period.

PART 3 - EXECUTION

3.1 INSTALLATION REQUIREMENTS

A. General:
   1. Install all equipment and components in accordance with the Drawings, approved Shop Drawings, and installation instructions furnished by the manufacturer.

   2. Coordinate with plant operations prior to performing any work within the existing PLC control section, DCU-9A. Impacts to plant operations due to construction activities must be minimized.

   3. Inspect each component for damage and defects before installation. Replace deficient items.

   4. Comply with the other specific installation, start-up, and testing requirements as specified in the other Division 40 Sections.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 40 67 17

PROCESS CONTROL PANELS AND ENCLOSURES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, start-up and place into satisfactory operation all process control panels and enclosures.
2. Operational and functional requirements for the various panels are shown in control schematics, pneumatic diagrams, and/or functional instrumentation diagrams on the Instrumentation (I) drawings and Electrical (E) drawings.
3. The Drawings and Specifications illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, piping, and accessories required to make a completely integrated system. Provide all piping, wiring, accessories, and labor required for a complete, workable, and integrated system.
4. Process system equipment control panels which are to be furnished as part of a "packaged" system by the various system equipment vendors, are identified by “V*” on the Instrumentation (I) drawings. Operational and functional requirements for these panels are specified in the various Division 40, 43, and 46 Sections and are shown on the Process and Instrumentation Diagrams.

B. Related Sections:
1. Section 03 30 00, Cast-In-Place Concrete.
2. Section 05 05 33, Anchorage Systems.
3. Section 31 23 05, Excavation and Fill.
4. Section 40 61 13, Process Control System General Provisions.
5. Section 40 61 23, Process Control System Startup and Field Testing.
6. Section 40 61 96, Process Control Descriptions
7. Section 40 78 00, Panel-Mounted Instruments and Devices.

1.2 QUALITY ASSURANCE

A. Standards, Codes and Regulations:
1. Construction of panels and the installation and interconnection of all equipment and devices mounted within shall comply with applicable provisions of the following standards, codes and regulations:
   a. National Fire Protection Association 79, Annex “D” Standards, (NFPA).
   b. National Electrical Code, (NEC).
   c. National Electrical Manufacturer's Association Standards, (NEMA).

d. American Society for Testing and Materials, (ASTM).
e. Operational Safety and Health Administration Regulations, (OSHA).
f. Underwriters' Laboratory, Inc., (UL).
g. State and Local code requirements.
h. Where any conflict arises between codes or standards, the more stringent requirement shall apply.

2. All materials and equipment shall be new and all panels shall be built in an Underwriters' Laboratory, Inc. (UL) approved panel shop and bear the UL label.

B. Acceptable Manufacturers:
1. Furnish panel instruments and devices by the named manufacturers or equal equipment by other manufacturers.
2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
3. Obtain all instruments or devices of a given type from the same manufacturer.

C. General Design Requirements:
1. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.
2. Comply with the control descriptions of Section 40 61 96, Process Control Descriptions.

D Factory Assembly and Testing:
1. Fully assemble and test each enclosure and panel at the factory prior to shipment, demonstrating that all specified functions are performed.
2. Comply with the requirements of Section 40 61 21, Process Control System Factory Testing.

1.3 SUBMITTALS

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

PART 2 - PRODUCTS

2.1 GENERAL CONSTRUCTION REQUIREMENTS

A. Provide all electrical and/or pneumatic components and devices, support hardware, fasteners, interconnecting wiring and/or piping required to make the control panels and/or enclosures complete and operational.

B. Locate and install all devices and components so that connections can be easily made and that there is ample room for servicing each item.

C. Layouts shall be submitted for review in accordance with Section 40 61 13, Process Control System General Provisions. All exterior panel mounted instruments shall have a NEMA rating equal to the enclosure. For devices that cannot be obtained with a NEMA rating equal to the enclosure, mount the device behind a transparent viewing window as specified below. The window shall maintain the NEMA rating of the enclosure.

D. Adequately support and restrain all devices and components mounted on or within the panel to prevent any movement.

E. Provide sub-panels for installation of all relays and other internally mounted components.

F. All wiring to panel connections from field instruments, devices, and other panels shall be terminated at master numbered terminal strips, unless otherwise specified.

G. Provide copper grounding studs for all panel equipment.

H. The bottom 12-inches of free-standing panels shall be free of all devices, including terminal strips, to provide ease of installation and testing.

2.2 IDENTIFICATION

A. Provide laminated plastic nameplates for identification of panels and components mounted thereon as follows:
   1. Nameplates shall be of 3/32-inch thick laminated phenolic type with white matte finish surface and black letter engraving.
   2. Panel identification nameplates to have 1/2-inch high letter engravings.
   3. Panel mounted component (e.g., control devices, indicating lights, selector switches, etc.) identification nameplates to have 1/4-inch high letter engravings.
   4. Nameplates shall be attached to the panel face with two stainless steel self-tapping screws.
   5. Nameplate engravings shall include the instrument or equipment tag number and descriptive title as shown and specified.

B. Tag all internally mounted instruments in accordance with the following requirements:
   1. Tag numbers shall be as listed in the Instrument Index.

2. The identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
4. Identification tag shall be installed so that the numbers are easily visible to service personnel.
5. Front of panel mounted instruments shall have the tag attached to rear of device.

C. Tag all electrical components and devices mounted within control panel enclosures with engraved nameplates as specified in Paragraph A. above. Tag all door-mounted devices on the rear of the door with engraved nameplates as specified in Paragraph A above. All interior panel nameplates shall be attached with self-backed adhesive.

D. Numerically code terminals on terminal strips.

E. Numerically code wiring as required by applicable standards. Wires shall be identified at each end with permanent alphanumeric codes as specified below. All wiring not de-energized by the panel disconnect or circuit breaker shall be orange wire.

F. For all panels containing wiring not de-energized by the panel disconnect or circuit breaker, provide a warning nameplate on the front of the panel stating "WARNING ORANGE WIRING NOT DE-ENERGIZED BY PANEL DISCONNECT". The nameplate shall be amber with black, ¼- inch high letter engravings and shall be attached to the panel face with stainless steel screws and adhesive.

2.3 PANELS AND ENCLOSURES

A. General:
1. Panels and enclosures shall meet the NEMA/UL Type requirements for the type specified.
2. Sizes shown are estimates. Provide panels and enclosures of the size required to house all equipment, instruments, front panel mounted devices, power supplies, wiring, tubing, and other components installed in the enclosures.

B. Construction Features:
1. All control panels shall be fabricated in accordance with the NEMA/UL Type ratings specified and/or as shown on the Drawings.
   a. Provide lifting eye bolts to facilitate handling of the enclosures, where enclosure size requires. Bolt lifting eyes directly to the enclosure structural members.
   b. Continuously weld all exterior seams and grind smooth. Surface grind complete removal of corrosion, burrs, sharp edges, and mill scale.

c. Reinforce sheet steel with steel angles where necessary to adequately support equipment and ensure rigidity and to preclude resonant vibrations.
d. Panel shall be flat within 1/16-inch over a 24-inch by 24-inch area, or flat within 1/8-inch for a larger surface. Flatness shall be checked by using a 72-inch long straight edge. Out-of-flatness shall be gradual, in one direction only, and shall not consist of obvious depressions or a series of wavy sections.
e. Use pan type construction for doors. Door widths shall not exceed 36 inches.
f. Mount doors with full-length heavy-duty piano hinge with stainless steel hinge pins.
g. Provide oil resistant gasket completely around each door or opening.
h. Use stainless steel fasteners throughout.
i. Provide interior mounting panels and shelves constructed of minimum 12-gauge steel with a white enamel finish.
j. All wall mounted, frame mounted, and floor mounted enclosures shall include full height rear subpanels.
k. Provide enclosure mounting supports and/or bases as required for floor, frame, or wall mounting and for free standing enclosures.
l. All panels outside of control rooms shall have solid bottoms.
m. Provide all holes and cutouts for installation of conduit and equipment. Cable and piping shall enter the enclosure through the bottom unless otherwise noted. All conduit and piping openings and all conduits shall be sealed watertight.

2. Control panels located in control or electrical room areas shall be NEMA/UL Type 12 rated unless otherwise noted on the Drawings.
   a. Fabricate enclosures using minimum 14-gauge steel for wall or frame mounted enclosures and minimum 12 gauge for floor mounted and free-standing enclosures. Steel shall be free of pitting and surface blemishes.
   b. For floor mounted enclosures, provide minimum 12-gauge steel floor stand kits bolted to the bottom of the enclosure and sealed and gasketed to maintain NEMA 12 rating. Floor stand heights shall be coordinated with enclosure sizes and base pads so as to comply with the general indication and control device mounting height requirements as specified herein and/or as shown on the drawings. Floor stands shall be mounted on base pads using anchor bolts and/or expansion anchors as specified in Paragraph 3.g below.
   c. Free-standing enclosures shall be constructed with an integral fully enclosed solid bottom section at least 6 inches in height from the bottom of the enclosure to the bottom edge of the enclosure door opening. Free-standing enclosures shall be mounted on base pads as specified in Part 3 below.
   d. Provide handle-operated, oil-tight, key-lockable three-point stainless steel latching system with rollers on latch-rods for easy door closing.

e. Completely clean all interior and exterior surfaces so they are free of corrosive residue, oil, grease, and dirt. Zinc phosphatize for corrosion protection.
f. One coat of primer shall be applied to all interior and exterior surfaces immediately after corrosion protection has been applied. Exterior surfaces shall then be given sufficient coats of primer surfacer, applied with sanding and cleaning between coats, until a Grade 1 finish can be produced on the finish coat.
g. All interior surfaces shall be painted with 2 coats of semi-gloss white enamel.
h. All exterior surfaces shall be painted with a minimum of 3 finish coats of enamel to ultimately produce a Grade 1 finish (super smooth; completely free of imperfections). Color to be selected by Engineer from complete selection of standard and custom color charts furnished by the manufacturer.
i. Primer and finish paint shall be compatible and shall be a low VOC, high solids polyurethane enamel as manufactured by Sherwin Williams, or equal.
j. Provide one extra quart of touch-up paint for each exterior finish color.

3. All control panels located outside or located in corrosive areas shall be NEMA/UL Type 4X rated stainless steel.
   a. Panels shall be Type 316 stainless steel construction with a minimum thickness of 12-gauge for all surfaces (except those areas requiring reinforcement) having a smooth brushed finish.
   b. Provide stainless steel fast-operating clamp assemblies on three sides of each door.
   c. Provide a rolled lip around three sides of door and along top of enclosure.
   d. Provide a hasp and staple for padlocking. Provide padlock for each enclosure, all keyed alike.
   f. Provide a clear plastic, NEMA 4X, gasketed, lockable, hinged door to encompass all non-NEMA 4X front of panel instruments.
5. Field Panels (NEMA 7): (Not Applicable)

2.4 ELECTRICAL SYSTEMS

A. Control of Environment (refer to Section 40 61 13, Process Control System General Provisions for ambient temperature design criteria)

B. Power Source and Internal Power Distribution:
   1. General: Control panel power supply source type, voltage, number of circuits and circuit ratings shall be as shown on the Electrical Drawings.
   2. The panels and enclosures shall be provided with internal 120 VAC DIN rail mounted circuit breakers sized as required to distribute power to the panel components. Provide quantity of circuits as shown on the Drawings or as required. Circuit breakers shall be Allen Bradley Bulletin 1492-CB, 1492-GH,

or equal. Provide a durable legend mounted near the circuit breakers in each panel which lists the circuit breaker numbers and functional descriptions.

3. Provide surge suppressors on all power sources as required to protect against damage from electrical surges.

C. Electrical Wiring and Accessories:

1. Unless otherwise specified, internal wiring shall be Type MTW stranded copper wire with thermoplastic insulation rated for 600 V at 105°C for single conductors, color coded and labeled with wire identification.
2. For DC signal wiring, use No. 16 minimum AWG twisted pairs with overall shield.
3. For AC power wiring, use No. 12 minimum AWG. For AC signal and control wiring, use No. 14 minimum AWG. For wiring carrying more than 15 amps, use sizes required by NEC and IEEE standards.
4. Install wiring runs in wire troughs along horizontal or vertical routes to present a neat appearance. Angled runs are not acceptable.
5. Separate and shield DC signal wiring from power and control wiring by a minimum of 4 inches, using separate wire troughs.
6. Where possible or practical in the panels and enclosures, route the low voltage DC signal wiring along the right portion of the enclosure subpanel(s) and route the AC power and control wiring to the left portion of the subpanel(s), with the incoming power and distribution circuit breakers located to the upper left.
7. Group or bundle parallel runs of wire using covered troughs. Maximum bundle size to be 1 inch. Troughs shall have 40 % spare capacity.
8. Adequately support and restrain all wiring runs to prevent sagging or other movement.
9. Terminal Blocks:
   a. Terminate field wiring and internal panel wiring not associated with PLC I/O interface modules at 600 V barrier type terminal blocks, Phoenix Contact UK 5N, Allen-Bradley 1492-W4 or equal.
   b. Terminal blocks shall be tubular screw type with pressure plate capable of accepting #30-#10 wires and shall be mounted on DIN rail. DIN rail by terminal block manufacturer or equal.
   c. End anchors shall be provided on both ends of all terminal strips to firmly anchor the terminal blocks to the mounting rail and insulating end barriers shall be provided on one end of the terminal strip as necessary. End anchors by terminal block manufacturer or equal.
   d. No more than two wires shall be terminated at any single screw. Provide jumpers as required to join adjacent terminal blocks for additional wiring connection points.
   e. All terminal blocks shall be labeled with permanently affixed numeric identifiers on each block. Identifiers shall be self-stick plastic tape strips with permanent, machine printed numbers.
   f. Provide a separate terminal block for landing each analog signal cable shield.
   g. Provide separate terminal strips for DC signal and AC power wiring.

h. Provide spare terminal blocks equal in number to 20 % of the terminals used for each type of wiring (i.e., DC signal and AC power).

10. Panel Front Face Port Interface: (Not Applicable)
11. Wire Markers:
    a. All panel wires and field wires shall have an alphanumeric identification tag at each point of termination.
    b. Where practical, wire numbers shall be unique and continuous. Where wire numbers change, the appropriate drawings shall include both wire numbers, clearly indicated, at the point of transition.
    c. Each wire number shall be solid, machine printed, and not pieced from other single and/or double-digit tags.
    d. Wire markers shall be heat, oil, water, and solvent resistant, vinyl, self-laminating, heat shrink labels.
    e. All wire labels shall be clearly visible and not hidden by wire duct or other components in the enclosures.
12. All wiring shall be installed such that if wires are removed from any one device, power will not be disrupted to any other device.
13. All alarms generated external to the panel, spare alarm, and repeat contacts shall be wired out to terminal blocks.
14. Use separate, isolated 5/16-inch diameter copper grounding studs or 1/4 inch thick drilled and tapped copper bus bars for instrument signal cable shield grounding connections and instrument power/equipment grounding system. Shield grounds shall be completely isolated from the enclosure instrument power/equipment grounds.
15. Where wires pass through panel walls, provide suitable bushings to prevent cutting or abrading of insulation.
16. When DC power and/or low voltage AC power is required, provide and install the necessary power supplies and transformers in the panel.
17. Provide circuit breakers to protect each circuit, with no more than six instruments on a single circuit.
18. Provide surge suppressors on field signal wiring as required to protect against damage from electrical surges.
19. All spare field wires within each panel or enclosure shall be coiled, and each coil shall be labeled with the wire destination. Neatly arrange spare wire coils in the bottom of the enclosure.
20. Provide complete wiring diagram showing "as built" circuitry. Diagram shall be enclosed in transparent plastic and placed in easily accessible pocket built into panel door.
21. Surge Protection:
    a. General: Surge protection shall be provided to protect the electronic instrumentation system from surges propagating along the signal and power supply lines. The protection systems shall be such that the protection level shall not interfere with normal operation, but shall be lower than the instrument surge withstand level, and be maintenance free and self-restoring. Instruments shall be housed in suitable metallic cases, properly grounded. Ground wires for all surge protectors shall be

connected to a good earth ground and where practical each ground wire run individually and insulated from each other. These protectors shall be mounted within the instrument enclosure or a separate junction box (compatible with the area designation) coupled to the enclosure.

b. Refer to Section 40 78 00, Panel Mounted Instruments and Devices, for additional component specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in conformance with the National Electrical Code.

B. Unless otherwise noted, install all frame mounted indoor and outdoor panels and sun shields using strut style structural support framing system members, plates and fasteners as specified in Section 26 05 29, Hangers and Supports for Electrical Systems. Frame bases shall be installed on a minimum one-inch thick non-shrink grout pad with edges sloped away from the base plate.

C. Install wall mounted enclosures and control panels using strut style support channels securely anchored to wall surface to provide offset mounting for air circulation behind panel. Do not install wall mounted panels directly on wall surfaces. Comply with requirements of Section 26 05 29, Hangers and Supports for Electrical Systems, for support framing system materials and methods.

D. Install anchor bolts and anchor in accordance with Section 05 05 33, Anchor Systems.

E. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls, and process controller components into and out of and among the enclosures as indicated on the Drawings.

3.2 TESTING AND ADJUSTMENTS

A. Perform system testing and make any adjustments necessary in accordance with this Section, Section 40 61 13, Process Control System General Provisions, Section 40 61 21, Process Control System Factory Testing, and Section 40 61 23, Process Control System Start-up and Field Testing.

B. Perform power supply, voltage adjustments to tolerances required by the appurtenant equipment.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 40 70 05

PRIMARY SENSORS AND FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation all primary sensors and field instruments shown and specified herein.
   2. Contract Documents illustrate and specify functional and general construction requirements of the sensors and field instruments and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Provide all components, piping, wiring, accessories and labor required for a complete, workable, and integrated system.
   3. Be responsible for installing in-line flow elements (magnetic flow meter flow tubes, insert flow tubes, propeller flow meters) and for providing taps in the process piping systems for installation of other flow, pressure, and temperature sensing instrumentation.

B. Coordination: Coordinate with other suppliers for installation of all items specified herein and required to ensure the complete and proper interfacing of all components and systems.

C. Related Sections:
   1. Section 40 61 13, Process Control System General Provisions.
   2. Section 40 61 23, Process Control System Startup and Field Testing.
   3. Section 40 61 26, Process Control System Training.
   4. Section 40 05 05, Exposed Piping Installation.
   5. Section 40 05 23.23, Stainless Steel Process Pipe for Liquid Service.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

B. Acceptable Manufacturers:
   1. Furnish primary process measurement devices by the named manufacturers or equal equipment by other manufacturers.
   2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.

3. Obtain all sensors and field instruments of a given type from the same manufacturer.

C. Manufacturers' Responsibilities and Services:
   1. Design and manufacture the primary process measurement devices in accordance with the applicable general design requirements specified in Section 40 61 13, Process Control System General Provisions, and the detailed Specifications herein.
   2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 40 61 23, Process Control System Startup and Field Testing, and Section 40 61 26, Process Control System Training.

1.3 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 40 61 13, Process Control System General Provisions.

B. Primary process measurement devices shall not be delivered to the Site until all product information and system Shop Drawings for the sensors and instruments have been approved by the ENGINEER.

1.4 SUBMITTALS

A. Comply with the requirements specified in Section 40 61 13, Process Control System General Provisions.

1.5 CHEMICAL SERVICE (Not Applicable)

1.6 MATERIALS OF CONSTRUCTION FOR WETTABLE PARTS

A. Provide compatible materials of construction for primary sensors and field instrument (wetted) parts that come in contact with the process fluids listed in the Instrument Index.

1.7 IDENTIFICATION TAGS

A. Performance Requirements:
   1. Tag numbers of sensors and field instruments shall be as shown and as specified. For items not shown or specifically tagged, the item tag number shall be established by the system supplier. All instruments, whether field or panel mounted, shall have an identification tag.
   2. Information to be permanently engraved onto the tag shall include the identifying tag number, manufacturer, model number, service, and range.

3. The tags shall be fastened to the device with self-tapping stainless steel screws. Where fastening with screws cannot be accomplished the tags shall be permanently attached to the device by a circlet of stranded stainless steel wire rope and clamp.
4. All sensors and field instruments mounted on or within control panels and enclosures shall have the identification tag installed so that the engravings are easily visible to service personnel. Panel mounted devices shall have the tag attached to the rear of the device.

B. Construction Features:
1. Tags shall be engraved with 3/16-inch letters and constructed as follows.
   a. 3/32-inch thick laminated phenolic for engraving composed of core, laminated on both sides with a matte (non-glare) finish cover sheet.
   b. Core to be black; cover sheet to be white.
   c. Mounting holes to be centered on width and 1/4-inch from each end.

1.8 FILLING LIQUID

A. Use silicone except for process fluids containing chlorine. When the process fluid contains chlorine, the filling liquid shall be Halocarbon 63 or Flurolube 63.

PART 2 - PRODUCTS

2.1 PROCESS TAPS, SENSING LINES AND ACCESSORIES

A. Water Pressure Sensing Lines and Accessories for Flow and Pressure Transmitters:
1. Material: Copper Water Tube, ASTM B-88, Type L, drawn temper or annealed.
2. Pressure Rating: 150 psi.
3. Size: 1/2-inch O.D. for water.
4. Connections: Brass Compression Type, "Swagelok" by Crawford, or equal.
5. Shut-off Valves:
   a. Type: Ball.
   b. Pressure Rating: 150 psi.
   c. Body, Ball and Stem: Brass.
   d. Packing: High Density TFE.
   e. Handle: Nylon with metal travel stops.
   f. Support Rings: TFE coated brass.
   g. End Connections: Removable "Swagelok", or equal.
   h. Model: Whitey 45 Series for water, or equal.
6. Manifolds:
   a. Type: 5-valve and 3-valve meter manifolds.
   b. Materials: Type 316 stainless steel body, bonnets and stems; delrin seats; teflon packing.

c. Products and Manufacturers: Provide one of the following:
   1) Anderson-Greenwood.
   2) Or equal.

2.2 AC POWER ON-OFF SWITCH (Not Applicable)

2.3 LOW TEMPERATURE (OUTDOOR) INSTRUMENT AND GAUGE CASES (Not Applicable)

2.4 LEVEL TRANSMITTERS - RADAR TYPE

A. Type: Microprocessor based, non-contacting, radar type continuous liquid level measuring system consisting of an antenna with attached transmitter. The radar liquid level measuring system shall produce an output signal linear with level.

B. Performance Requirements:
   1. Range: As specified in the Instrument Index.
   2. Local Indication: Identical to Range.
   3. Accuracy: 0.1 percent of range.
   4. Reaction Time: One second, minimum.
   5. Vibration Resistance: 20 to 2000 Hz.
   6. Power: 24 VDC loop power.
   7. Output: Isolated 4 to 20 mADC, into 0 to 550 ohms.
   8. Process Pressure (maximum): 150 lbs.
   9. Ambient Temperature Limits:
      a. Transmitter: -40 to 176 degrees F.
      b. Antenna/seal: -40 to 150 degrees F
   10. Level sensor shall be rated for the environment it will be installed; Class 1, Division 1.

C. Construction Features:
   1. Enclosure:
      a. NEMA 4X.
      b. Enclosure material: Powder coated aluminum.
   2. Electrical Connection: 1/2-inch NPT.
   3. Mounting: Three-inch flange mounting.

D. Accessories:
   1. Mounting Hardware: Three-inch flange with Type 316 stainless steel hardware.
   2. Antenna Extension: Sized as required to allow antenna to clear end of floor pipe or nozzle.
   3. Weather shield/protective cover.

E. Products and Manufacturers: Provide one of the following:
   1. Endress+Hauser, Model Micropilot, FMR60.
   2. Or equal.

2.5 PRESSURE SWITCHES

A. Type: Switch assembly with diaphragm/piston pressure sensor.

B. Function: Sense gauge or absolute pressure and open or close a contact when the pressure reaches the specified trip point.

C. Performance Requirements:
   1. Operating Range: As specified in the Instrument Index.
   2. Setpoint: As specified in the Instrument Index.
   3. Setpoint Repeatability: ± One percent of range.
   4. Output: Snap action switch, SPDT rated not less than ten amp resistive at 120 VAC and 1/2 amp resistive at 125 VDC.
   5. Switch and Reset Action: Adjustable deadband.
   6. Adjustable Deadband Range and Setting: As specified in the Instrument Index.
   7. Ambient Temperature Limits: -4 degrees F to 140 degrees F.

D. Construction Features:
   1. Pressure Transducer Housing and Diaphragm Materials: Coordinate with the process piping materials.
      a. Water Service with Copper Pipe: Brass housing with Buna-N diaphragm.
      b. Other Services: Housing and diaphragm to be compatible with the process fluid as indicated in the Instrument Index.
   2. Set and Reset Point Adjustments: Adjustable external adjusting nuts and pressure setting scales in psi.
   3. Process Connection: 1/4-inch NPT.
   4. Housing: Copper-free die cast aluminum, NEMA 4. NEMA 7 construction required for hazardous locations.
   5. External Mounting Lugs.
   6. Adjusting Nuts Metal Cover with Gasket.
   7. Electrical Connection: 3/4-inch NPT.

E. Products and Manufacturers: Provide one of the following:
   1. Automatic Switch Company, Tri-point SA Series.
   2. Or equal.

2.6 PRESSURE GAUGE – BOURDON TUBE

A. Type: Bourdon Tube Pressure Element Type, Liquid Filled Gauge (for pressure ranges of 15 psi and greater and vacuum ranges to 30-inches Hg):

B. Performance Requirements:
   1. Range: As specified in the Instrument Index.
   2. Accuracy: ±0.5 percent of span (ANSI B40.1 Grade 2A).

C. Construction Features:
   1. Case:
      a. Solid front design constructed of glass filled polyester.
      b. Color: Black.
   2. Size: 4-1/2-inch.
   3. Ring: Threaded, glass filled polyester.
   4. Window: Glass.
   5. Dial: White with black markings.
   6. Filling Liquid: See Article 1.8.
   7. Overpressure protection: Full blowout back.
   8. Bourdon Tube and Socket:
      a. Type 316 stainless steel.
      b. Heliarc welded, unless otherwise specified.
   9. Movement:
      a. Type 300 series stainless steel.
      b. Rotary geared with Teflon S coating, or cam and roller type.
      c. Built-in overload and underload movement stops.
   10. Connection: 1/4-inch male NPT, bottom.
   11. Mounting: Stem Mount.
   12. Calibration:
      a. Adjustable pointer.
      b. Externally accessible zero adjustment.

D. Accessories:
   1. Pressure Snubber: Sintered stainless steel snubber threaded into gauge socket or in external stainless steel housing with 1/4-inch NPT male and female connections.
   2. Process Isolation: Provide ball valves for process isolation in accordance with the requirements of Article 2.1, above.

E. Products and Manufacturers: Provide one of the following:
   1. Ashcroft, Duragage 1279 Series.
   2. Helicoid, Series 900.
   3. Wika EN 837.
   4. Or equal.

2.7 CORIOLIS FLOWMETER

A. Type: Coriolis flow meter for permanent installation above ground. The meter shall utilize a measuring principle based on the controlled generation of Coriolis forces, whereby both translational and rotational movements are superimposed. The Coriolis flow meter shall produce flow rate, density, temperature, and viscosity measurements when specified.

B. Performance Requirements:
   1. Accuracy: Each meter shall ship with a certificate of a 2-point calibration report exceeding stated standard accuracy of 0.25% to 0.05% of rate as specified.
   2. Repeatability: 0.25% to 0.05% of rate as specified.
   3. Signal Output: 4 to 20 mADC, isolated, 0 to 600 ohms load.
   4. Operating Pressure: Maximum of 1,400 psig.
   5. Flow Element Range: 0 to 80,850 lb/min.
   6. Power Input: 24V DC, ± 20% Terminal Voltage, 10 Watts max.
   7. Operating Temperature:
      a. Flow Element: -40 degrees F to 140 degrees F.
      b. Flow Transmitter: -4 degrees F to 140 degrees F.
   8. Flow Range: As specified in the Instrument Index.
   9. Pipeline Size: As shown.
   10. Calibration: Factory calibrated at a specified flow range under given conditions.

C. Construction Features:
   1. The flow meter shall be a flanged sensor (by application and instrument schedule) and transmitter mounted integral (compact) to the sensor.
      a. The flow meter shall be microprocessor based and possess a method in which to store the sensor calibration and transmitter setup information in non-volatile memory. The electronics shall be interchangeable for meters sizes 3/8” – 10”
      b. The sensor shall be the proper size to measure the design flow rate of the piping and measure bi-directional flow as a standard.
      c. The sensor shall include a dual tube Stainless Steel or Alloy C22 material design to promote compatibility, easy installation and maintenance.
      d. The system shall simultaneously produce several process variables (ex. mass flow, volume flow, density, or temperature) while in operation.
      e. The system shall be a compact design insensitive to external vibrations and immune from external piping forces due to robust design
      f. The measuring principal shall operate independently of physical fluid properties such as viscosity and density.

g. The sensor design shall be fully drainable under the installation criteria specified in the technical documentation supplied with the meter.

h. The flow meter shall be designed to perform in a fiscal custody measurement application and be provided with a National Type Evaluation Program certificate for country compliance.

2. The transmitter shall be a three-stage microprocessor controller mounted integrally as specified in the instrument schedule. The transmitter shall operate on AC (100 to 240V) or DC (24 V) via a dedicated or universal power supply as specified. The transmitter housing will carry a NEMA 4X rating and shall be constructed to prevent moisture ingress, promote corrosion resistance, and be impervious to saline environments.

a. The transmitter shall allow local or remote programming that can be operated via an optical display or WLAN connection without opening the compartment.

b. The transmitter display shall indicate simultaneous flow rate and total flow with three Totalizers (eg. forward, reverse and net total) and user-selectable engineering units, readout of diagnostic remedy messages, and support at least 19 standard languages.

c. The transmitter shall safeguard against entering of invalid data for the particular meter size and all programming parameters shall be access-code protected and retained in the embedded HistoROM.

d. The transmitter primary output shall be specified, as:

4-20mA HART

And up to (2) secondary configurable analog I/O slots (freely programmable to 4-20mA in/output, 0-10 kHz pulse/frequency, or status input)

e. The transmitter output(s) shall be integral to the Coriolis flowmeter transmitter electronics; using an external third party signal converter is unacceptable.

f. The transmitter output selected must be supported by Add-on Instructions (AOI), faceplates, device drivers, instructions and pre-engineered code.

g. The transmitter shall internally retain all setup parameters, calibration parameters and accumulated measurements in non-volatile memory in the event of power failure.

h. The transmitter shall be protected against voltage spikes from the power source with internal transient protection.

i. The transmitter and sensor must support an onboard, ISO traceable means of attested in-situ verification utilizing redundant references to validate measurement quality over the lifespan.

j. The transmitter shall provide access to service and monitoring parameters designed to identify transient or permanent process influences.

k. The transmitter shall provide lock-out from vandalism or programming changes of K-factor and zero point when used for fiscal measurement as specified.

l. The transmitter shall support commissioning and maintenance options via a service interface for operation via an internal web server, accessible via a standard RJ-45 cable.

m. The transmitter shall include a wireless local area network (WLAN) option built into the device display with a five meter operating range. The WLAN shall permit unique SSID programming, four encryption levels and activation/deactivation of the function at the owner preference.

3. Remote configuration shall be capable of being performed thorough the programmable automation controller with common off the shelf tools, software, interfaces or gateways. Generic profiles or special tools and hardware will not be acceptable.

D. Accessories:
1. Stainless steel tag - labeled to match the contract documents.

E. Products and Manufacturers: Provide one of the following:
1. Endress+Hauser - Promass F 300
2. Or equal.

2.8 SPARE PARTS AND TEST EQUIPMENT

A. Each instrument shall be tested before commissioning and the ENGINEER shall witness the interface capability in the PLC control system and associated registers.

B. Each instrument shall provide direct programming capability through the PLC.

C. Each instrument shall provide direct control of totalizer reset functions through the PLC.

D. Each instrument shall be supported with a device profile permitting direct integration in the PLC.

E. The ENGINEER shall witness all instrument verifications in the field.

F. Manufacturers Field Services are available for start-up and commissioning by a Factory field service representative or a manufacturer's authorized service provider (ASP) – the warranty against manufacturing defects is three years.

G. Manufacturer representative shall verify installation of all installed flow tubes and transmitters.

H. Manufacturer representative shall notify the ENGINEER in writing of any problems or discrepancies and proposed solutions.

I. Manufacturer representative shall perform field verification at the time of installation for long-term analysis of device linearity, repeatability and electronics health. A comparative report shall be generated for each meter tested.

J. Manufacturer representative shall generate a configuration report for each meter.

K. Verify factory setup of all instruments in accordance with the Manufacturer's instructions.

PART 3 - EXECUTION

3.1 INSTALLATION

A. As shown on installation details and mechanical Drawings.

B. As recommended by the manufacturer's installation and operation manual.

C. Specific attention should be given to the following technical requirements:
   a. Verify flow meter is not installed at the high point of a piping system or directly upstream of a free pipe outlet in a downward flowing pipe.

D. Conform to all applicable provisions of the NEMA standards, NEC and local, State and Federal codes when installing the equipment and interconnecting wiring.

3.2 START-UP, CALIBRATION, TESTING, AND TRAINING

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions, Section 40 61 23, Process Control System Startup and Field Testing, and Section 40 61 26, Process Control System Training.

+ + END OF SECTION + +

[THIS PAGE INTENTIONALLY LEFT BLANK]

SECTION 40 78 00

PROCESS CONTROL PANEL INSTRUMENTS AND DEVICES

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. Provide all labor, materials, equipment and incidentals as shown, specified and required to furnish, install, calibrate, test, adjust and place into satisfactory operation panel instruments and devices.
   2. Contract Documents illustrate and specify functional and general construction requirements of the panel components and do not necessarily show or specify all components, wiring, piping and accessories required to make a completely integrated system. Provide all piping, wiring, accessories and labor required for a complete, workable and integrated system.

B. Coordination: Coordinate the installation of all items specified herein and required to ensure the complete and proper interfacing of all the components and systems.

1.2 QUALITY ASSURANCE

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

B. Acceptable Manufacturers:
   1. Furnish instruments and devices by the named manufacturers or equal equipment by other manufacturers.
   2. The named manufacturers have been specified to establish the standard of quality and performance of the equipment to be supplied.
   3. Obtain all instruments or devices of a given type from the same manufacturer.

C. Manufacturers' Responsibilities and Services:
   1. Design and manufacture the instruments and devices in accordance with the applicable general design requirements specified in Section 40 61 13, Process Control System General Provisions, and the detailed Specifications herein.
   2. Field supervision, inspection, start-up and training in accordance with the requirements of Section 40 61 23, Process Control System Startup and Field Testing, and Section 40 61 26, Process Control System Training.

1.3 SUBMITTALS

A. Comply with the requirements of Section 40 61 13, Process Control System General Provisions.

1.4 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Comply with the requirements specified in Section 40 61 13, Process Control System General Provisions.

B. Instruments and devices shall not be assembled in the panels until all product information and system Shop Drawings for respective components have been approved.

1.5 IDENTIFICATION TAGS

A. All panel instruments and devices shall have an identification tag meeting the following requirements:
   1. Tag numbers shall be as listed in the Instrument Index.
   2. Identifying tag number shall be permanently etched or embossed onto a stainless steel tag which shall be fastened to the device housing with stainless steel rivets or self tapping screws of appropriate size.
   3. Where neither of the above fastenings can be accomplished, tags shall be permanently attached to the device by a circlet of 1/16-inch diameter stainless steel wire rope.
   4. All instruments and devices mounted within panels shall have the stainless steel identification tag installed so that the numbers are easily visible to service personnel. Front of panel mounted components shall have the tag attached to the rear of the device.
   5. Front of panel mounted components shall have nameplates, which comply with the requirements specified in Section 40 67 17, Process Controls Panels and Enclosures.

PART 2 - PRODUCTS

2.1 POWER SUPPLIES

A. Function: Provide DC power for two wire current loops. Provide a separate dedicated power supply for each current loop.

B. Type: A single output, regulated, plug-in type 24 Vdc power supply.

C. Performance Requirements:
   1. Temperature: Operational from -10 to 65°C.
   2. Output: 24 VDC, current load determined by equipment.

3. Power Requirements: 120 VAC, 60 Hz, single phase.
4. Regulation: ±1.0%.
5. Ripple: 100 mV RMS.
6. Protection: Overvoltage protection.
7. Approval: U.L. recognized.

D. Construction Features:
1. Mounting: Power supply to snap onto DIN rail.

E. Manufacturer and Model:
1. Phoenix Contact MINI-PS-100-240AC/24DC Series.
2. Sola SDP Series.
3. Or equal.

2.2 UNINTERRUPTIBLE POWER SYSTEM (Not Applicable)

2.3 SELECTOR SWITCHES, PUSHBUTTONS AND INDICATING LIGHTS

A. Type: Full size (30.5 mm), heavy duty, oiltight, round type operators with modular contacts and NEMA rating equal to that of the enclosure on which devices are installed.

B. Performance Requirements:
1. Selector switches, pushbuttons and indicating lights shall be supplied by one manufacturer and be of the same series or general model type.
2. Provide individual legend plates for indication of switch, pushbutton, and light functions (e.g. Open, Closed, Hand-Off-Auto). Legend plates shall conform to the requirements of Paragraph 2.2 above.
3. All components shall be flush mounted on front of panel, unless otherwise noted.

C. Construction Features:
1. Selector Switches:
   a. Two (2), three (3) and four (4) position as required.
   b. Maintained or momentary contacts; number and arrangement as required to perform intended functions specified but not less than one double pole, double throw, double break contact per switch. Contact rating shall be compatible with ac or dc throughput current of devices simultaneously operated by the switch contacts but not less than 10 amperes resistive at 120 volts AC or DC continuous.
   c. Black knob operator.
2. Pushbuttons:
   a. Maintained or momentary as required and as shown on the Drawings.
   b. Contacts shall comply with requirements specified for selector switches above.

c. Provide extended head pushbutton for all stop functions and flush head pushbuttons for all other functions.
d. Colors:
1) Red - Start, Open.
2) Green - Stop, Close.
3) Black - Status.

3. Indicating Lights (LED type):
a. Transformer type pilot lights.
b. LED types.
c. 120 VAC.
d. Remote common test or integral push-to-test as specified above.
e. Lens Colors:
1) Red – Running, Open.
2) Green - Stopped, Closed.
3) Amber - Malfunction.
4) White - Status.
5) Blue - Power On.

D. Product and Manufacturers:
1. Allen-Bradley Types 800T and 800H.
2. Or equal.

2.4 DIGITAL INDICATOR

A. Type: Digital panel meter, utilizing current to convert analog signal to LED readout.

B. Required Construction Features:
1. Accept 1-5V dc or 4-20 mA dc input signal.
2. Accuracy: 0.05%, 2 counts.
3. Zero and span adjustment/scaling.
4. Display: 4 digits (9999) minimum LED display.
5. Mounting: Housing designed for front panel mounting. Provide NEMA 4X rated front when required.
6. Power Supply: 120 Vac, 50/60 Hz.
7. Resistors: Provide 1% precision resistors for 4-20 mA dc input signal conversion where required.
8. Display Segment Size: 0.56 inches.
9. Display Color: Red.
10. Relays: Adjustable alarm trip with 2 SPDT relay contacts rated at 2 amps at 250VAC.
11. Loop Power: 24 VDC loop power for two-wire instruments.
12. Range and Scale: As specified in Instrument Schedule for associated signal transmitter.
13. Provide relay output module.

C. Manufacturer and Model:
   1. Precision Digital, Model PD765.
   2. Or equal.

2.5 CONTROL RELAY

A. Type: General purpose, plug-in type rated for continuous duty.

B. Performance Requirements:
   1. UL recognized.
   2. Contact Configuration: Number and arrangement as required to perform the intended functions, plus a minimum of one spare SPDT contact per relay function.
   3. Coil Voltage: 24 VDC or 120 VAC as required.

C. Construction Features:
   1. Contact Material and Rating:
      a. General Use: Silver or silver cadmium oxide contacts rated for 10 amps minimum at 120 VAC.
      b. Low Power Switching: Fine silver, gold flashed contacts specifically designed for low power switching, rated for 2 amps minimum at 30 VDC.
   2. Mounting: Pin or blade mount in sockets for subpanel mounting on DIN rail. Sockets shall have screw terminals for wiring connections which shall accept a minimum of two #14 AWG wires.

D. Accessories:
   1. Clear plastic dust cover, with hold down clips.
   2. Indicator light.

E. Manufacturer and Model:
   1. Potter & Brumfield, KRPA or R10-T.
   2. IDEC, RR Series, or RY Series.
   3. Or equal.

2.6 TIME DELAY RELAY

A. Type: Dial adjustable, plug-in type time delay relay providing delay-on-make, delay-on-break or interval operation.

B. Construction Features:
   1. MOS digital circuit with transformer coupled power.
   2. Two different dial selectable timing range versions as listed below. Provide timing range version as required by the application:
      a. Six dial selected ranges of 1 or 10 sec/min/hours.
      b. Six dial selected ranges of 5 or 50 sec/min/hours.

3. Minimum Setting: 2 percent of range, with exception of 50 ms for the 1 second range.
4. Contacts:
   a. Type: DPDT.
   b. Rating: 10 amperes resistive at 120/240 VAC and 30 VDC.
5. Housing: Plug-in design with dust and moisture resistant molded plastic case, designed for 11 pin surface/DIN rail socket mounting or panel cutout mounting with rear facing terminal socket.
6. Power Input: Universal 24-240 VAC and 24 V dc, reverse polarity protected.
7. Relays to be UL recognized.
8. Flashing cycle in progress indication via front mounted LED.
9. Large easy to read dial display with decimal points automatically displayed when fractional ranges are selected.

C. Manufacturer and Model:
   1. Automatic Timing and Controls Company, Series 339.
   2. Or equal.

2.7 BEACON

A. Performance Requirements:
   1. 10,000 hour strobe tube.
   2. 300 effective candela power.
   3. 1,000,000 peak candela power.
   4. Red lens.

B. Construction Features:
   1. Type 4X rating.
   2. Mounting: Surface mounted.
   3. Housing: NEMA 4X, corrosion resistant finish.
   4. Power: 120 VAC, 60 Hz.
   5. U.L. listed.

C. Manufacturer and Model:
   1. Federal Signal Model FB2PST
   2. Or equal.

2.8 SPARE PARTS AND TEST EQUIPMENT

A. Spare replacement instruments and components shall be provided for the panel mounted devices as follows. Round up to the nearest component.
   1. 2 of each type and color of bulb used in the system.
   2. 5 of each type of fuse used in the system.
   3. 1 of each type of relay used in the system.
   4. 1 of each type of power supply used in the system.

B. All spare parts shall be individually packaged for protection against impact, moisture and dirt. Each package shall be clearly labeled as to its contents with a description and part number.

C. All spare parts shall become the property of the OWNER. Supplier shall maintain the spare parts inventory as listed above, and replace, at no additional cost, all spare parts consumed during the one-year warranty period.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install equipment in conformance with Underwriters Laboratory.

B. Install and interconnect all equipment, devices, electrical hardware, instrumentation and controls, and process controller components into and out of and among the enclosures as indicated on the Drawings.

3.2 START-UP, CALIBRATION, TESTING AND TRAINING

A. Comply with the requirements of Section 40 61 23, Process Control System Startup and Field Testing, and Section 40 61 26, Process Control System Training.

+ + END OF SECTION + +

SECTION 40 96 20

SCHEDULES: FIELD INSTRUMENTS

PART 1 - GENERAL

1.1 SUMMARY

A. The Schedules Field Instrument is not a take-off list. Refer to Drawings and Specifications for additional information. Where any discrepancies between this list and the P&ID drawings arise, the P&ID shall govern.

B. Abbreviations used in the Instrument Index are defined on the Drawings.

C. The "Notes" column contains the following information in order from left to right:
   1. Process fluid.
   2. NEMA enclosure type.
   3. Integral or Remote transmitter.
   4. Where "N/A" is listed, the information is not relevant to the instrument type, or can be found in the body of the associated instrument Specification.

D. Vendor supplied instruments are not included in the Schedules Field Instrument.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 SCHEDULES FIELD INSTRUMENT

A. Schedules Field Instrument attached.

END OF SECTION

TABLE 40 96 20 - FIELD INSTRUMENT SCHEDULE							
P&ID Drawing Number	Tag	Type-ClassName	Status	Instrument description	Size / Rating	Setpoints / Range	Comments
I-03	TSH-001	Field Discrete Instrument	New	Motor Overtemp Switch			
I-03	TSH-011	Field Discrete Instrument	New	Motor Overtemp Switch			
I-03	PSH-011	Field Discrete Instrument	New	Pressure Switch		35 / 20-35 psig	
I-03	TSH-012	Field Discrete Instrument	New	Motor Overtemp Switch			
I-03	PI-011	Field Analog Instrument	New	Pressure Gauge - Bourdon Tube		15-30 psig	
I-03	PSH-012	Field Discrete Instrument	New	Pressure Switch		35 / 20-35 psig	
I-03	PI-012	Field Analog Instrument	New	Pressure Gauge - Bourdon Tube		15-30 psig	
I-03	LE/LIT-001	Field Analog Instrument	New	Level Transmitter - Radar Type		0-16 ft	LAHH Setpoint 15.6 FT LALL Setpoint 1.7 FT
I-04	TSH-021	Field Discrete Instrument	New	Motor Overtemp Switch			
I-04	PSH-021	Field Discrete Instrument	New	Pressure Switch		35 / 20-35 psig	
I-04	PI-021	Field Analog Instrument	New	Pressure Gauge - Bourdon Tube		15-30 psig	
I-04	TSH-022	Field Discrete Instrument	New	Motor Overtemp Switch			
I-04	PSH-022	Field Discrete Instrument	New	Pressure Switch		35 / 20-35 psig	
I-04	PI-022	Field Analog Instrument	New	Pressure Gauge - Bourdon Tube		15-30 psig	
I-04	FIT-001	Field Analog Instrument	New	Coriolis Flow Meter	3"	20-70	

SECTION 41 22 13

STATIONARY DAVIT CRANE

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install a stationary davit crane complete and operational.
   2. Included are crane unit assembly, anchorage systems and all appurtenances.
   3. Extent of the equipment is shown on the Schedule of Service Conditions contained in Part 2 of this specification.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the davit crane Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 09 91 00, Painting.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Manufacturers Association, (ABMA).
   2. American Gear Manufacturers Association, (AGMA).
   3. American Institute of Steel Construction, (AISI).
   4. American National Standards Institute, (ANSI).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years' experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section, regardless of the component manufacturer, from a single manufacturer.
   2. The davit crane equipment manufacturer to review and approve or prepare all

Shop Drawings and other submittals for all components furnished under this Section.

3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the inline grinder equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, data sheets, fabrication, assembly and mounting drawings to demonstrate compliance with specified requirements. Data must include at least:
         1. Materials of construction.
         2. Dimensional drawings.
         3. Design loads at each crane position.
         4. Weight of the complete assembly.

B. Closeout Submittals:
   1. Operation and Maintenance Manuals:
      a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
      b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. General:
   1. Stationary Davit Crane shall be installed at the location indicated in the drawings and shall be used primarily for removal of rock trap basket screen. Davit crane shall be supplied with pedestal base and power winch.

B. Design Parameters
   1. Operation: Electric with pendant control station.
   2. Power supply: 120/1/60 VAC.
   3. Lift capacity: 1,000 lbs (minimum) at all boom positions.
   4. Hook reach: Boom when horizontal shall have a minimum reach of 65 inches measured from mast center to hook center.
   5. Hook height: Hook height shall be adjustable to two positions, one at horizontal and the other at 45 degrees from vertical, with a minimum of 30 inches between the lowest position and the highest position.
   6. Clearance: Minimum height of the boom shall be 48 inches between mounting surface and the underside of the boom.
   7. Rotation: Mast and boom shall rotate 360 degrees at the base.

2.2 MANUFACTURERS

A. Products and Manufacturers:
   1. Thern - Commander 1000 Series.
   2. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Materials:
   1. Crane boom, mast and base fabricated from heavy duty welded constructed structural steel pipe and tubing that limits deflection and meets ASTM standards.
   2. Finish: Stainless Steel.

2.4 ANCHOR BOLTS

A. Furnish adhesive anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturers. Anchor bolt materials shall be of 316 stainless steel conforming to the requirements of Section 05 05 33, Anchor Systems.

2.5 SURFACE PREPARATION AND PAINTING

A. Surface preparation and painting shall conform to the requirements of Section 09 91 00, Painting.

B. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

2.6 LUBRICANTS

A. Furnish lubricants and oil and grease as required for initial operation. Products shall be as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSPECTION AND INSTALLATION

A. CONTRACTOR shall verify that crane is installed on a level surface.

B. Follow Manufacturer's instructions for recommended assembly sequence and general crane installation.

C. Lubricate entire crane before testing.

3.2 FIELD QUALITY CONTROL

A. All equipment will be given running tests by CONTRACTOR at the Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately and is ready for permanent operation.

B. Test procedure must be executed by operating the crane with a load not exceeding the load rating, according to manufacturer’s recommendations. The winch handle must rotate freely in both directions. Boom must rotate freely when pushed and remain stationary when released.

+ + END OF SECTION + +

SECTION 43 21 36.23

ROTARY LOBE PUMPS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install positive displacement lobe pumps complete and operational.
   2. Included are pump, motor, drive, belt,coupling, mounting base, anchorage systems and all appurtenances applicable, as shown and specified.
   3. Extent of the equipment is shown in Part 2 of this Section.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before the positive displacement lobe pumps Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 23, Anchor Systems.
   3. Section 09 91 00, Painting.
   4. Section 40 05 93, Common Motor Requirements for Process Equipment.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearings Manufacturers Association, (ABMA).
   2. American Gear Manufacturers' Association, (AGMA).
   3. American National Standards Institute, (ANSI).
      a. ANSI S5.1, CAGI-PNEUROP Test Code for the Measurement of Sound from Pneumatic Equipment.
   4. ANSI/Hydraulics Institute, (ANSI/HI).
   5. American Society for Testing and Materials, (ASTM).
      a. ASTM A 536, Specification for Ductile Iron Castings.
   6. Institute of Electrical and Electronics Engineers, (IEEE).
   7. National Electrical Code, (NEC).
   8. National Electrical Manufacturers' Association, (NEMA).

1.3 QUALITY ASSURANCE

A. Manufacturer’s Qualifications:

1. Manufacturer shall have a minimum of five years' experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section regardless of the component manufacturer from a single rotary lobe pump manufacturer.
   2. The rotary lobe pump manufacturer shall review and approve or shall prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically designed for corrosive and abrasive FOG service and shall be integrated into the overall equipment design by the rotary lobe pump equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, illustrations, specifications, and engineering data, including materials of construction for all components of the equipment being furnished.
      b. Performance data and curves showing allowable suction lift, flow rate, head, brake horsepower, motor horsepower and speed. Where variable speed units are specified, curves shall have at least five speeds plotted between maximum and minimum rpm.
   2. Shop Drawings:
      a. Drawings showing fabrication methods, assembly, accessories, installation details and wiring diagrams.
      b. Setting drawings, templates, and directions for the installation of anchor bolts and other anchorages.

B. Informational Submittals: Submit the following:
   1. Source Quality Control Submittals:
      a. Submit copies of pump performance test results and hydrostatic test.
   2. Site Quality Control Submittals:
      a. Submit a written report giving the results of the required field tests.
      b. Submit a written report of the results of each visit by a manufacturer's service representative, including purpose and time of visit, tasks performed and results obtained.

C. Closeout Submittals: Submit the following:
   1. Operation and Maintenance Data:
      a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
      b. Furnish Operation and Maintenance Manuals in conformance with the

requirements of Section 01 78 23, Operations and Maintenance Data.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work.
   2. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. General: Design equipment to be suitable for the process and service conditions described below and in the Design Criteria.
   1. Pumps shall be heavy-duty positive displacement rotary lobe pumps industrial type. Each pump shall be capable of bi-directional rotation and shall be able to run dry for an indefinite period of time.
   2. The pumps, when installed and operating with motors and all appurtenances, shall not have a noise level greater than 90 dBA emanating from the pump assembly at a distance of five feet from the pump assembly at any specified or required speed.

B. Design Criteria:
   1. Offloading/ Mixing Pumps
      a. Number of Pumps: 2
      b. Liquid Pumped: pre-screened brown FOG
      c. Maximum Solid to be Passed: 1”
      d. Solids, (percent): 7%
      e. Maximum Liquid Temperature: 100ºF
      f. pH: 4 – 8, corrosive
      g. Suction Condition: flooded
      h. Pump Suction Size: 6”
      i. Design Point: 180 gpm @ 30 psig discharge pressure

j. Motor Horsepower: 7.5 HP
k. Variable Frequency Drive: No
l. Configuration: Overhead frame design with cogged or v-belt.

2. Metering Pumps
   a. Number of Pumps: 2
   b. Liquid Pumped: pre-screened brown FOG
   c. Maximum Solid to be Passed: 1”
   d. Solids, (percent): 7%
   e. Maximum Liquid Temperature: 100ºF
   f. pH: 4 – 8, corrosive
   g. Suction Condition: flooded
   h. Pump Suction Size: 4”
   i. Design Point: 70 gpm @ 30 psig discharge pressure
   j. Required turndown with VFD: 20 gpm@30psig
   k. Motor Horsepower: 5 HP
   l. Variable Frequency Drive: Yes
   m. Configuration: Direct coupling.

2.2 MANUFACTURERS

A. Manufacturers: Provide equipment of one of the following:
   1. Boerger
   2. Vogelsang
   3. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Pump Materials and Construction:
   1. Construct pump body and casing of ductile iron ASTM A 536, having a Rockwell "C" hardness of not less than 150 to 190. The front end cover shall have a Rockwell "C" hardness of not less than 700.
   2. Rotor shall be of multi-lobe form and suitable for pumping FOG containing grit. All parts in contact with FOG must be Stainless Steel or BUNA-N. Rotors shall be securely located on shafts by a locking assembly to render the rotors easily replaceable. The rotor case shall have replaceable wear plates.
   3. Flush end cover shall not have any recesses or dead pockets where solids can accumulate. The cover shall be sealed with a BUNA-N O-ring and shall provide complete access to the pump chamber without disconnecting piping, glands, or bearings.
   4. Flush end cover shall be bolted to the casing with stud bolts to permit reversal of the cover. The front end cover shall be mounted on hinges arranged so that the cover is fully supported when pulled from the pump and swung aside to provide complete access to the rotors.
   5. Construct shafts of carbon-steel and fit with replaceable stainless steel shaft sleeves, where passing through the gland area. Shafts shall be timed in their rotation by straight cut, zero backlash, high quality gears, keyed to the shafts

and running in a separate oil chamber. Shaft bearings shall have a minimum B-10 life of 100,000 hours at the maximum operating condition.

6. Pump shall be fitted with mechanical seals, one seal per shaft. Mechanical seal shall be a double inside mounted end face seal of the rubber bellows type as manufactured by John Crane, or equal. Seal shall be suitable for the specified pump pressures. O-rings material: BUNA-N.
7. Pump shall have side suction and discharge connections which shall be ANSI Class 150 pound American Standard.
8. Pump shall be mounted on a steel base plate reinforced to resist shock loads during operation.
9. Shaft slingers shall be provided.
10. Attach a stainless steel nameplate giving the manufacturer's model and serial number, rated capacity, head, speed and all other pertinent data.

B. Motor:
1. Motors shall conform to the requirements of Section 40 05 93, Common Motor Requirements for Process Equipment.
2. Motors shall be a totally enclosed fan cooled motor with Class B insulation, with a maximum speed of 1,800 rpm.
3. Motors shall be suitable for operation on 480 volt, 3 phase 60 Hz power.
4. Motors for use with variable frequency drives shall be inverter duty type and shall be compatible with characteristics of the intended variable frequency inverters.
5. Provide space heaters, 120 volt, single phase.
6. Provide thermostat type winding thermal protection for motors.
7. Motors shall have a 1.15 service factor, and shall comply with the latest ANSI, NEMA, ABMA and IEEE Standards as a minimum.
8. Locked rotor current shall be as specified in NEMA standards.
9. Motor terminal boxes shall be oversized to provide adequate space for connections and shall be constructed of cast-iron or fabricated steel, neoprene gasketed and bolted. The motor leads shall be permanently marked in agreement with the connection diagram.

C. Flexible Coupling:
1. Direct Connection pumps:
   a. Furnish a flexible, forged steel coupling of an approved type for connecting the pump and motor. Provide coupling of the proper size to transmit the power required to drive the pump under all conditions of operation. Coupling shall be suitably lubricated and designed for long periods of continuous operation. Coupling design shall take care of inaccuracies of alignment and permit axial adjustment. Coupling construction shall be such that either shaft of a unit may be removed without disturbing adjustment of the other. Provide and install a steel guard over the coupling.

D. Common Steel Base:

1. Direct Connection Pumps:
   a. Factory mount pump and motor, coupled together, on a common steel base, properly braced to form a rigid support for the entire unit. Factory align the units on the base prior to shipment.
2. Belt Driven Pumps:
   b. Factory mount pump and belt drive assembly, coupled together on a common steel base, properly braced to form a rigid support for the entire unit. Factory align the units on the base prior to shipment.

2.3 TOOLS AND SPARE PARTS

A. Furnish and deliver the following boxed and labeled.
   1. Furnish the following spare parts for each size pump:
      a. Two sets of packing.
      b. One set of gaskets.
      c. One shaft.
      d. One set of bearings.
      e. Front cover "O" ring.
      f. One set of lobes.
      g. One set of shaft sleeves.
      h. Two sets of any special tools required for normal maintenance and operation.
      i. One set of replacement belts (for the overhead frame pump).
   2. The following spare parts shall be furnished for each size mechanical variable speed drive:
      a. One set of bearings.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part.

2.4 ANCHOR BOLTS

A. Furnish anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturer. Anchor bolt materials shall be of 316 stainless steel conforming to the requirements of Section 05 05 23, Anchor Systems.

2.5 SHOP PAINTING

A. Surface preparation and prime coat ferrous metal surfaces of equipment in the shop in accordance with the requirements of Section 09 91 00, Painting.

B. Surface preparation and painting shall conform to the requirements of Section 09 91 00, Painting.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. CONTRACTOR shall certify, in writing, that the shop primer and shop finish coating system conforms to the requirements of Section 09 91 00, Painting.

2.6 LUBRICANTS

A. Furnish lubricant and oil and grease as required for initial operation. Use products recommended by the manufacturer.

2.7 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Shop test each pump as follows:
      a. Hydrostatically test each pump casing. The pump test shall comply with ANSI/HI 3.6-2016; The test Type shall be appropriate with pump size specified.

PART 3 - EXECUTION

3.1 INSPECTION

A. Inspection:
   1. Inspect and verify that structures or surfaces on which equipment will be installed have no defects which will adversely affect installation.
   2. Inspect all equipment prior to installation.
   3. Promptly report defects which may affect the Work to ENGINEER.

3.2 INSTALLATION

A. Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and adjust the equipment to assure that the system operates to the OWNER'S satisfaction.

B. Install pumping units on concrete bases and secure with anchor bolts in accordance with the manufacturer's recommendations complying with ANSI/HI 3.5 and as shown. Concrete bases shall be poured up to 1-inch below the metal bases or soleplates. Concrete work and grout are specified in Division 03, Concrete. The base with the equipment mounted thereon, or the soleplate, shall then be accurately shimmed to grade and the spaces between filled with an approved non-shrink grout.

After the grout has reached its initial set, exposed edges shall be cut back 1/2-inch and the edges neatly finished with 1 to 2 cement mortar.

3.3 FIELD PAINTING

A. Field painting shall conform to the requirements of Section 09 91 00, Painting.

3.4 FIELD QUALITY CONTROL

A. All equipment will be given running tests by CONTRACTOR at the Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately, and is ready for permanent operation.
   1. Following running tests with clean water, pumps shall be tested with FOG to be provided by the OWNER. CONTRACTOR to coordinate with the OWNER and the ENGINEER to schedule FOG receiving to the site and pump testing.

B. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 02 visits, minimum 04 hours on-Site for each visit, to the Site. Manufacturer's representative shall test operate the system in the presence of the ENGINEER and verify that the pumps conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

C. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the OWNER.

++ END OF SECTION ++

SECTION 46 24 23

INLINE GRINDER AND ROCK TRAP

PART 1 - GENERAL

1.1 DESCRIPTION

A. Scope:
   1. CONTRACTOR shall provide all labor, materials, equipment and incidentals as shown, specified and required to furnish and install rock trap and inline grinding equipment complete and operational.
   2. Included are manual rock trap, grinder, drive unit assembly, control panel, anchorage systems and all appurtenances.
   3. Extent of the equipment is shown on the Schedule of Service Conditions contained in Part 2 of this specification.

B. Coordination:
   1. Review installation procedures under this and other Sections and coordinate the installation of items that must be installed with, or before, the inline grinders Work.

C. Related Sections:
   1. Section 03 60 00, Grouting.
   2. Section 05 05 33, Anchor Systems.
   3. Section 09 91 00, Painting.
   4. Section 40 05 93, Common Motor Requirements for Process Equipment.
   5. Section 40 67 17, Process Control Panels and Enclosures.
   6. Section 40 78 00, Panel-Mounted Instruments and Devices.

1.2 REFERENCES

A. Standards referenced in this Section are listed below:
   1. American Bearing Manufacturers Association, (ABMA).
   2. American Gear Manufacturers Association, (AGMA).
   3. American Institute of Steel Construction, (AISI).
   4. American National Standards Institute, (ANSI).
      a. ANSI B16.1, Cast-Iron Pipe Flange and Flange Fittings.
      b. ANSI A21.10, Cast-Iron and Ductile Iron Fittings, 2 Thru 48-Inches.
   5. American Society of Testing Materials, (ASTM).
      a. ASTM A 536, Specification for Ductile Iron Castings.
   6. National Electrical Code, (NEC).
   7. National Electrical Manufacturers Association, (NEMA).
   8. Institute of Electrical and Electronic Engineers, (IEEE).

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications:
   1. Manufacturer shall have a minimum of five years experience producing substantially similar equipment and shall be able to show evidence of at least five installations in satisfactory operation for at least five years.

B. Component Supply and Compatibility:
   1. Obtain all equipment included in this Section, regardless of the component manufacturer, from a single inline grinder manufacturer.
   2. The inline grinder equipment manufacturer to review and approve or prepare all Shop Drawings and other submittals for all components furnished under this Section.
   3. All components shall be specifically constructed for the specified service conditions and shall be integrated into the overall assembly by the inline grinder equipment manufacturer.

1.4 SUBMITTALS

A. Action Submittals: Submit the following:
   1. Product Data:
      a. Manufacturer's literature, data sheets, fabrication, assembly and mounting drawings of the following components showing materials and significant dimensions in sufficient detail to demonstrate compliance with specified requirements.
         1. Materials of construction.
         2. Grinder Shafts and Cutting Elements:
            a) Diameter.
            b) Materials of construction.
            c) Seals.
         3. Grinder Gear Reducer:
            a) Materials of construction.
            b) Bearing ratings.
            c) Bearing life under maximum loading conditions.
         4. Grinder Motor:
            a) Horsepower.
            b) Rpm.
            c) Insulation and enclosure details.
            d) Efficiency at full, 3/4 and 1/2 load.
         5. Electrical Information:
            a) Wiring diagrams showing all electrical connections to the motor and controls.
            b) Drawings of control panels furnished in accordance with Section 40 61 13, Process Control System General Provisions.

6. Weight of the complete assembly.

B. Informational Submittals: Submit the following:
   1. Source Quality Control Submittals:
      a. Submit results of Grinder's Hydrostatic test.
      b. Submit results of required control panel shop tests.
   2. Site Quality Control Submittals:
      a. Submit a written report giving the results of the required field tests.
      b. Submit written report of the results of each visit by a manufacturer's serviceman, including purpose and time of visit, tasks performed and results obtained.

C. Closeout Submittals:
   1. Operation and Maintenance Manuals:
      a. Submit complete Installation, Operation and Maintenance Manuals, including, test reports, maintenance data and schedules, description of operation, and spare parts information.
      b. Furnish Operation and Maintenance Manuals in conformance with the requirements of Section 01 78 23, Operations and Maintenance Data.

D. Maintenance Material Submittals: Furnish the following:
   1. Spare Parts:
      a. Furnish all required spare parts as specified in Part 2 of this specification.
   2. Tools:
      a. Furnish all required special tools as specified in Part 2 of this specification.

1.5 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading:
   1. Deliver materials to the Site to ensure uninterrupted progress of the Work. Deliver anchor bolts and anchorage devices which are to be embedded in cast-in-place concrete in ample time to prevent delay of that Work.

B. Storage and Protection:
   1. Store materials to permit easy access for inspection and identification. Keep all material off the ground, using pallets, platforms, or other supports. Protect steel members and packaged materials from corrosion and deterioration.

C. Acceptance at Site:
   1. All boxes, crates and packages shall be inspected by CONTRACTOR upon delivery to the Site. CONTRACTOR shall notify ENGINEER, in writing, if any loss or damage exists to equipment or components. Replace loss and repair damage to new condition in accordance with manufacturer's instructions.

PART 2 - PRODUCTS

2.1 EQUIPMENT PERFORMANCE

A. General:
   1. All components shall be specifically designed for receiving brown grease from restaurant grease traps (FOG) from vacuum trucks or other carrier means under gravity or pressure. FOG material is viscous, corrosive and abrasive, with 2-7% Total Solids and pH 4-8.

B. Rock Trap
   1. Rock Trap shall reduce the velocity of the material and screen solids to separate non-biodegradable items (such as utensils, bolts, rocks), collect items in a removable basket and allow for batch rinsing of the collected debris, while allowing the biodegradable material to flow.
   2. Design parameters:
      a. Number of units: 01
      b. Maximum flowrate: 400gpm
      c. Working pressure/ design pressure: 15psig / 30psig
      d. Solids handling capacity: 1.1 ft^3
      e. Trap bar screen spacing: 1”
      f. Trap debris basket perforation size: 1/2”
      g. Trap nominal wash water requirement: 8 gpm (max) at 40 psig (min)

C. Inline Grinder
   1. Grinder will normally operate with a flooded suction. When operated manually, grinder could be subject to a less than full pipeline.
   2. Design parameters:
      a. Number of Units: 01
      b. Cutter configuration: 7 – tooth CAM
      c. Cutting Chamber Height, (in.): 12”
      d. Grinder cutter force at tooth-tip (min. peak), (lbs/hp):1,831
      e. Grinder nominal flange diameter (in.)/ drilling: 4” ANSI Class 125
      f. Motor, (Hp): 3 HP
      g. Capacity, (gpm): > 200gpm
      h. Operating Pressure, (psig): < 1psig
      i. Pressure Drop at Capacity: 2ft.

2.2 MANUFACTURERS

A. Products and Manufacturers:
   1. Rock Trap: Provide one of the following:
      a. JWC Environmental

b. Or equal.

2. Grinder: Provide one of the following:
   a. JWC Environmental
   b. Or equal.

2.3 DETAILS OF CONSTRUCTION

A. Rock Trap Materials and Construction: The heavy object trap shall include cylindrical tank with feet, sealable cover with handle, inlet and outlet flanges for primary flow, removable bar screen elements, integral rinse water manifold, water supply inlet with valve and liquid drain with valve.
   1. Tank shall be cylindrical of diameter, built in Stainless Steel. Tank shall have a false bottom to distribute wash water to spray nozzle piping.
   2. Tank shall be fitted with a full-diameter flange allowing access to the bar screen, debris basket and collected debris.
   3. Lid shall be sealed to tank flange with a suitable sealing ring, compressed in place using a series of compression knobs. Tank design shall accommodate design working pressure and maximum pressure as identified in the Design Parameters.
   4. Bar screen shall be removable to permit access to debris basket and collected debris. Bars shall be of suitable profile and orientation to reduce liquid velocity to below 1 ft/s (0.3 m/s) based on rated tank capacity.
   5. Solids collection basket shall be designed to maximize the volume of material collected in the tank. Sides and bottom of basket shall be fabricated of perforated plate of 14 gauge minimum thickness. Basket shall be fitted with handle(s) to allow for safe and controlled removal of the basket and collected debris.
   6. Tank shall incorporate a water inlet with ¾” water manual control valve, ball type, in Stainless Steel.
   7. Two (2) spray nozzles of flat type shall direct wash water to the bar screen.
   8. Tank bottom shall be fitted with a liquid drain and 2” bronze ball valve as identified in Performance Requirements.

B. Grinder Materials and Construction:
   1. Housing:
      a. Inline grinder casing shall be of A536-84 ductile iron designed to resist corrosion due to cavitation and galvanic action. Each grinder shall be arranged for inline installation as shown. Housing shall have standard 125-pound ANSI B16.1 inlet and outlet connections. Provide two gasketed cleanout and inspection handholes with covers to facilitate cleaning and inspection of the cutting mechanism.
      b. Each inline grinder shall have a rated working pressure of 30 psig.
   2. Grinder Shafts and Cuttings Elements:

a. The two inline grinder shafts shall counter rotate and be equipped with spacers and intermeshing 7-tooth cutters. The shafts shall rotate at non-synchronous speeds, one at 40 rpm and one at 60 rpm maximum. The shafts shall be of hexagonal shape constructed of AISI-4140 steel hardened to Rockwell C38 - C42. The cutters and spacers shall be cast from 8620 steel hardened to Rockwell C45 - C50. Cutters shall be 7-tooth cam design. The spacers and cutters shall be secured to the shaft in a manner that they cannot be loosened due to torque resulting from either direction.

3. Seals:
   a. Seal system shall consist of a layrinth seal and a mechanical seal. Seals shall be easily replaceable and shall not require an external water source.
4. Drive Unit Assembly:
   a. Drive unit assembly shall have a speed reducer and electric motor connected by a flexible shaft coupling.
   b. Drive unit shall conform to AGMA rating and specification for moderate shock, 24 hour, full load operation with a service factor of 1.15.
   c. Speed reducer shall be of the epicycloidal or planetary type enclosed in a weatherproof casing.
   d. Speed reducer moving parts shall be immersed in oil, and bearings shall be anti-friction throughout. Casing shall be provided with inspection covers, oil fill, and drain connections and means for inspection of oil flow. Inspection, oil fill and drain covers shall be chained to the casing.
5. Bearings and Seals:
   a. Bearings and seals shall be housed in a replaceable cartridge that supports and aligns the bearings and seals. Seals shall require no external water source, or any lubrication. The mechanical seal shall be rated at 90 psig continuous duty.
   b. The radial and axial loads of the shaft shall be supported by heavy-duty sealed deep-groove ball type bearings.
   c. The bearings shall be protected by a combination of tortuous path device and end face mechanical seals.
   d. O-rings shall be used for sealing between the seal faces and the cartridge components, as well as between each cartridge and the corresponding shaft and housing. O-rings shall be of BUNA-N material.
7. Supports:
   a. Lifting hooks shall be provided to facilitate the handling of equipment. Necessary supports shall be provided in place at the centerline elevations as shown.

C. Grinder Drive Unit:
   1. Drive unit shall be an electric motorized gear-reducing unit. Each motor-reducing unit shall be as a single unit with flanged connection to the grinder casing. The motor shall be directly connected to a epicycloidal type gear reduction unit.

2. Drive unit shall conform to AGMA rating and specification for 500% shock, 24-hour, full-load operation with a service factor of 1.15. Each unit shall bear an AGMA rating plate.
3. Unit shall be a minimum of 85 percent efficient and achieve a reduction ratio of 29:1 with a 1,725 rpm motor.

D. Grinder Motor:
1. Motors shall conform to the requirements of Section 40 05 93, Common Motor Requirements for Process Equipment.
2. Motors shall be a totally enclosed fan cooled (TEFC) motor with Class B insulation, with a maximum speed of 1,800 rpm.
3. Motors shall be suitable for operation on 480 volt, 3 phase 60 Hz power.
4. Provide space heaters, 120 volt, single phase.
5. Motors shall have a 1.15 service factor, and shall comply with the latest ANSI, NEMA, ABMA and IEEE Standards as a minimum.
6. Locked rotor current shall be as specified in NEMA standards.
7. Motor terminal boxes shall be oversized to provide adequate space for connections and shall be constructed of cast-iron or fabricated steel, neoprene gasketed and bolted. The motor leads shall be permanently marked in agreement with the connection diagram.
8. Motor shall be provided with normally closed over-temperature thermostat in the motor windings.

E. Control Panel:
1. General:
   a. Furnish a control panel for the inline grinder to be installed as indicated on the Plans.
   b. Panel construction shall be Type 4X with 316 Stainless Steel enclosure and shall conform to the applicable requirements of Section 40 67 17, Process Control Panels and Enclosures.
   c. Factory test control panel prior to shipment.
   d. Furnish a 480 volt, 3 phase, 60 Hz power feeder to the control panel. Include a main breaker and through door disconnecting means, control power transformer for 120 volt control.
   e. Panel shall contain the following:
      1) Full voltage reversing motor starter. Solid state control logic shall be provided with fuse protection and shall shut down the motor and provide a fail alarm signal on motor/grinder overload, as specified below.
      2) Either relays or solid state Logic Controllers may be used to perform the specified functions. Should CONTRACTOR elect to use solid state logic controllers, provide a hand-held programming device and a copy of the programming.

3) When the ON/OFF selector switch in the ON position, the grinder immediately starts and runs until the selector switch is put in the OFF position. There is no automatic control from SCADA system.
4) Furnish panel with a jam sensing current transformer which shall sense high torque caused by grinder jam or overload. When this occurs, the grinder shall stop instantly, reverse its rotation to clear the obstruction, stop once again, and commence the forward or normal action. If the jam was cleared, the counting circuit shall reset after approximately 30 seconds. If the jam remains, the above procedure shall be repeated up to three times. After three cycles have occurred, the grinder shall shut down automatically and transmit a shutdown and alarm signal to a remote location.
5) Refer to the P&ID drawings for indicator lights and signals to be provided for remote monitoring. Remote signals shall be S.P.D.T. dry-contacts rated at 5A, 120 VAC.6) Panel shall have two 3/4-inch hubs at the top and one 3/4-inch hub at the bottom for conduit installation.
7) The inline grinder shall be configured to shutdown in the event a high-high level condition occurs in tank TNK-001. This will be a dry-contact input from LCP-LVL-001.
8) An emergency stop pushbutton shall be provided on the control panel to immediately shutdown the grinder.

2.4 ANCHOR BOLTS

A. Furnish adhesive anchor bolts and nuts of ample size and strength for the purpose intended, sized by the equipment manufacturers. Anchor bolt materials shall be of 316 stainless steel conforming to the requirements of Section 05 05 33, Anchor Systems.

2.5 TOOLS AND SPARE PARTS

A. Furnish and deliver the following for each size boxed and labeled:
   1. 100 percent replacement seals for one machine.
   2. 100 percent replacement cutters for one machine.
   3. 100 percent replacement gaskets for one machine.
   4. Two sets of any special tools required for normal operation and maintenance.

B. Spare parts shall be packed in sturdy containers with clear indelible identification markings and shall be stored in a dry, warm location until transferred to the OWNER at the conclusion of the Project.

C. Manufacturer shall furnish a list of additional recommended spare parts for an operating period of one year. The list shall describe each part, the quantity recommended, and the unit price of the part.

2.6 SURFACE PREPARATION AND PAINTING

A. Grinders, motors, frames, appurtenances, etc., shall receive shop primer conforming to the requirements of Section 09 91 00, Painting.

B. Surface preparation and painting shall conform to the requirements of Section 09 91 00, Painting.

C. All gears, bearing surfaces, machined surfaces and other surfaces which are to remain unpainted shall receive a heavy application of grease or other rust-resistant coating. This coating shall be maintained during storage and until the equipment is placed into operation.

D. CONTRACTOR shall certify, in writing, that the shop primer and finish coating system conforms to the requirements of Section 09 91 00, Painting.

2.7 LUBRICANTS

A. Furnish lubricants and oil and grease as required for initial operation. Products shall be as recommended by the manufacturer.

2.8 SOURCE QUALITY CONTROL

A. Shop Tests:
   1. Test each grinder hydrostatically for 30 minutes at 50 psig.

B. Visual Inspection: Verify that equipment complies with these Specifications and approved Shop Drawings.

C. Packing:
   1. Inspect prior to packing to assure that assemblies and components are complete and undamaged.
   2. Protect machined surfaces and mating connections.
   3. Protect bearings and gearing with a shop applied corrosion prevention coating.
   4. Cover all openings into gear boxes with vapor inhibiting and water repellent material.
   5. Adequately crate to prevent damage during shipment, delivery and storage.
   6. Identify crate contents on packing slip fastened to outside of crate.

PART 3 - EXECUTION

3.1 INSPECTION

A. CONTRACTOR shall verify that structures, pipes and equipment are compatible.

B. Make adjustment required to place system in proper operating condition.

3.2 INSTALLATION

A. Manufacturer's representative shall check and approve the installation prior to operation. Manufacturer's representative shall field test and calibrate the equipment to assure that the system operates to the OWNER'S satisfaction.

3.3 FIELD QUALITY CONTROL

A. All equipment will be given running tests by CONTRACTOR at the Site following installation of the equipment and controls. Should the tests indicate any malfunction, CONTRACTOR shall make any necessary repairs and adjustments. Such tests and adjustments shall be repeated until, in the opinion of the ENGINEER, the installation is complete and the equipment is functioning properly and accurately and is ready for permanent operation.
   1. Grinder and rock trap shall be tested with FOG to be provided by the OWNER. CONTRACTOR to coordinate with the OWNER and the ENGINEER to schedule FOG receiving to the site and pump testing.

B. A factory trained representative shall be provided for installation supervision, start-up and test services and operation and maintenance personnel training services. The representative shall make a minimum of 02 visits, minimum 04 hours on-Site per visit. Visit shall be for checking the completed installation, start-up and training of the system. Manufacturer’s representative shall test operate the system in the presence of the ENGINEER and verify that the equipment conforms to the requirements. Representative shall revisit the Site as often as necessary until all trouble is corrected and the installation is entirely satisfactory.

D. All costs, including travel, lodging, meals and incidentals, for additional visits shall be at no additional cost to the OWNER.

+ + END OF SECTION + +